CITY OF OAKLAND

2021 – 2026 Hazard Mitigation Plan

Agency Review Draft

TETRA TECH

APRIL 2021

City of Oakland 2021 – 2026 Hazard Mitigation Plan

April 2021

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Other Agency Support

- Todd Becker, California Governor's Office of Emergency Services (analysis of the tsunami hazard)

Special Acknowledgements

Development of this plan would not have been possible without the commitment of the City of Oakland Hazard Mitigation Plan Steering Committee. The dedication of this committee's members to allocate their time to developing the plan is greatly appreciated. Residents of Oakland are also commended for their participation in the outreach strategy identified by the Steering Committee. This outreach will set the course to successful implementation of this plan during its next performance period. Further, the City Oakland commits to continuing this outreach and building on the work performed during the development of this plan as it prepares to undertake a comprehensive update to its Safety Element of the General Plan and additional General Plan updates.

DEFINITIONS/ACRONYMS

0.2 percent-annual-chance flood—The flood that has a 0.2 percent chance of being equaled or exceeded in any given year; often referred to as the 500-year flood

1 percent-annual-chance flood—The flood that has a 1 percent chance of being equaled or exceeded in any given year; often referred to as the 100-year flood

AB—Assembly Bill

active shooter—A criminal attempt to kill people in a confined and populated area.

ADA—Americans with Disabilities Act

ARkStorm—Theoretical west coast mega-storm scenario developed by the U.S. Geological Survey; The name indicates "atmospheric river 1,000," as the storm was originally projected as a 1-in-1,000-year event

ART— Adapting to Rising Tides Program

ASDSO—Association of State Dam Safety Officials

asset—Any man-made or natural feature that has value, including people; buildings; infrastructure, such as bridges, roads, sewers, and water systems; lifelines, such as electricity and communication resources; and environmental, cultural, or recreational features such as parks, wetlands, and landmarks.

base flood—The flood having a 1% chance of being equaled or exceeded in any given year, also known as the "100-year" or "1 percent annual chance" flood. The base flood is a statistical concept used to ensure that all properties subject to the National Flood Insurance Program (NFIP) are protected to the same degree against flooding.

basin—The area within which all surface water—whether from rainfall, snowmelt, springs, or other sources—flows to a single water body or watercourse. The boundary of a river basin is defined by natural topography, such as hills, mountains, and ridges. Basins are also referred to as "watersheds."

benefit/cost analysis—A systematic, quantitative method of comparing projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

benefit—A net project outcome and is usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including reduction in expected property losses (buildings, contents, and functions) and protection of human life.

BRIC C&CB—Building Resilient Infrastructure and Communities grant program; Capability and Capacity-Building activities

CAL FIRE—California department of Forestry and Fire Protection

Cal OES—California Governor's Office of Emergency Services

Caltrans—California Department of Transportation

CAO—City Administrator's Office

capability assessment—An analysis of a community's capacity to address threats associated with hazards. The assessment includes two components: an inventory of an agency's mission, programs, and policies, and an analysis of its capacity to carry them out.

CCR—California Code of Regulations

CDBG-DR—Community Development Block Grant—Disaster Recovery

CDBG-MIT—Community Development Block Grant—Mitigation

CEQA—California Environmental Quality Act

CFR—Code of Federal Regulations

civil unrest—Civil unrest is an activity arising from a mass act of civil disobedience (such as a demonstration, riot, or strike) in which the participants become hostile toward authority, and authorities incur difficulties in maintaining public safety and order, over the disorderly crowds.

climate change—A change in global or regional climate patterns, in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels.

Community Rating System (CRS)—A voluntary program under the NFIP that rewards participating communities (provides incentives) for exceeding the minimum requirements of the NFIP and completing activities that reduce flood hazard risk by providing flood insurance premium discounts.

critical facilities—Facilities and infrastructure that are critical to the health and welfare of the population. These become especially important after any hazard event occurs.

CRS—Community Rating System

CWA—Clean Water Act

cyber-terrorism—An attempt to damage, disrupt, or gain unauthorized access to a computer, computer system or electronic communications network.

dam failure—An uncontrolled release of impounded water due to a partial or complete breach in a dam (or levee) that impacts its integrity.

dam—Any artificial barrier or controlling mechanism that can or does impound or divert water.

debris flow—Dense mixtures of water-saturated debris that move down-valley; looking and behaving much like flowing concrete. They form when loose masses of unconsolidated material are saturated, become unstable, and move down slope. The source of water varies but includes rainfall, melting snow or ice, and glacial outburst floods.

DFIRM—Digital Flood Insurance Rate Maps

DHCD—Department of Housing and Community Development (City of Oakland)

Disaster Mitigation Act (DMA; Public Law 106-390)—The latest federal legislation enacted to encourage and promote proactive, pre-disaster planning as a condition of receiving certain federal financial assistance.

DRE—Department for Race and Equity

drought—The cumulative impacts of long periods of dry weather. These can include deficiencies in surface and subsurface water supplies and general impacts on health, well-being, and quality of life.

DSOD—Division of Safety of Dams (California)

DWR—Department of Water Resources (California)

EAP—Emergency Action Plan

earthquake—The shaking of the ground caused by an abrupt shift of rock along a fracture in the earth or a contact zone between tectonic plates.

EBMUD—East Bay Municipal Utility District

ECAP—2030 Equitable Climate Action Plan

EMPG—Emergency Management Program Grant

EMSD—Emergency Management Services Division

EPA—U.S. Environmental Protection Agency

epidemic—The spread of an infectious disease beyond a local population, reaching people in a wider geographical area. Several factors determine whether an outbreak will become an epidemic: the ease with which the disease spreads from vectors, such as animals, to people, and the ease with which it spreads from person to person.

ESA—Endangered Species Act

exposure—Exposure is defined as the number and dollar value of assets considered to be at risk during the occurrence of a specific hazard.

extent—The extent is the size of an area affected by a hazard.

extreme cold—Temperatures from winter storms associated with freezing rain, sleet, snow and strong winds that may cause hypothermia or frostbite.

extreme heat—Temperatures that hover 10 ºF or more above the average high temperature for a region and last for several days.

extreme wind—A windstorm featuring violent winds, generally of short-duration involving straight-line winds or gusts over 50 mph, strong enough to cause property damage.

federal disaster declaration—Declarations for events that cause more damage than state and local governments and resources can handle without federal government assistance. A federal disaster declaration puts into motion long-term federal recovery programs, some of which are matched by state programs, to help disaster victims, businesses, and public entities.

FEMA—Federal Emergency Management Agency

FERC—Federal Energy Regulatory Commission

FHSZ—fire hazard severity zone

FIRM—Flood Insurance Rate Map

flash flood—A flash flood occurs with little or no warning when water levels rise at an extremely fast rate

Flood Insurance Rate Map (FIRM)—The official maps on which the Federal Emergency Management Agency delineate the Special Flood Hazard Area.

Flood Insurance Study—A report published by the Federal Insurance and Mitigation Administration for a community in conjunction with the community's Flood Insurance rate Map. The study contains such background data as the base flood discharges and water surface elevations that were used to prepare the FIRM. In most cases, a community FIRM with detailed mapping will have a corresponding flood insurance study.

floodplain—The land area along the sides of a river that becomes inundated with water during a flood.

flood—The inundation of normally dry land resulting from the rising and overflowing of a body of water.

FRA—Federal Responsibility Area (for fire protection services)

freeboard—The margin of safety added to the base flood elevation.

frequency—How often a hazard of specific magnitude, duration, and/or extent is expected to occur on average. Statistically, a hazard with a 100-year frequency is expected to occur about once every 100 years on average and has a 1 percent chance of occurring any given year. Frequency reliability varies depending on the type of hazard considered.

geographic information system (GIS)—A computer software application that relates data regarding physical and other features on the earth to a database for mapping and analysis.

GHAD—Geologic Hazards Abatement District

GIS—Geographic Information System

goal—A general guideline that explains what is to be achieved. Goals are usually broad-based, long-term, policy-type statements and represent global visions. Goals help define the benefits that a plan is trying to achieve. The success of a hazard mitigation plan is measured by the degree to which its goals have been met (that is, by the actual benefits in terms of actual hazard mitigation).

greenhouse gases—Methane, nitrous oxide and other gases that trap heat and warm the Earth, as a greenhouse traps heat from the sun.

ground shaking—The result of rapid ground acceleration caused by seismic waves passing beneath buildings, roads, and other structures.

GSI—Green stormwater infrastructure

hazard—A source of potential danger or adverse condition that could harm people and/or cause property damage.

hazardous material—A substance or combination of substances (biological, chemical, radiological, and/or physical) that, because of its quantity, concentration, or physical, chemical or infectious characteristics, has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors.

Hazards U.S. Multi-Hazard Loss Estimation Program (Hazus)—A GIS-based program used to support the development of risk assessments as required under the DMA. The Hazus software program assesses risk in a quantitative manner to estimate damage and losses associated with natural hazards.

Hazus—Hazards, United States

high occupancy fire—A fire that occurs in a building categorized as "high occupancy," such as an office or hotel, that yields a higher population per square-foot than non-high occupancy uses, and requires additional response equipment and staffing.

high-hazard dam—Dams that can cause loss of human life from the failure or improper operation of the dam.

HMA—Hazard Mitigation Assistance

HSGP—Homeland Security Grant Program

intensity—The measure of the effects of a hazard.

inventory—The assets identified in a study region comprise an inventory. Inventories include assets that could be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

IPCC—Intergovernmental Panel on Climate Change

liquefaction— Loosely packed, water-logged sediments losing their strength in response to strong shaking, causing major damage during earthquakes.

local government—Any county, municipality, city, town, township, public authority, school district, special district, intrastate district, council of governments (regardless of whether the council of governments is incorporated as a nonprofit corporation under State law), regional or interstate government entity, or agency or instrumentality of a local government; any Indian tribe or authorized tribal organization, or Alaska Native village or organization; and any rural community, unincorporated town or village, or other public entity.

LRA—Local Responsibility Area (for fire protection services)

magnitude—The measure of the strength of an earthquake.

meteorological drought—Precipitation at levels below normal over a period of time. Meteorological measurements are the first indicators of drought and are usually region-specific.

mitigation actions—Specific actions to achieve goals and objectives that minimize the effects from a disaster and reduce the loss of life and property.

mitigation—A preventive action taken in advance of an event to reduce or eliminate risk to life or property.

mph—Miles per hour

Mw—Moment Magnitude Scale

NASA—National Aeronautics and Space Administration

NCEI—National Centers for Environmental Information

NEHRP—National Earthquake Hazards Reduction Program

NFIP—National Flood Insurance Program

NID—National Inventory of Dams

NIMS—National Incident Management System

NOAA—National Oceanic and Atmospheric Administration

NSSL—National Severe Storms Laboratory

NWS—National Weather Service

objective—A short-term aim that, when combined with other objectives, forms a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

OCOO—Oakland Code of Ordinances

OPW—Oakland Public Works

pandemic—An epidemic of infectious disease that has spread through human populations across a large region, multiple continents, or worldwide.

PBD—Planning and Building Department

peak ground acceleration (PGA)—A measure of the highest amplitude of ground shaking that accompanies an earthquake, based on a percentage of the force of gravity.

PGA—peak ground acceleration

preparedness—Actions that strengthen the capability of government, residents, and communities to respond to disasters.

probability of occurrence—A statistical measure or estimate of the likelihood that a hazard will occur. This probability is generally based on past hazard events in the area and a forecast of events that could occur in the future. A probability factor based on yearly values of occurrence is used to estimate probability of occurrence.

PSPS—Public Safety Power Shutoff event

radiological incidents—An incident involving radioactive materials that can occur wherever radioactive materials are used, stored, or transported.

repetitive loss property—Any NFIP-insured property that, since 1978 and regardless of any changes of ownership during that period, has experienced—Four or more paid flood losses in excess of $1000.00; or two paid flood losses in excess of $1000.00 within any 10-year period since 1978; or three or more paid losses that equal or exceed the current value of the insured property.

risk assessment—The process of measuring potential loss of life, personal injury, economic injury, and property damage resulting from hazards. This process assesses the vulnerability of people, buildings, and infrastructure to hazards

risk ranking—Process to score and rank hazards based on the probability that they will occur and the impact they will have if they do.

risk—The estimated impact that a hazard would have on people, services, facilities, and structures in a community. Risk measures the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate, or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

riverine—Of or produced by a river. Riverine floodplains have readily identifiable channels.

Robert T. Stafford Act—The statutory authority for most federal disaster response activities, especially as they pertain to FEMA and its programs (Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107). Signed into law November 23, 1988; amended by the Disaster Relief Act of 1974 (Public Law 93-288).

SEMS—Standardized Emergency Management Systems

SFHA—Special Flood Hazard Area

significant-hazard dam—Dams that can cause economic loss, environmental damage or disruption of lifeline facilities, or can impact other concerns, but not necessarily loss of life.

special flood hazard area—The base floodplain delineated on a Flood Insurance Rate Map. The SFHA is mapped as a Zone A in riverine situations and zone V in coastal situations. The SFHA may or may not encompass all of a community's flood problems

SRA—State Responsibility Area (for fire protection services)

stakeholder—Business leaders, civic groups, academia, non-profit organizations, major employers, managers of critical facilities, farmers, developers, special purpose districts, and others whose actions could impact hazard mitigation.

terrorism—The unlawful use or threatened use of force or violence against people or property with the intention of intimidating or coercing societies or governments. Terrorism is either foreign or domestic, depending on the origin, base, and objectives of the terrorist or organization.

thunderstorm—A storm with lightning and thunder produced by cumulonimbus clouds. Thunderstorms usually produce gusty winds, heavy rains, and sometimes hail. Thunderstorms are usually short in duration (seldom more than 2 hours).

tornado—A violently rotating column of air extending between and in contact with a cloud and the surface of the earth. Tornadoes are often (but not always) visible as funnel clouds.

TSD—Transportation Services Division (City of Oakland)

urban fire—A fire that can rapidly spread to adjoining structures and damage or destroy large commercial buildings, apartment complexes, and other living or business facilities**.**

USDM—U.S. Drought Monitor

USGS—U.S. Geological Survey

vulnerability—Assessment of how exposed or susceptible an asset is to damage. Vulnerability depends on an asset's construction, contents, and the economic value of its functions.

WSM—Watershed & Stormwater Management

watershed—An area that drains downgradient from areas of higher land to areas of lower land to the lowest point.

windstorm—Generally short-duration events involving straight-line winds or gusts exceeding 50 mph. These gusts can produce winds of sufficient strength to cause property damage.

WUI—Wildland-urban interface

zoning ordinance—Ordinance that designates allowable land use and intensities for a local jurisdiction.

EXECUTIVE SUMMARY

HAZARD MITIGATION OVERVIEW

Hazard mitigation is the use of long-term and short-term policies, programs, projects, and other activities to alleviate the death, injury, and property damage that can result from a disaster. The City of Oakland has developed a hazard mitigation plan to reduce risks from disasters to the people, property, economy, and environment within the city. The plan complies with federal and state hazard mitigation planning requirements to establish eligibility for funding under Federal Emergency Management Agency (FEMA) grant programs.

PLAN DEVELOPMENT APPROACH

The *City of Oakland 2021 – 2026 Hazard Mitigation Plan* is an update of the previous hazard mitigation plan the City adopted in 2016. The Oakland Fire Department's Emergency Management Services Division managed the project and will oversee its implementation and revisions. The planning area for the hazard mitigation plan was defined as the incorporated area of the City of Oakland.

A core planning team facilitated the development of this plan, consisting of staff from several departments of the City of Oakland and a contract consultant. A 22-member steering committee of mostly City staff oversaw the plan development. Coordination with other local, state, and federal agencies involved in hazard mitigation occurred throughout the planning process. The planning team and Steering Committee reviewed the City's previous hazard mitigation plan (the *2016-2021 Local Hazard Mitigation Plan*), the 2018 *State of California Multi-Hazard Mitigation Plan*, and existing programs that may support hazard mitigation actions.

The planning team implemented a multi-media public involvement strategy that was approved by the Steering Committee. This plan was drafted during the COVID-19 pandemic, limiting in-person public outreach events, and under an expedited project timeline. Public outreach efforts included a hazard mitigation survey, town hall meetings, a project website, the use of social media, and distribution of city-wide newsletters.

Based on the review of existing plans and programs, the input received through the public involvement strategy, the direction of the Steering Committee, and the findings of a new, detailed risk assessment, this hazard mitigation plan meets federal hazard mitigation planning requirements. Once pre-adoption approval of the document is granted by the California Governor's Office of Emergency Services and FEMA Region IX, the City of Oakland City Council will formally adopt the plan.

RISK ASSESSMENT

Risk assessment is the process of measuring the potential loss of life resulting from hazards, as well as personal injury, property damage and environmental damage. The assessment determines a community's overall vulnerability to hazard events. The Steering Committee used the risk assessment to gauge the potential impacts of each natural hazard of concern in the planning area.

For this plan, risk assessment models for natural hazards were enhanced with data and technologies that were not used in the previous plan. The assessment of each hazard of concern includes discussion of the following:

- Hazard identification and profile
- The impact of hazards on the population, property, and the environment
- Specific areas of vulnerability
- The estimated cost of potential damage, where applicable.

RISK RANKING

Based on the risk assessment, natural hazards were ranked for the risk they pose to the overall planning area as shown in Figure ES-1. Non-natural hazards were also included in the risk assessment, but risk was not ranked for these hazards.

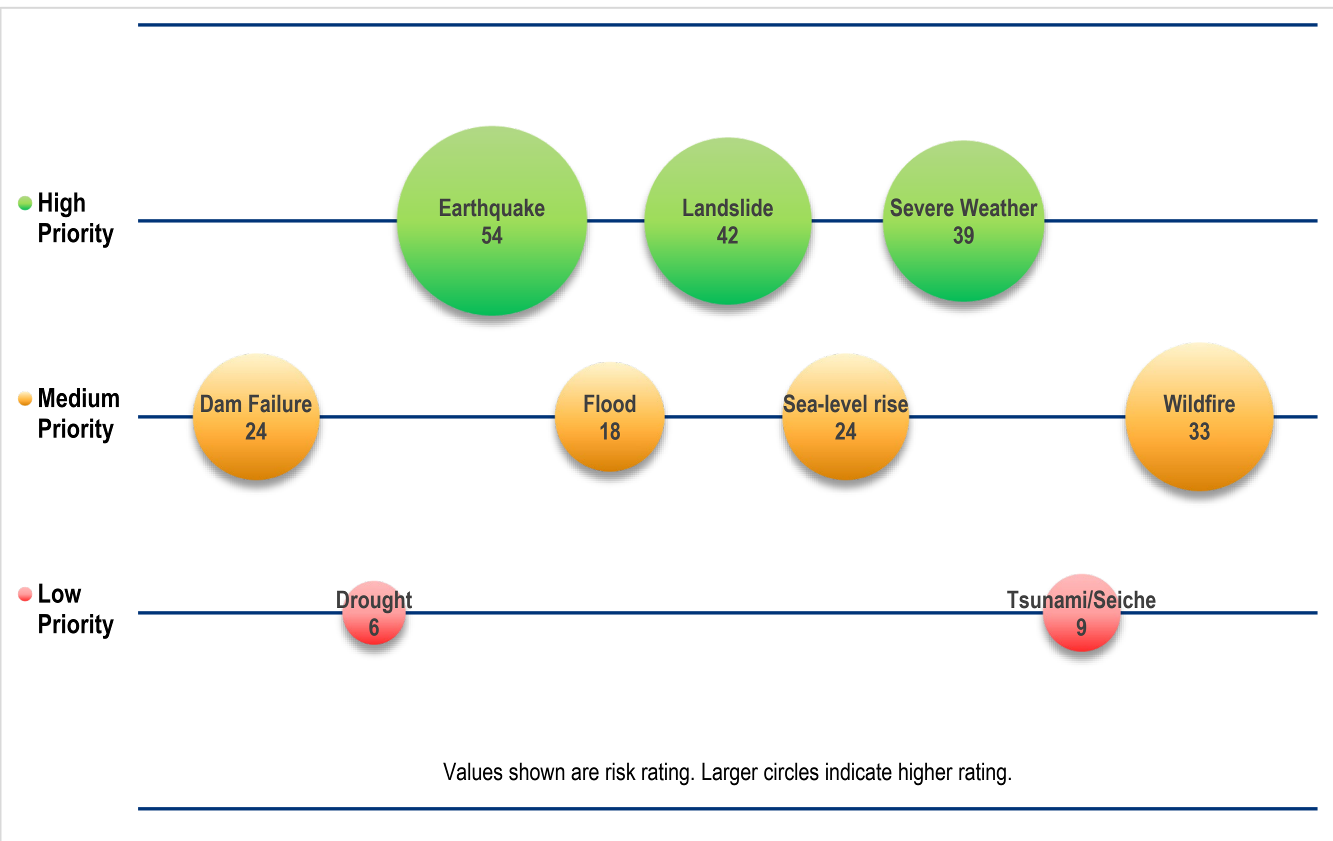


Figure ES-1. Hazard Risk Ranking

MISSION STATEMENT, GOALS, AND OBJECTIVES

The City's 2016 hazard mitigation plan did not include a mission statement. The Steering Committee determined the need for a mission statement for the current plan, reviewed several example mission statements, and approved the following as the statement through consensus of the Steering Committee members:

> To equitably reduce risk and increase resilience, the mission of the City of Oakland local hazard mitigation plan is to establish and promote a comprehensive mitigation strategy and efforts to protect the whole community and environment from identified natural and manmade hazards.

The Steering Committee determined the following goals for the updated hazard mitigation plan:

1. Protect life, property, the environment, and natural and cultural resources.
2. Increase public awareness of and the prevention and preparedness for risks.
3. Coordinate with other programs that can support or enhance hazard mitigation.
4. Increase the effectiveness of emergency services provided to the City.
5. Pursue feasible, cost-effective, and environmentally sound hazard mitigation measures.
6. Increase adaptive capacity to reduce risk from hazard impacts based on a changing climate.
7. Reduce racial disparities in how communities prepare for, respond to, and recover from local hazards.

The Steering Committee identified the following objectives for the current hazard mitigation plan:

1. Reduce repetitive losses due to flood, fire, and earthquake by informing land use, design, and construction policies.
2. Identify natural and manmade hazards that threaten life and property in the City.
3. Use best available hazard data while reviewing proposed development opportunities.
4. Encourage the incorporation of hazard mitigation measures into repairs, major alterations, new development, and redevelopment practices, especially in areas subject to substantial hazard risk.
5. Encourage and support leadership within the private sector, non-profit agencies, and community-based organizations to promote and implement local hazard mitigation activities.
6. Incorporate risk reduction considerations in new and updated infrastructure and development plans to reduce the impacts of hazards.
7. Continue providing City emergency services staff with training and equipment to address all identified hazards.
8. Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private sector and nonprofit groups.
9. Establish and maintain partnerships among all levels of government, private sector, community groups, and institutions of higher learning that improve and implement methods to protect life and property.
10. Create financial and regulatory incentives to motivate stakeholders such as homeowners, private sector businesses, and nonprofit community organizations to mitigate hazards and risk.
11. Continue developing and strengthening inter-jurisdictional coordination and cooperation in the area of emergency services.

12. Support the protection of vital records, and strengthen or replace buildings, infrastructure, and lifelines to minimize post-disaster disruption and facilitate short-term and long-term recovery.
13. Coordinate state and local efforts to reduce greenhouse gas emissions and implement climate action strategies through hazard mitigation plans and actions.
14. Implement hazard mitigation programs and projects that protect life, property, and the environment.
15. Promote and implement hazard mitigation plans and projects that are consistent with state, regional and local climate adaptation goals, policies, and programs.
16. Advance community resilience through preparation, adoption, and implementation of state, regional, and local multi-hazard mitigation plans and projects.
17. Prioritize vulnerable populations in policy responses, including but not limited to, low-income individuals and families; people of color; the young; the elderly; people with disabilities; people with existing health issues; and people with limited English proficiency.

MITIGATION ACTION PLAN

Mitigation actions presented in this plan are designed to reduce or eliminate losses resulting from hazard events. The development process resulted in the identification of 18 mitigation actions. Many of these actions are within the current capabilities of the City of Oakland, resulting in a high priority for implementation over the next five years. Table ES-1 summarizes the actions and their priority for implementation and for seeking grant funding.

IMPLEMENTATION AND MAINTENANCE

Plan implementation will occur over the next five years as City departments begin to implement the actions identified in this plan. Full implementation of the recommendations will require time and resources. The measure of the plan's success will be its ability to adapt to changing conditions. The framework established by this plan prioritizes actions whose benefits exceed their cost.

The Steering Committee developed a plan maintenance strategy that includes annual progress reporting, a strategy for continued public involvement, a commitment to plan integration with other relevant plans and programs, and continued oversight from a plan maintenance steering committee.

Table ES-1. Mitigation Action Plan

Action Number and Description	Priority for Implementation	Priority for Pursuing Grants
O-1: Safer Housing for Oakland: Soft Story Apartment Retrofit Program	Medium	High
O-2: Continue the Earthquake Safe Homes Program	Medium	High
O-3: Green Stormwater Infrastructure Program	Medium	High
O-4: Identify stormwater infrastructure projects that would be good projects for which to pursue funding under FEMA Hazard Mitigation Assistance grant programs	Medium	High
O-5: Defensible Space Vegetation Program to manage wildfire hazards; preparation of a Vegetation Management Plan	High	Medium
O-6: Continuity of Operations Emergency Planning	High	Medium
O-7: Implement the City's Energy Assurance Plan	Medium	N/A
O-8: Assessment and retrofits of critical facilities & infrastructure	Medium	High
O-9: Continue to maintain the City's good standing and compliance under the National Flood Insurance Program	High	N/A
O-10: Create a comprehensive master plan for three city facilities to reliably serve as resilience hubs	Medium	High
O-11: Develop an "integrated preparedness plan" that will consider the range of preparedness activities within the Integrated Preparedness Cycle	High	Medium
O-12: To support implementation of and future updates to the City's local hazard mitigation plan, Safety Element, and Environmental Just Element, use the best available local data to identify racial disparities in the City of Oakland	High	High
O-13: Maritime Terminal Study on Liquefaction Potential	Medium	High
O-14: Middle Harbor Shoreline Park dike repair	High	Medium
O-15: Maritime Intelligent Transportation System	High	N/A
O-16: Maritime Area Seismic Monitors	Medium	High
O-17: Sea-Level Rise Vulnerability and Assessment Improvement Plan	Medium	High
O-18: Tree Planning.	High	Medium
O-19: Reestablish Full Compliance and Good Standing Under the NFIP	High	N/A
O-20: Update Sea Level Rise Road Map	High	N/A
O-21: Vulnerability Assessment and Adaptation Plan	High	Medium

City of Oakland 2021 – 2026 Hazard Mitigation Plan

PART 1—PLANNING PROCESS AND COMMUNITY PROFILE

1. INTRODUCTION TO HAZARD MITIGATION PLANNING

1.1 WHY PREPARE THIS PLAN?

1.1.1 The Big Picture

Hazard mitigation is defined as any action taken to reduce or alleviate the loss of life, personal injury, and property damage that can result from a disaster. It involves long- and short-term actions implemented before, during and after disasters. Hazard mitigation activities include planning efforts, policy changes, programs, studies, improvement projects, and other steps to reduce the impacts of hazards.

For many years, federal disaster funding focused on relief and recovery after disasters occurred, with limited funding for hazard mitigation planning in advance. The Disaster Mitigation Act (DMA; Public Law 106-390), passed in 2000, shifted the federal emphasis toward planning for disasters before they occur. The DMA requires state and local governments to develop hazard mitigation plans as a condition for certain federal hazard mitigation grant programs. It is also a DMA requirement that hazard mitigation plans be regularly updated. Regulations developed to fulfill the DMA's requirements are included in Title 44 of the Code of Federal Regulations (44 CFR).

The responsibility for hazard mitigation lies with many, including private property owners, commercial interests, and local, state, and federal governments. The DMA encourages cooperation among state and local authorities in pre-disaster planning. The enhanced planning network called for by the DMA helps local government articulate accurate needs for mitigation, resulting in faster allocation of funding and more cost-effective risk-reduction projects.

The DMA also promotes sustainability in hazard mitigation. To be sustainable, hazard mitigation needs to incorporate sound management of natural resources and address hazards and mitigation in the largest possible social and economic context.

1.1.2 Purposes for Planning

The City of Oakland prepared this DMA-compliant hazard mitigation plan and will formally approve and adopt it following approval by the Federal Emergency Management Agency (FEMA). This plan identifies resources, information, and strategies for reducing risk from natural hazards. Elements and strategies in the plan were selected because they meet a program requirement and the intent of the City and its residents to mitigate hazards. The plan will help guide mitigation activities throughout the planning area. It was developed to meet the following needs:

- Meet or exceed program requirements specified under the DMA.

- Enable the City of Oakland to apply for federal grant funding to reduce hazard risk through mitigation.
- Fulfill state and federal requirements for hazard mitigation planning.
- Create a risk assessment that focuses on the hazards of concern in Oakland.
- Coordinate existing plans and programs so that high-priority projects to mitigate potential disaster impacts are funded and implemented.
- Act as an implementation annex for the Safety Element of the City's General Plan.
- Develop hazard and risk information that will inform the process for the City's upcoming comprehensive General Plan update, including updates to the Safety Element and Housing Element and a new Environmental Justice Element.

1.2 WHO WILL BENEFIT FROM THIS PLAN?

All residents, businesses and employees of the City of Oakland are the beneficiaries of this hazard mitigation plan. The plan reduces risk for those who live in, work in, and visit the City. It provides a viable planning framework for all foreseeable natural hazards. Participation in development of the plan by key stakeholders helped to ensure that the outcomes will be mutually beneficial. The plan's goals and recommendations lay groundwork for the development and implementation of local mitigation activities and partnerships.

1.3 FOCUS ON EQUITY

1.3.1 The City of Oakland's Equity Goals

Social equity is critical in promoting healthy and diverse communities. Oakland has a long history of activism around issues of inequity and social justice. The City was chosen in 2017 to be among the first cohort of five cities to develop local equity indicator tools in partnership with the City University of New York's Institute for State and Local Governance, with funding from the Rockefeller Foundation. The project began as a joint effort between the Resilient Oakland Office and the Department of Race and Equity. It has resulted in a framework that has been adopted across several departments as the City strives to advance equity by using strategies determined through an intentional focus on racial and ethnic disparities and their root causes.

The City of Oakland defines equity as fairness. It means that identity—such as race, ethnicity, gender, age, disability, sexual orientation, or expression—has no detrimental effect on the distribution of resources, opportunities, and outcomes for the City's residents. Oakland's *Equity Indicators Report* presents a baseline quantitative framework that can be used by City staff and community members to better understand the impacts of race, measure inequities, and track changes in the disparities for different groups over time. This framework can then be used to guide and inform policies that address these disparities.

1.3.2 Addressing Equity in Hazard Mitigation

The planning process for this hazard mitigation plan was designed to stimulate better, more effective, sustainable and vital connections between stakeholders, toward the common objective of mitigating hazard risks to the community. The plan emphasizes equity in order to empower the City's most vulnerable people to play a role in building resilience. This is referred to as the application of an equity lens, which is defined as a critical thinking approach to undoing institutional and structural biases by evaluating burdens, benefits, and outcomes on underserved communities. An equity lens was developed and applied throughout the public outreach process, in the evaluation of risk, and in the development of mitigation actions.

Through this broad engagement and focus on equity, the City seeks to reduce vulnerability to natural hazards for all communities so that the benefits of hazard mitigation, such as the following, can be shared by all:

- A faster recovery and return to normal life for neighborhoods after a hazard event
- Reduced stress on emergency responders and social services
- A faster return to work for workers after a hazard event, resulting in less economic disruption and fewer businesses closing
- Maintenance of the culture, diversity, and distinct neighborhoods of the City

The planning process sought to identify specific needs for targeted mitigation actions that can overcome traditional barriers and challenges to equity. Such actions should achieve the following objectives:

- Minimize the impacts of hazard events so that they do not become disasters.
- Provide a better quality of life to all groups and members of the community.
- Build trust and networks that can be relied upon for other developmental activity.
- Promote overall sustainability and resilience.

The risk assessments and the action plan in this hazard mitigation plan aimed for equity by considering the diversity of communities in the City and each community's access to resources (including information, knowledge, and technology), social networks and connections, beliefs and customs, age, gender, race, health, and physical ability. The City will continue to apply an equity lens to address hazard mitigation through a proposed comprehensive update to the Safety Element of the City's General Plan, accompanied by the adoption of a new Environmental Justice Element.

1.4 CONTENTS OF THIS PLAN

This hazard mitigation plan is organized into three primary parts:

- Part 1—Planning Process and Community Profile
- Part 2—Risk Assessment
- Part 3—Mitigation Strategy

The following appendices provided at the end of the plan include information or explanations to support the main content of the plan:

- Appendix A—Public outreach information used in preparation of this plan
- Appendix B—Summary of federal and state regulations and programs pertinent to hazard mitigation
- Appendix C—Descriptions of the sources and methods used to generate hazard maps for this plan
- Appendix D—City of Oakland adopted conditions of permit approval related to natural hazards
- Appendix E—Detailed results by district from risk assessment analyses
- Appendix F—Status of recommended actions from previous hazard mitigation plan

- Appendix G—City of Oakland resolution adopting this hazard mitigation plan
- Appendix H—Template for preparing annual hazard mitigation plan progress reports

Each part of the plan includes elements required under federal guidelines. DMA requirements are cited at the beginning of subsections as appropriate to illustrate compliance.

2. PLAN UPDATE—WHAT HAS CHANGED

Preparation of the *2021 – 2026 Hazard Mitigation Plan* continues the hazard mitigation planning process that has been in place in the City of Oakland since the early 1970s, with the adoption of the first Seismic and Safety Elements to the City's General Plan. The City of Oakland is a leader in the regional discussion of hazards, hazards mitigation, and disaster recovery. The City was designated one of the first Disaster Resistant Communities in the United States, as well as one of the first "100 Resilient Cities."

This is the third update to the City of Oakland's initial 2006 hazard mitigation plan (previously updated in 2011 and 2016). Prior plan updates reconciled changes or enhancements made to the plan as required by FEMA for local hazard mitigation plan updates. This section reconciles changes and enhancements to the 2016 update.

2.1 THE 2016 PLAN

Oakland's 2016 hazard mitigation plan provided direction for reducing the potential for loss of life, property damage, and environmental degradation from natural disasters, while accelerating economic recovery from those disasters. Earthquakes, liquefaction, wildfire, floods, tsunami, extreme heat, drought, inundation from sea-level rise, and hazardous materials release were all studied for their potential effects on the City. The 2016 plan identified four main goals:

- Protect the health and safety of Oakland residents and others in the city by minimizing potential loss of life and injury caused by safety hazards.
- Safeguard Oakland's economic welfare by reducing potential property loss, damage to infrastructure, and social and economic dislocation and disruption resulting from safety hazards. Assist Oakland residents in recovering quickly from adversity and staying "rooted" in the City.
- Preserve Oakland's environmental quality by minimizing potential damage to natural resources from safety hazards. Improve public infrastructure to increase environmental and health benefits from the City's air, soil, and water.
- Ensure the Downtown Specific Plan (expected adoption in 2017-18) and all future specific plans and the Oakland General Plan updates include recognition of projected sea-level rise and other natural hazards; and include policies and goals that encourage future development projects to adapt to the predicted effects of climate change.

To develop the plan, City staff engaged Oakland residents at four community meetings and through an online survey, to hear their concerns and priorities for reducing risks from known hazards. The City convened a group of internal City staff in various departments, as well as outside agencies and districts, to update hazard risk profiles and prioritize mitigation measures. To address the impacts from the seven hazards that were assessed, the plan identified and prioritized 21 mitigation strategies across five categories:

- Building and Facility—2 actions
- Infrastructure—4 actions
- Fire Prevention—3 actions
- Emergency Planning and Preparation—5 actions
- Port of Oakland, Airport and Maritime Mitigations—7 actions

The previous plan is available online at https://cao-94612.s3.amazonaws.com/documents/oak058455.pdf .

2.2 WHY UPDATE?

2.2.1 Federal Eligibility

Title 44 of the Code of Federal Regulations (44 CFR) stipulates that hazard mitigation plans must present a schedule for monitoring, evaluating, and updating the plan. This provides an opportunity to reevaluate recommendations, monitor the impacts of actions that have been accomplished, and determine if there is a need to change the focus of mitigation strategies. The Robert T. Stafford Act requires that jurisdictions have current hazard mitigation plans to pursue and receive certain federal grant funding.

2.2.2 Changes in Development

Tracking previous and future growth in potential hazard areas provides an overview of increased exposure to hazards within a community. Hazard mitigation plan updates must be revised to reflect changes in development within the planning area during the previous performance period of the plan, as stated in 44 CFR Section 201.6(d)(3). The plan must describe changes in development in hazard-prone areas that increased or decreased vulnerability since the last plan was approved. If no changes in development impacted overall vulnerability, then plan updates may validate the information in the previously approved plan. The intent of this requirement is to ensure that the mitigation strategy continues to address the risk and vulnerability of existing and potential development and takes into consideration possible future conditions that could impact vulnerability.

According the California Office of Finance, the population of the City of Oakland increased by 3.3 percent during the performance period of the 2016-2021 plan. The total number of housing units increased by 2.5 percent for the same time frame, and the average number of persons per household held steady at 2.60. The vacancy rate decreased from 7.6 percent to 6.4 percent over the performance period. The change in demographics for household types over the performance period was as follows:

- Single Detached: +0.46 percent
- Single Attached: +1.23 percent
- 2 to 4 Units: +0.63 percent
- Five or More Units: +6.08 percent
- Mobile Homes: no change

The City has adopted a general plan that governs land-use decisions and policymaking, as well as a building code and specialty ordinances based on state and federal mandates. This hazard mitigation plan update assumes that some new development triggered by the increase in population occurred in hazard areas. All such new development would have been regulated pursuant to local programs and codes. Therefore, it is assumed that hazard vulnerability did not measurably increase even if exposure did. Any new development would have accounted for potential hazard impacts under codes and standards such as the International Building Code and flood damage prevention requirements of the National Flood Insurance Program (NFIP).

A comprehensive review of permitting since completion of the previous plan can help to identify recent development trend and anticipated future development. Table 2-1 summarizes development trends in the performance period since the preparation of the previous hazard mitigation plan, as well as expected future development trends.

Table 2-1. Recent and Expected Future Development Trends

<table>
<tr><th>Criterion</th><th>Response</th></tr>
<tr><td>Land annexed since last hazard mitigation plan</td><td>None.</td></tr>
<tr><td>Land targeted for annexation in next five years</td><td>None.</td></tr>
<tr><td>Areas targeted for development or major redevelopment in the next five years, and whether any of the areas interface with known hazard risk areas.</td><td>The City has an extensive list of development and redevelopment proposals throughout the City. These developments are highly likely to interface with one or more of the hazards assessed by this plan. The City's General Plan and Building Code provide the capacity to address the risk to these developments when they interface with a known hazard area</td></tr>
<tr><td>Number of permits for new construction issued in the City since the preparation of the previous hazard mitigation plan</td><td>
<table>
<tr><th></th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th></tr>
<tr><td>Single Family</td><td>90</td><td>165</td><td>239</td><td>357</td><td>343</td></tr>
<tr><td>Multi-Family</td><td>606</td><td>838</td><td>1,349</td><td>4,258</td><td>1,885</td></tr>
<tr><td>Other (commercial, mixed use, etc.)</td><td>—</td><td>1,109</td><td>2,457</td><td>—</td><td>—</td></tr>
<tr><td>Total</td><td>696</td><td>2,112</td><td>4,045</td><td>4,615</td><td>2,228</td></tr>
</table>
Notes:
Other (commercial, mixed-use, etc.) building permit types typically fall under the multifamily category. For 2015 and 2017, this data was disaggregated.
Single-family permits include single-family detached, townhomes, condos, and accessory dwelling units.
Multi-family permits are for structures with 2+ units
Data provided by the Bureau of Planning</td></tr>
<tr><td>Number of new construction permits for each hazard area (or qualitative description of where development has occurred).</td><td>The City currently does not track permit activity by known hazard areas, with the exception of new development proposals that occur within the FEMA-designated special flood hazard area, pursuant to the minimum requirements of the National Flood Insurance Program.</td></tr>
<tr><td>Level of buildout in the City, based on a buildable lands inventory.</td><td>Oakland does not have a buildable lands inventory</td></tr>
</table>

2.2.3 New Analysis Capabilities

The risk assessment for this updated hazard mitigation plan provides more detailed information than the previous plan on exposed population and building counts for each hazard of concern. It focuses on all property and populations in the City, unlike the previous plan's focus on critical facilities and special populations. This update also increases the level of detail in the loss estimate modeling for dam failure, earthquake, flood, and tsunami hazards—the estimates are presented at the community planning area level in addition to citywide findings. This enhanced risk assessment allows for a more detailed understanding of the City's risk associated with natural hazards.

2.3 THE UPDATED PLAN—WHAT IS DIFFERENT?

The City used the current update process to make significant changes to the format and content of the hazard mitigation plan. The plan was re-packaged in its entirety to improve readability and to better align with DMA requirements for hazard mitigation plans. A renewed effort was made to establish a plan maintenance and implementation protocol that clearly defines the City's commitment to the plan's ongoing success. Some of the major differences between the current and previous plans are as follows:

- A new mission statement and goals and objectives were identified for the updated plan to better align with existing City plans and programs and identified state priorities.
- The list of evaluated hazards was updated based on the most current community experience and concerns.
- A new review was conducted of existing plans and programs that are relevant for hazard mitigation.
- The risk assessment was updated using the best available data, including updated general building stock and critical facility databases.
- Discussion on existing land uses was included for each hazard of concern that has defined extents and locations.
- A new risk ranking protocol was employed to assist in establishing mitigation priorities.
- The protocol for prioritizing actions was updated and included a qualitative benefit-cost review.
- The strategy for plan maintenance and implementation was revised and updated to encourage greater coordination and planning for hazard mitigation funding opportunities.

Table 2-2 indicates the major changes between the two plans as they relate to 44 CFR planning requirements.

Table 2-2. Plan Changes Crosswalk

<table>
<tr><th>44 CFR Requirement</th><th>2016-2021 Plan</th><th>2021 Plan Update</th></tr>
<tr><td>§201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:
(1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval.
(2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and
(3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.</td><td>The focus of the 2016-2021 plan planning effort was to establish the hazard mitigation plan as an “implementation annex” to the safety element of the City’s General Plan. The City’s preparation of the 2016-2021 hazard mitigation plan included a review of all existing programs and strategies, identifying any gaps that may lead to disaster vulnerabilities, assimilation of complementary efforts, such as the Oakland Preliminary Resilience Assessment, and prioritization of existing and proposed mitigation measures. Four community workshops were held by the City prior to publication of a final public review document, allowing the pubic to contribute ideas and comments on the City’s priorities for hazard reduction. The City also released an online survey, which had 157 respondents.</td><td>Two groups played significant roles in the planning process for the 2021 plan update:
• A core planning team, made up of discipline leads from the City and technical consultant, made all milestone decisions on plan process and content.
• Those milestone decisions were vetted and validated through an oversite Steering Committee made up of City staff and outside stakeholders.
Both committees reviewed existing plans and programs that could support or enhance the outcomes from this plan and identified and participated in a robust public engagement strategy.</td></tr>
<tr><td>§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.</td><td>Included a qualitative risk assessment that looked at nine hazards of concern:
• Earthquakes
• Liquefaction
• Wildfire
• Floods
• Tsunami
• Extreme Heat
• Drought
• Inundation from Sea-level rise
• Hazardous materials release</td><td>A comprehensive risk assessment for the planning area that looks at nine hazards of concern: dam failure, drought, earthquake, flood, landslide, sea-level rise, severe weather, tsunami, and wildfire. This was a quantitative assessment that used the best available data and science with the Hazus (version 4.2) risk assessment software and geographic information system (GIS) analysis. Chapter 17 includes profiles for other hazards of interest to the City that were not fully assessed or ranked (hazardous materials, public health incidents, and terrorism).</td></tr>
<tr><td>§201.6(c)(2)(i): [The risk assessment shall include a] description of the … location and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.</td><td>The 2016-2021 plan includes qualitative discussion of each hazard of concern that meets the requirement as specified.</td><td>Comprehensive risk assessments of each hazard of concern are presented in Chapters 7 through 15. Each chapter includes the following:
• Hazard profile, including maps of extent and location, historical occurrences, frequency, severity, and warning time
• Secondary hazards
• Exposure of people, property, critical facilities, and the environment
• Vulnerability of people, property, critical facilities, and the environment
• Future trends in development
• Scenarios
• Issues
The hazards are compared to each other via a risk ranking methodology described in Chapter 18.</td></tr>
</table>

44 CFR Requirement	2016-2021 Plan	2021 Plan Update
§201.6(c)(2)(ii): [The risk assessment shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall summary of each hazard and its impact on the community.	Plan includes a qualitative assessment of each hazard profiled. No modeling was completed, most data referenced was from other plans and studies. Each hazard profiled discussed the probability and the impact of each hazard.	Vulnerability was assessed for all hazards of concern. The Hazus computer model was used for the dam failure, earthquake, flood, and tsunami hazards. These were Level-2 (user-defined) analyses using coordinating agency and local data. Critical facilities and assets were defined and inventoried using the Hazus Comprehensive Data Management System and other available datasets. Outputs were generated for other hazards by applying an estimated damage function to affected assets when available. The asset inventory was extracted from the Hazus model. Best available data were used for all analyses.
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods.	Section 5.1.4 of the plan addresses the six repetitive-loss properties that were in the City at the time of that update.	The description of the National Flood Insurance Program and repetitive loss discussion was enhanced to meet new DMA and CRS planning requirements. The update includes a comprehensive analysis of repetitive loss properties. For these properties, the type of structure was determined and causes of flooding were cited, and the information was reflected on maps. National Flood Insurance Program capability is also assessed.
§201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard area.	The vulnerability for each hazard profiled is discussed in terms of the area exposed. No numbers were provided for the types of general building stock or critical facilities. Maps were provided that illustrated the extent and location of each hazard.	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern. The steering committee defined "critical facilities" as they pertain to the planning area, and these facilities were inventoried by exposure. Each hazard chapter provides a discussion of future development trends as they pertain to the hazard.
§201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	No loss estimation was attempted by the 2016-2021 plan.	Dollar loss estimations were generated for all hazards of concern. These were generated by Hazus for the dam failure, earthquake, flood, and tsunami hazards. For the other hazards, loss estimates were generated by estimating loss as a percentage of exposed property value. The asset inventory was the same for all hazards and was generated in the Hazus model.
§201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land-use decisions.	The plan looks at the exposure of City urban land to the natural hazards studied using data provided by the Association of Bay Area Governments.	There is a discussion on future development trends as they pertain to each hazard of concern. This discussion looks predominantly at the existing land use and the current regulatory environment that dictates this land use.

44 CFR Requirement	2016-2021 Plan	2021 Plan Update
§201.6(c)(3): The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs, and resources, and its ability to expand on and improve these existing tools.	Chapter 6 of the plan includes a mitigation and adaptation strategy. This strategy is built upon four goals. The plan identifies and prioritizes 21 strategies.	An action plan was developed (Chapter 21) via a facilitated process that included: • Risk ranking • Capability assessment • Action alternative review • Action selection • Action prioritization • Action category analysis.
§201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.	Section 6.3 of the plan identifies four goals for the plan.	Chapter 19 identifies a mission statement, seven goals and 17 objectives. Objectives were selected that meet multiple goals, and actions were selected and prioritized based on meeting multiple objectives. All of these planning components were new for this plan update.
§201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.	The 21 actions identified were grouped into the following categories: • Building and facilities • Infrastructure • Fire prevention • Emergency planning and preparations • Port of Oakland – airport and maritime mitigations	A hazard mitigation catalog was developed from which recommended actions were selected. A table in the action plan section analyzes each action by mitigation type to illustrate the range of actions selected.
§201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	Section 5.1.4 discusses the City's participation in the NFIP and its status as of that planning effort. However, there is no discussion on the City's commitment to maintaining a complaint status under the NFIP.	Section 5.3.7 includes an assessment of capabilities related to NFIP requirements. The action plan in Chapter 21 includes actions supporting continued compliance and good standing under the program.
§201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.	The mitigation measures are grouped by priority—"High" and "Moderate." The City committed to analyzing the cost-benefit of each of the "High" priority actions and pursuing strategies that are the most cost effective . Grant-funded mitigation strategies were identified to be undertaken when the funding is secured.	Each of the recommended actions is prioritized using a qualitative methodology that looked at the objectives the project will meet, the timeline for completion, how the project will be funded, the impact of the project, the benefits of the project and the costs of the project. This prioritization scheme is detailed in Section 21.3.
§201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a 5-year cycle.	Chapter 7 included a plan maintenance protocol that committed the City to an annual review of the plan and quarterly oversight by the City's Disaster Council.	Chapter 22 includes a detailed plan maintenance strategy centered on an annual progress report by the City over the 5-year performance period of the plan. This is an entirely new strategy from the 2016-2021 plan.
§201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	Strategies for integrating the hazard mitigation plan into the City's general planning and capital facilities planning programs were identified.	The detailed plan maintenance strategy in Chapter 22 includes the following: • Annual review and progress reporting • Defined role for steering committee • Plan update triggers • Plan incorporation guidelines • Strategy for continuing public involvement • Grant coordination protocol.

44 CFR Requirement	2016-2021 Plan	2021 Plan Update
§201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	Section 7.2 of the plan identifies the City's website as the principle means for continued public access to the plan.	Chapter 22 details a comprehensive strategy for continuing public involvement
§201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the plan (e.g., City Council, County Commission, Tribal Council).	The plan does not include any proof of adoption.	Section 22.1 will include formal adoption and FEMA plan approval documentation once adopted by the City.

3. PLAN DEVELOPMENT APPROACH

3.1 CITY FUNDING

City general funds and a 2019 Urban Area Security Initiative Grant covered 100 percent of the cost of developing this hazard mitigation plan update. The Oakland Fire Department's Emergency Management Services Division (EMSD) administered the development of the plan.

3.2 FORMATION OF THE PLANNING TEAM

The City of Oakland contracted with Tetra Tech, Inc. to assist with development and implementation of the plan. The Tetra Tech project manager reported directly to the City of Oakland project manager. A core planning team was formed to lead the planning effort, made up of the members shown in Table 3-1. This core planning team coordinated regularly throughout the update process to track plan development milestones and to identify meeting content for a steering committee established to help with plan development.

Table 3-1. Core Planning Team Makeup

City of Oakland	
Jessica Feil, EMSD Manager, Oakland Fire Department	Christina Ferracane, Bureau of Planning
Angela Robinson Piñon, Planning and Building	Daniel Findley, Bureau of Planning
Kelly Nguyen, Oakland Fire Department EMSD	Daniel Hamilton, Office of Public Works
Alex McBride, City Administrator's Office	Ed Manasse, Bureau of Planning
Tetra Tech	
Rob Flaner, Project Manager	Jeana Wiser-Gomez, Public Outreach Lead
Bart Spencer, Lead Project Planner	Desmian Alexander, Planning Support
Carol Baumann, Risk Assessment Lead	Magda UsarekWitek, Story-Map Lead

This core planning team met six times during this update process to track plan development milestones and identify meeting content for a steering committee established to help with development of the plan.

3.3 DEFINING THE PLANNING AREA

The planning area consists of the incorporated limits for the City of Oakland. Relevant planning area characteristics are described in Chapter 4. The defined planning area is shown in Figure 3-1.

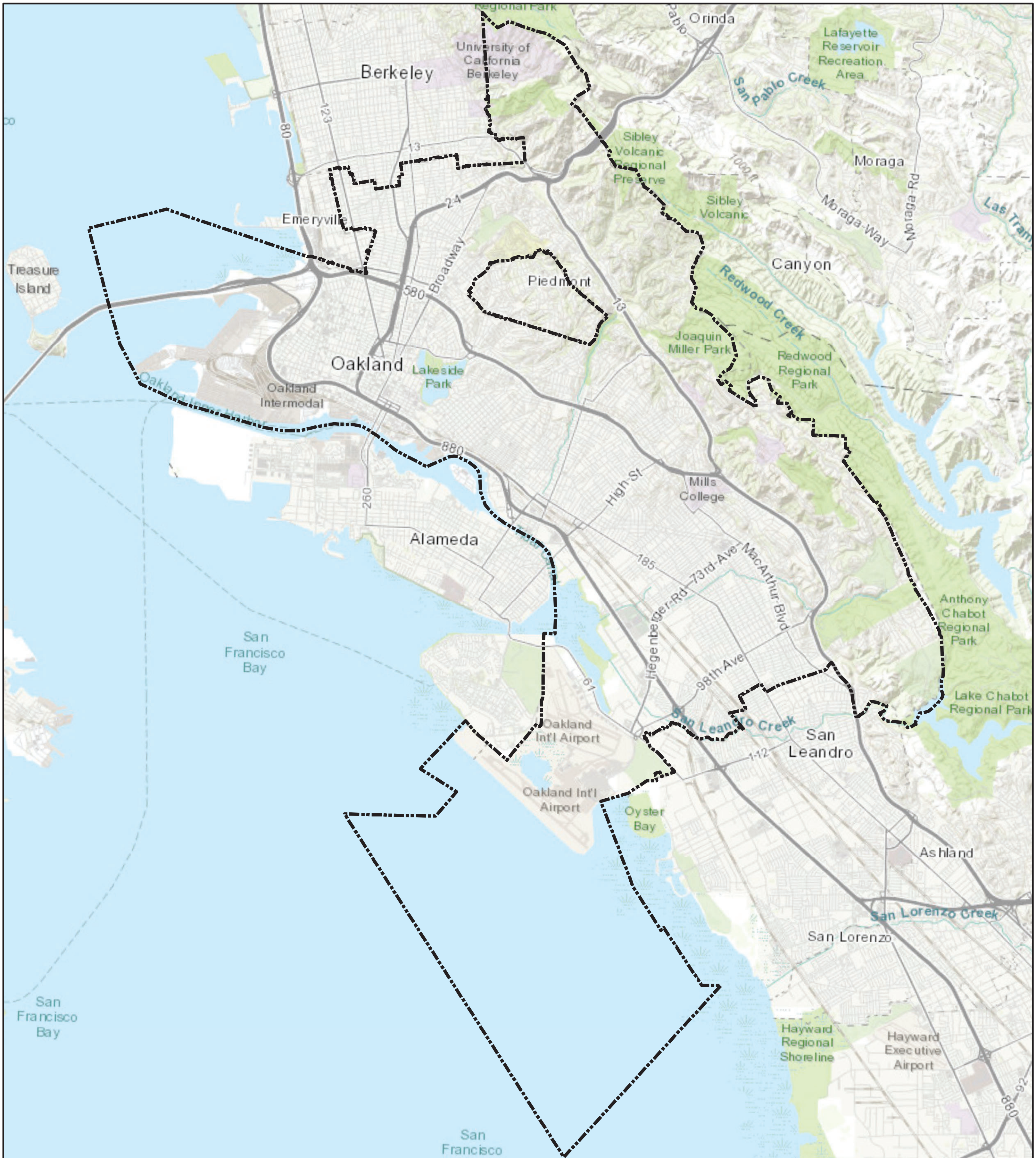


Figure 3-1. Planning Area for the Hazard Mitigation Plan

City Limits

N

0 1 2 Miles

Data Sources: Esri Basemap

3.4 THE STEERING COMMITTEE

A steering committee was formed to oversee all phases of the development of this plan. The planning team confirmed a committee of 22 members at a kickoff meeting, all of them City staff. The Steering Committee met regularly throughout the plan update process to review and validate all milestone deliverables from the planning team. Table 3-2 lists the Steering Committee members.

Table 3-2. Steering Committee Members

Name	Department or Agency	Title
Michael Branson	City Attorney's Office	Deputy City Attorney
Julian Ware	Information Technology Department/geographic information system (GIS)	Spatial Data Administrator
Micaela Pronio	Planning & Building Department/GIS	Graphic Delineator
Daniel Hamilton	Oakland Public Works Department (OPW)	Manager, Sustainability Program
Kristin Hathaway	OPW/Creeks and Stormwater	Project Manager II
Jimmy Mach	OPW/Wastewater	Engineer, Civil Principal
Scott Means	Human Services Department	Aging and Adult Services Manager
Anh Nguyen	Americans with Disabilities Act (ADA) Programs	ADA Programs Manager/Citywide Disability Access Coordinator
Dana Riley Hayes	Oakland Parks, Recreation & Youth Development	Assistant Director, Parks & Recreation
Karen Boyd	City Administrator's Office (CAO)	Citywide Communications Director
Michael Hunt	Oakland Fire Department	Chief of Staff
Orlando Arriola	Oakland Fire, Fire Prevention	Fire Marshall
Greg Elliot	Risk Management	Employee Fleet and Safety Coordinator
Loyd Ware	Housing & Community Development	Program Manager, Development/Redevelopment
Warren Logan	Mayor's Office	Policy Director of Mobility and Inter Agency Relations
Wlad Wlassowsky	Oakland Department of Transportation	Assistant Director
Tim Birch	Oakland Police Department	Police Services Manager
Joe DeVries	CAO	Director of Interdepartmental Operations
Paul Hess	Alameda County Office of Emergency Services	Emergency Services Supervisor
Nick Luby	Oakland Fire	Deputy Chief of Fire
Megan Wier	Oakland Department of Transportation	Safe Streets Division Manager
Matt Lee	OPW	Assistant Director

Leadership roles and ground rules were established during the Steering Committee's initial meeting on January 21, 2021. The Steering Committee agreed to meet on the third Thursday of every month from 10:00 a.m. to 11:00 a.m. through the course of the plan's development. The planning team facilitated each Steering Committee meeting, which addressed a set of objectives based on the work plan established for the planning process. The Steering Committee met four times from January through April 2021. All meetings agendas and summaries were posted on the hazard mitigation plan website and questions from the public were addressed during the meetings. Meeting summaries are included in Appendix A.

3.5 COORDINATION WITH STAKEHOLDERS AND AGENCIES

Opportunities for involvement in the planning process must be provided to neighboring communities, local and regional agencies involved in hazard mitigation, agencies with authority to regulate development, businesses, academia, and other private and nonprofit interests (44 CFR, Section 201.6(b)(2)). The planning team met this requirement as follows:

- **Agency Notifications**—The following agencies were invited to participate in the plan development process from the beginning and were kept apprised of plan development milestones:
  - City of Oakland Fire Department, Emergency Management Services Division
  - City of Oakland Planning & Building Department
  - City of Oakland Public Works Department
  - City Attorney's Office
  - City of Oakland Police Department
  - City of Oakland City Administrator Office
  - City of Oakland Department of Transportation
  - City of Oakland Office of the Mayor
  - City of Oakland Communications Division
  - City of Oakland Parks, Recreation & Youth Development
  - City of Oakland Department of Housing and Community Development
  - City of Oakland Human Services Department
  - City of Oakland ADA Programs
  - Port of Oakland
  - Alameda County Office of Emergency Services

  These agencies received meeting announcements, meeting agendas, and meeting minutes by e-mail throughout the plan development process. Some of them supported the effort by attending meetings or providing feedback on issues.
- **Pre-Adoption Review**—All the agencies listed above were provided an opportunity to review and comment on this plan during the public comment period, primarily through the hazard mitigation plan website. Each agency was sent an e-mail message informing them that draft portions of the plan were available for review. In addition, the complete draft plan was sent to the California Governor's Office of Emergency Services (Cal OES) and FEMA for a pre-adoption review to ensure program compliance.

3.6 REVIEW OF EXISTING PROGRAMS

Hazard mitigation planning must include review and incorporation, if appropriate, of existing plans, studies, reports and technical information (44 CFR, Section 201.6(b)(3)). Chapter 5 of this plan provides a review of laws and ordinances in effect within the planning area that can affect hazard mitigation actions, including an assessment of all City of Oakland regulatory, technical, and financial capabilities to implement hazard mitigation actions. In addition, the following programs and plans can affect mitigation within the planning area:

- 2016 City of Oakland Local Hazard Mitigation Plan
- City of Oakland Emergency Operations Plan
- Oakland Municipal Code
- Oakland Planning Code
- City of Oakland Capital Improvement Program
- City of Oakland General Plan
- Land Use and Transportation Element
- Estuary Policy Plan
- Safety Element

- Historic Preservation Element
- Housing Element
- Oakland 2030 Equitable Climate Action Plan
- Oakland Preliminary Sea-level rise Road Map
- Resilient Oakland Playbook
- California Fire Code
- 2019 California Building Code
- California Clean Air Act
- California State Hazard Mitigation Forum
- Disabled Access Code
- Title 24 California Energy Code 2019 Edition
- California Green Building Standards 2019 Edition

3.7 PUBLIC INVOLVEMENT

Broad public participation in planning helps ensure that diverse points of view about the area's needs are addressed. The public must have opportunities to comment on hazard mitigation plans during plan drafting and prior to approval (44 CFR, Section 201.6(b)(1)). This plan was drafted during the COVID-19 pandemic, limiting in-person public outreach events, and under an expedited timeline. The planning team developed a public involvement strategy that amplified the number of voices contributing to the plan development and laid the groundwork for ongoing engagement after the plan's completion, including through outreach for the City's anticipated Safety Element and Housing Element updates and new Environmental Justice Element by 2023.

3.7.1 Strategy

The strategy for involving the public in this plan was organized around the following phases:

- Phase 1 (January 2021):
    - Community member survey
    - MLK 40 Days of Service mitigation and preparedness activities
    - Hazard mitigation website and email
    - Media release
- Phase 2 (February 2021):
    - Community member survey
    - MLK 40 Days of Service mitigation and preparedness activities
    - Public forums with stakeholders
    - Local news interview
- Phase 3 (March through April 2021):
    - Public forums with stakeholders
    - City of Oakland Hazard Mitigation Story Map
    - Public comment period

The planning team relied on the community survey (available in English, Spanish, Chinese, and Vietnamese) as the primary method for gathering information and feedback from the public and to determine if the public's perception of risk and support of hazard mitigation have changed since the previous planning process. The survey was available to complete via an online form through the City of Oakland's Veoci emergency management software platform and was administered verbally during the six public forums. Comments were also collected via email to the core planning team.

The planning team developed a robust public outreach process within the very short project timeline, attempting to reach as many Oakland community members and stakeholders as possible through the following activities:

- Development of a public outreach plan, approved by the Steering Committee
- An ESRI Story Map website accessible to the public for interaction to provide members of the public with customizable data views regarding hazards threatening Oakland and their own homes
- Attendance at advertised public outreach events and virtual meetings with live interaction
- Development of a hazard mitigation plan webpage on the City's website
- Development and advertisement of a public survey posted on the plan's webpage to collect pertinent information from residents and the business community
- Publication of the survey in Oakland's most commonly spoken languages: English, Spanish, Chinese, and Vietnamese
- Language translation support during two targeted public forums to the City's Latinx community and Chinese-American community
- Use of social media, such as Nextdoor, Facebook and Twitter

Stakeholder Outreach

Stakeholders are the individuals, departments, agencies, and jurisdictions that have a vested interest in the recommendations of the hazard mitigation plan. The effort to include stakeholders in this process included stakeholder participation on the Steering Committee. The following federal, state, regional, and local stakeholders also played a role in the planning process:

- **Federal Agencie**s—FEMA Region IX provided planning guidance and data from the National Flood Insurance. The U.S. Geological Survey provided ShakeMaps for earthquake analyses. The U.S. Army Corps of Engineers provided information regarding the dam failure hazard for five dams: Temescal, Central, Chabot, Dunsmuir, and New Upper San Leandro.
- **State and Regional Agencies**—Cal OES provide planning guidance and reviewed the draft and final versions of the plan as part of the state hazard mitigation planning process required by the DMA. The San Francisco Bay Conservation and Development Commission provided sea-level rise data and the Association of Bay Area Governments provided liquefaction susceptibility data.
- **Local Stakeholders**—In addition to the agencies represented on the Steering Committee, the following governmental and non-governmental organizations were given the opportunity to review the draft version of the plan to provide input:
    - Oakland City Council
    - The Port of Oakland
    - City of Oakland Youth Commission
    - Mayor's Commission on Persons with Disabilities

- City of Oakland Planning Commission
- Asian Pacific Environmental Network
- West Oakland Environmental Indicators Project
- Landmarks Preservation Advisory Board
- Mayor's Commission on Aging
- NorCal Resilience Network
- Oakland Housing Authority
- Oakland Community Preparedness and Response
- Unity Council—Resilient Fruitvale
- Allendale Neighbor's Network
- West Oakland Community Action Plan
- East Oakland Collective
- Hope Collective
- Acta Non Verba
- Brower Dellums Institute
- Higher Ground Neighborhood Development Corp.
- Local Clean Energy Alliance / People Power Solar
- Planting Justice
- Sobrante Park Resident Action Council
- Communities for a Better Environment
- Black Cultural Zone
- Youth Against Apocalypse
- Mayor's Environmental Justice Committee
- Sogorea Te Land Trust
- Intertribal Friendship House

Project Website

During the planning process, a webpage was created on the City of Oakland website to introduce the hazard mitigation plan and keep the public apprised of upcoming outreach events, meeting dates and times, public survey, and plan development process (see Figure 3-2). The website address is:

> https://www.oaklandca.gov/topics/2021-local-hazard-mitigation-plan#city-of-oakland-2021-local-hazard-mitigation-plan-update

The site's address was publicized at all public meetings and in all social media releases. Information on the plan development process, the Steering Committee, the survey, and drafts of the plan were made available to the public on the website. The City will continue to place hazard mitigation information on the website after the plan is adopted to keep the public informed about successful mitigation projects and future plan updates.

City of Oakland Story Map

An "Story Map" was created, using ESRI Story Map software, to communicate the variety and severity of hazard risks facing the City of Oakland (see Figure 3-3 and Figure 3-4). The applicability of the City of Oakland Story Map goes beyond the life of the hazard mitigation plan update, meaning that it will remain with the City (on its own ESRI account) and continue as a template to support visual and data-based communication about the range of hazards relevant in Oakland. New and revised data can be loaded into the platform in the future to compare hazard risk with any other spatial data set (i.e. soft story structure inventory, social vulnerability data, etc.).

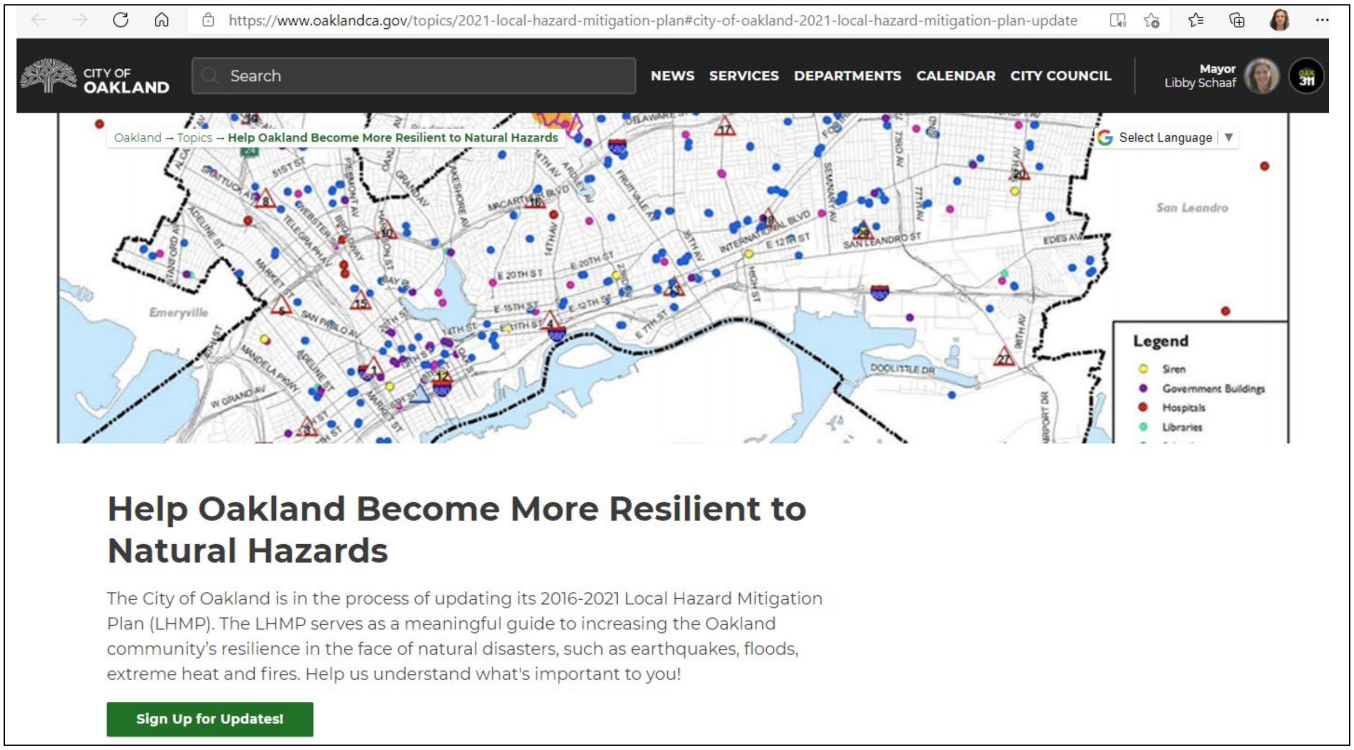


Figure 3-2. Hazard Mitigation Plan Webpage on the City of Oakland Website

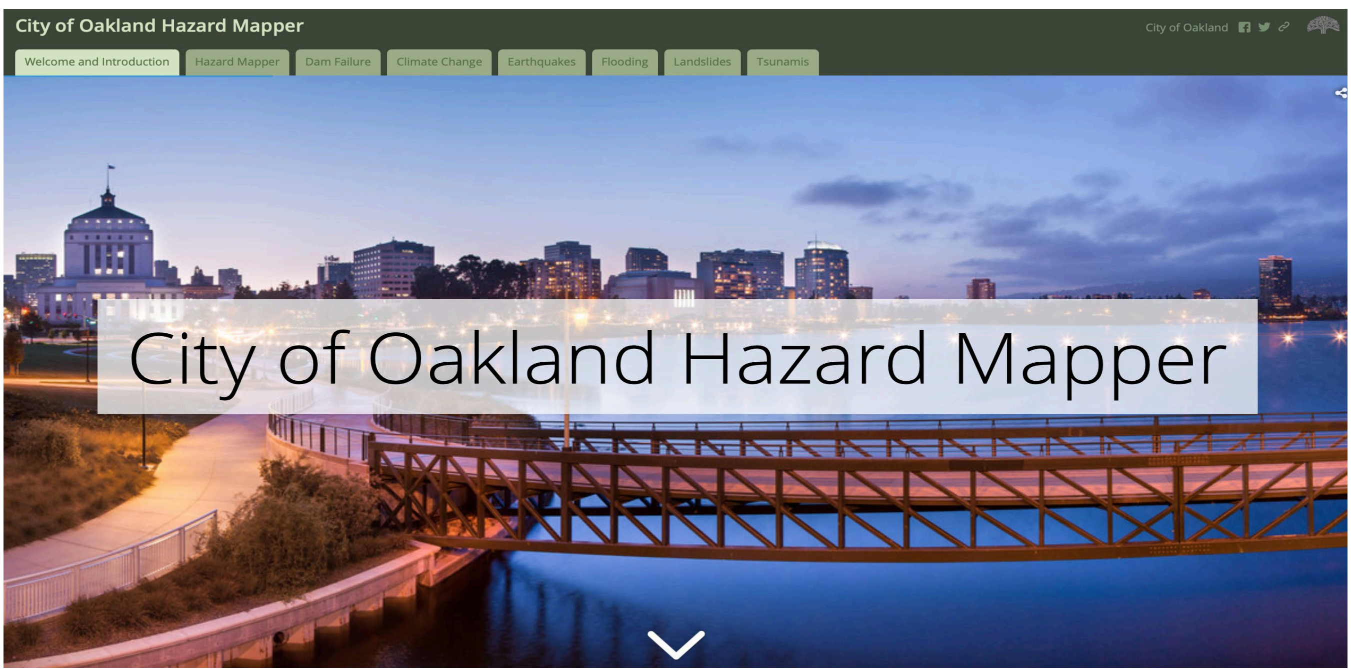


Figure 3-3. Example Story Map Cover Page

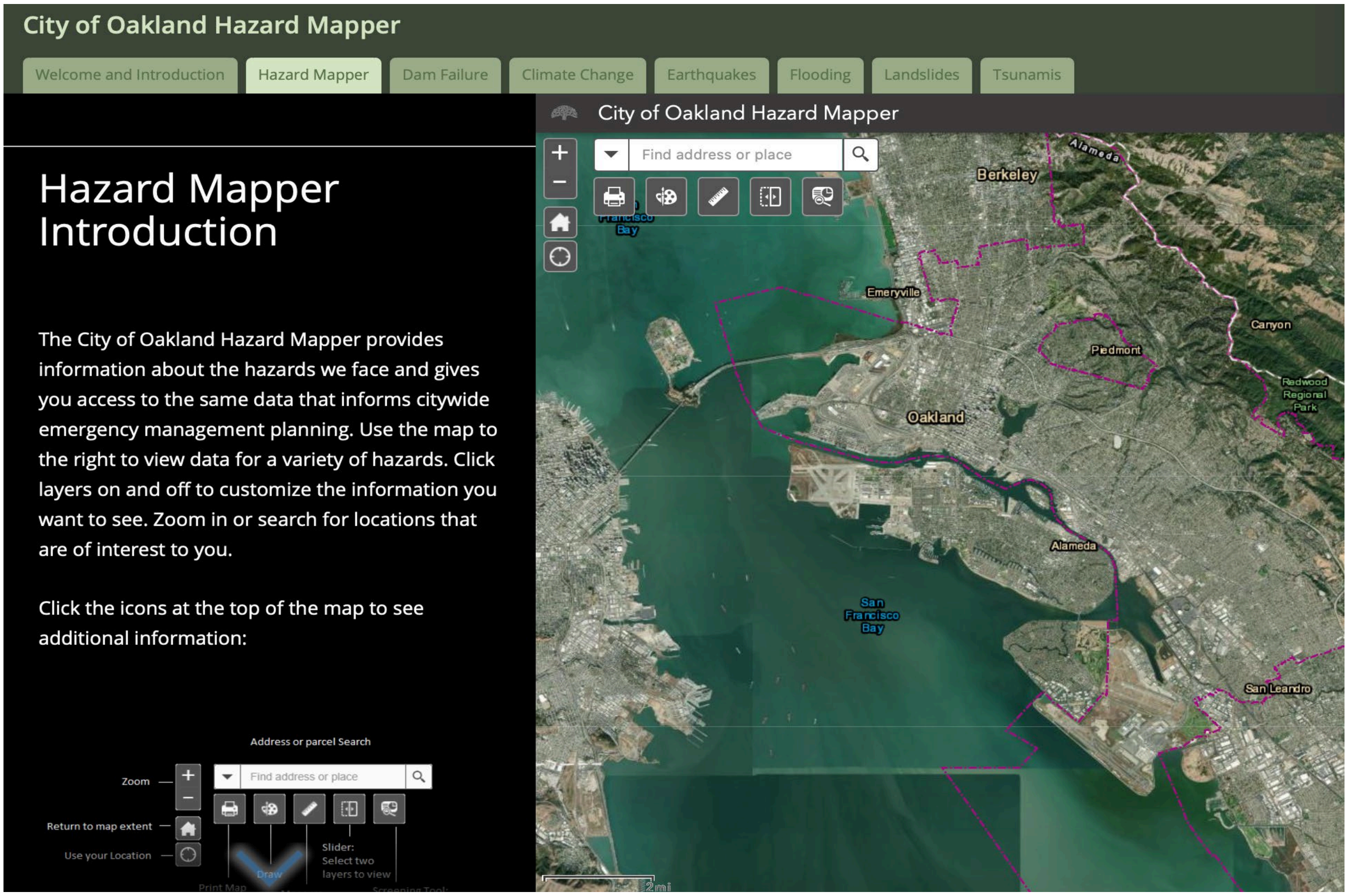


Figure 3-4. Example Story Map Data Page

During the update process, the Story Map was released to the public and promoted through social media and the project website. It included risk assessment results for all relevant hazards, an interactive hazard mapping tool, and a report function to produce comprehensive hazard exposure summaries for any given property, block, or defined area. The Story Map expanded opportunities for public outreach and the ways in which members of the public could interact with hazard data as the hazard mitigation plan update was underway.

Public Survey

A hazard mitigation plan survey (see Figure 3-5) was developed by the planning team to be distributed to the public. The Steering Committee provided guidance on the questions and approved the final survey. The survey was used to gauge level of knowledge about preparedness activities to reduce risk and loss from the City of Oakland's relevant hazards, including risk perception. The survey also helped identify housing status (homeowner, renter, or currently unhoused/temporary housing) with the recognition that housing status is a function of personal risk during disaster.

The survey was designed identify which hazards Oakland's community members and other stakeholders are most concerned about, including general levels of awareness and preparedness regarding hazard mitigation and the city's exposure to hazards. The answers to its 26 questions helped guide the Steering Committee in recommending mitigation actions. Surveys were distributed at public-outreach events, and a link to a web-based version of the survey was provided on the hazard mitigation plan webpage. Appendix A presents the survey.

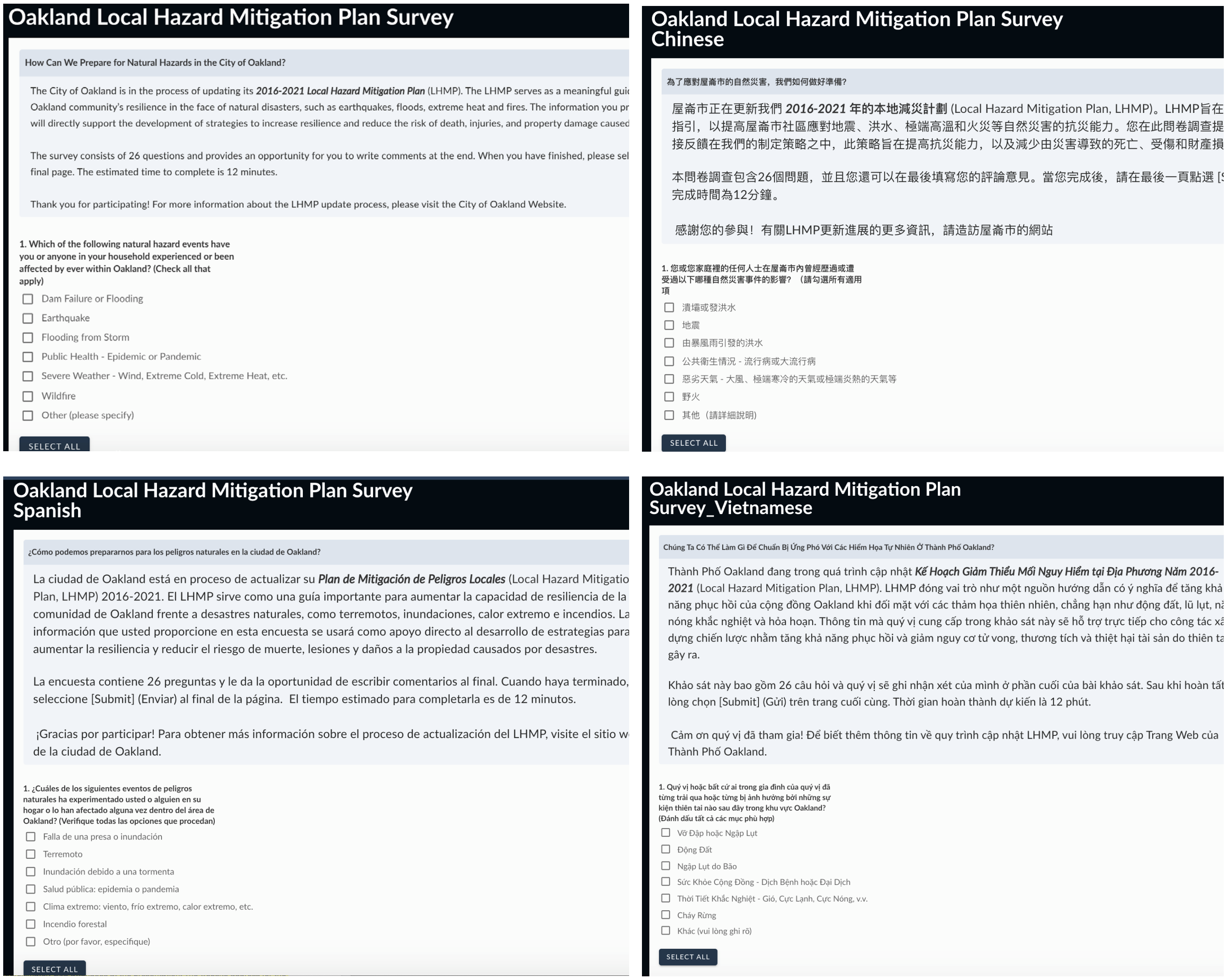


Figure 3-5. Example On-Line Survey Page in Four Languages

Social Media

The Oakland Fire Department's social media accounts (Twitter, Facebook, and Nextdoor) were used to share information about the hazard mitigation planning process, including the survey, the virtual town halls, and the public comment period.

Local Media

Following the release of a media advisory in February 2021, several local news outlets—including Oakland Fire Safe Council and SF Gate—picked up the information and shared the major highlights of the advisory with their readership. In addition, there were two news stories about the hazard mitigation plan update, one via The Oaklandside and one in Bay City News, which is disseminated widely to news desks in the region.

Public Events

The Steering Committee determined the public events that would best serve the City in making the public aware of the development of the hazard mitigation plan. Announcements of these events were posted on the City's hazard mitigation webpage and other City department webpages. Due to COVID-19 considerations, all public events were held as virtual town halls, using the City's Zoom account and were widely accessible to any interested community members and/or stakeholders.

Jessica Feil, the City's EMSD manager, gave the presentations, which informed the audiences about the development of the hazard mitigation plan and the public outreach being done. The website address for the hazard mitigation survey was provided, as well as an announcement about the subsequent events in the City where hazard mitigation plan outreach was being conducted. The events were as follows:

- A presentation and live hazard risk perception survey during the January 21 Oakland Youth Advisory Commission meeting, co-sponsored by the Oakland Public Library. At the end of the presentation, attendees were polled using a shortened version of the public survey.
- A presentation on February 22 during an Oakland Fire Department virtual town hall. Information about the City's CERT program was shared in addition to the hazard mitigation information.
- A presentation on February 24 during an event hosted by Oakland Community Preparedness and Response.
- A presentation on February 28 during a virtual meeting hosted by People Power Solar Cooperative, Maxwell Park Neighborhood Council, and ImpactZ Youth Group.
- A presentation on March 19 during a virtual town hall hosted by Resilient Fruitvale Collaborative, Hope Collaborative, People Power Solar Cooperative, and Local Clean Energy Alliance. Spanish translation service was available throughout this meeting.
- A presentation on March 19 during an East Bay Asian Local Development Cooperation virtual town hall (see Figure 3-6). Mandarin translation service was available throughout this meeting.

Draft Plan Public Comment Period

A 14-day public comment period was initiated on April 12, 2021. During this comment period, the public was asked to review the proposed draft of the hazard mitigation plan and provide comments to the planning team by April 26, 2021. The public comment period was advertised on the hazard mitigation plan website as well as in a press release to all media outlets and in a social media blast through outlets used by the City. Targeted outreach to key stakeholders and community-based organizations took place at the beginning of the public comment period. The draft plan was presented to the City of Oakland Public Safety Committee and the Planning Commission and was shared with each council member prior to formal adoption by the City Council.

A virtual public meeting was held on April 19, 2021, via Zoom and Facebook Live. The session covered the purposes for planning and presented highlights of the draft plan and how the public could provide comment. The presentation given at the session is included in Appendix A.

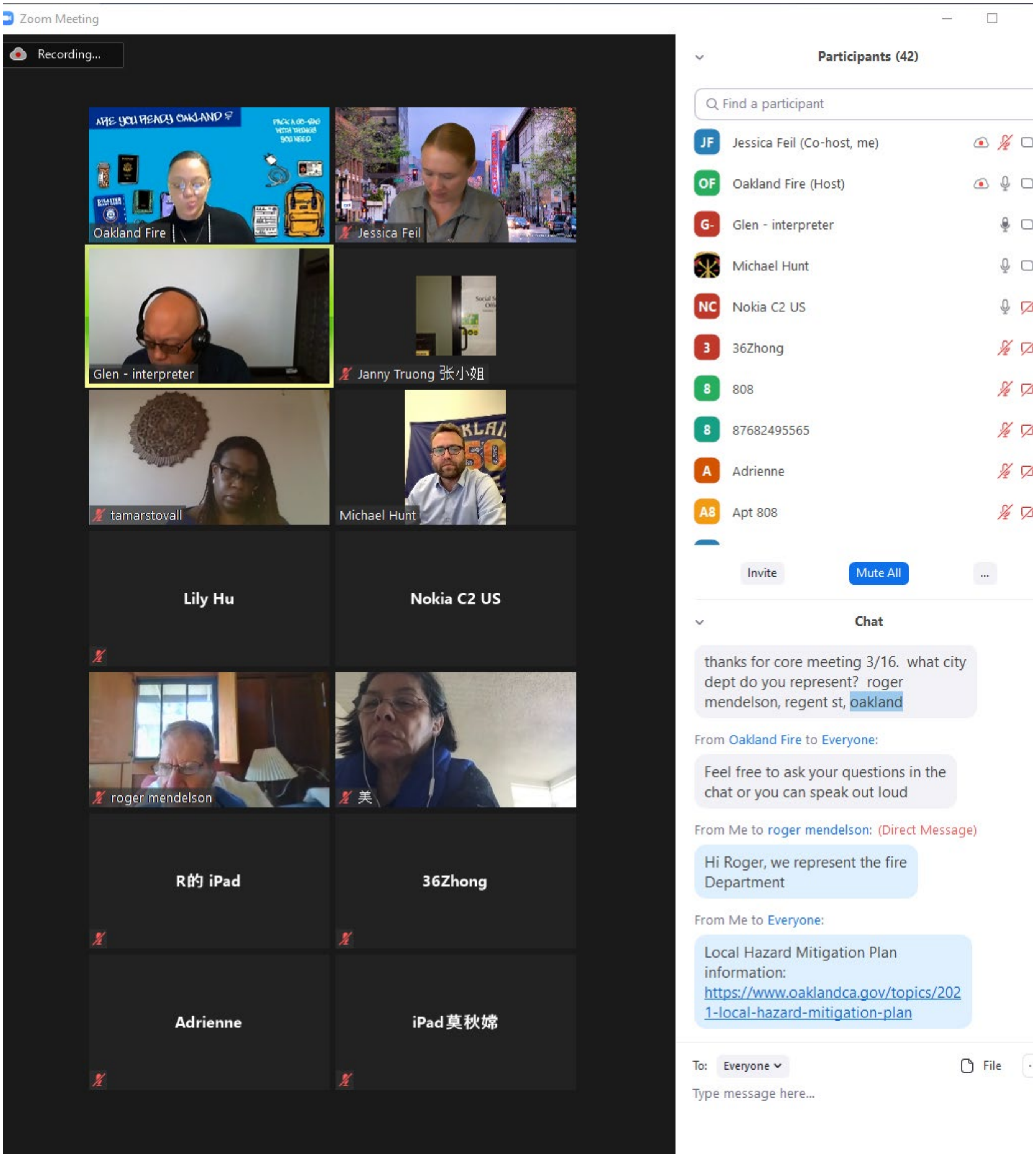


Figure 3-6. Screenshot of the March 16 Town Hall with the East Bay Asian Local Development Corporation

3.7.2 Public Involvement Results

Survey Results

Completed surveys were received from 813 respondents. Survey results were provided to the Steering Committee. Detailed survey results are provided in Appendix A. Key results are summarized as follows:

- Survey respondents ranked the following as the top 5 hazards "extremely concerned" about:
  - Wildfire (39 percent)
  - Earthquakes (34 percent)
  - Climate Change (32 percent)
  - Drought (20 percent)
  - Public Health (19 percent)
- Survey respondents ranked the following as the top 5 hazards "not concerned" about:
  - Dam failure (69 percent)
  - Tsunami (47 percent)
  - Flooding (39 percent)
  - Landslide (34 percent)
  - Hazardous Materials Accident (23 percent)
- Survey respondents reported having personal experience with hazards in Oakland as follows:
  - Public health (81 percent)
  - Earthquakes (72 percent)
  - Severe weather (59 percent)
  - Wildfire (59 percent)
  - Flooding (14 percent)
- 45 percent of respondents indicated their home is in an area at risk for wildfire; 39 percent stated that their home is not; the rest were unsure
- 7 percent of respondents stated that they have flood insurance and 34 percent stated that they have earthquake insurance.
- 43 percent of respondents indicated that the presence of a hazard risk zone was not disclosed to them when they purchased their home; 62 percent indicated that disclosure of such information would have influenced their decision to purchase or move into a home.
- 81 percent of respondents stated that property tax incentives would encourage them to spend money to protect their home against disasters; 77 percent stated that insurance premium discounts would encourage them to do so.
- Only 38 percent of respondents said they are at least adequately prepared for hazard event; 57 percent said they are somewhat prepared
- 41 percent of respondents strongly agreed it is their personal responsibility to protect themselves and their property from disasters.
- 46 percent of respondents strongly agreed it is the responsibility of the government (local, state, and federal) to inform residents about education and programs to reduce their exposure and risk to hazards.
- The highest number of respondents identified social media as the best method to receive emergency preparedness information, followed by City newsletters. Additional methods that scored well were

schools and the internet, followed by television news and Community Emergency Response Training classes.

- Of respondents who provided demographic information:
  - 60 percent indicated household incomes greater than $100,000; 29 percent indicted household incomes of $50,000 to $100,000
  - 62 percent were male, 33 percent female, and 2 percent non-binary
  - 60 percent were older than 50; 33 percent were between 31 and 50
  - 73 percent were white; 8 percent were Asian; 8 percent were mixed race; 6 percent were African-American.

Survey responses included 190 comments provided by respondents. These comments were reviewed by the planning team and considered during the overall review of survey results and plan update development.

Social Media Results

The following statistics provide a closer look at how many Oaklanders engaged with the Oakland Fire Department's hazard mitigation-related social media posts:

- Approximately 3,500 users saw the hazard mitigation-related tweets on their own Twitter timeline.
- One Nextdoor message from the Oakland Fire Department about the hazard mitigation plan was disseminated to 135,000 total Oakland subscribers. Of the 135,000 Oakland subscribers, 2,288 opened the message and interacted with it to comment or say thank you.

Public Outreach Events

The public involvement strategy used for the plan development introduced the concept of mitigation to the public and provided the Steering Committee with feedback to use in developing the plan. All community members in the planning area had opportunities to provide comment during all phases of the planning process. Attendance and survey distribution at the plan development's public meetings are summarized in Table 3-3.

Table 3-3. Summary of Public Meetings

Date/Time	Notes	Attendance	Co-Hosts
Thursday, January 21, 2021		10	Oakland Youth Advisory Commission Meeting Co-Sponsor – Oakland Public Library
Monday, February 22. 2021		7	No Host
Wednesday, February 24, 2021		13	Oakland Community Preparedness & Response
Sunday, February 28, 2021		34	People Power Solar Cooperative, Maxwell Park Neighborhood Council, ImpactZ Youth Group
Tuesday, March 9, 2021	Spanish Translation	78	Resilient Fruitvale Collaborative, Hope Collaborative, People Power Solar Cooperative, Local Clean Energy Alliance
Tuesday, March 16, 2021	Mandarin Translation	42	East Bay Asian Local Development Cooperation
Monday, April 19, 2021		23	Virtual public meeting to present draft plan sponsored by Oakland Emergency Management Services Division.
TOTAL		**207**	

Public Comments on the Draft Plan

The core planning team processed comments received during the two-week public comment period (April 12 – 26, 2021). Most comments were inquisitive in nature, asking for clarification on specific topics. One set of written comments from the East Bay Municipal Utility District (EBMUD) provided new information relevant to the dam failure hazard. Content of the chapter describing the dam failure risk assessment (Chapter 7) was revised to address the EBMUD comments, which are included in Appendix A.

3.8 PLAN DEVELOPMENT CHRONOLOGY/MILESTONES

Table 3-4 summarizes important milestones in the planning process.

Table 3-4. Plan Development Chronology/Milestones

Date	Event	Description	Attendance
2020			
9/25	Organize Resources	• City initiates a procurement process for a technical support contractor	N/A
11/13	Organize Resources	• City selects Tetra Tech, Inc as its technical support contractor	N/A
12/2	Project Kickoff meeting	• Project Overview • Committee organization • Plan review • Public Outreach strategy • Next Steps	14
12/16	Core Planning Team Call #2	• Public outreach • Data needs • Goals and Objectives • Hazard Analysis • Homework	9
12/30	Core Planning Team Call #3	• Project Overview • Planning Process • Public Involvement Strategy • Hazard Analysis Process • Action Items and Next Steps	11
2021			

1/13	Core Planning Team Call #4	• Public outreach status update
		  ○ Website
		  ○ Survey
		  ○ Town-halls
		• Risk assessment update
		• Core capability assessment
		• Mission, goals and objectives
			12

1/21	Steering Committee Meeting #1	• Steering Committee Role • Planning Process • Hazard Analysis • Public Engagement	25
1/27	Core Planning Team Call #5	• Public outreach status update • Risk assessment update • Finalize goals/objectives • Core capability assessment	12

Date	Event	Description	Attendance
2/10	Core Planning Team Call #6	• Story-map Update • Planning Process-Timeline status update • Plan Maintenance strategy • Risk assessment update	13

2/18	Steering Committee Meeting # 2	• Planning Process
		  ○ Timeline update
		  ○ Final goals/objectives
		• Hazard Analysis-Exposure results
		• Public Engagement
		  ○ Survey Results
		  ○ Preview Story-map
			22

2/24	Core Planning Team Call #7	• Public outreach status update • Prior Action review • Develop new action plan • Finalize plan maintenance strategy	9
3/10	Core Planning Team Call #8	• Port of Oakland status • Finalize the action Plan • Prioritization of the action plan • Reconciliation of "Town Halls" • Adaptive Capacity assessment	10
4/12	Public Outreach	• Initiation of 2-week final public comment period	N/A
4/19	Public Outreach	• Virtual public meeting to present the draft plan for public comment, 6:00 to 7:30 p.m.	23
4/26	Public Outreach	• Closure of 2-week final public comment period	N/A
5/3	Plan Review	• Submittal of "pre-adoption" draft of the plan to CalOES for compliance review and approval	NA
TBD	Plan Review	• Approval Pending Adoption (APA) granted by FEMA Region IX	N/A
TBD	Plan Adoption	• Plan Adopted by Oakland City Council	N/A
TBD	Plan Approval	• Fnal approval of the plan issued by FEMA Region IX	N/A

4. CITY OF OAKLAND PROFILE

4.1 GEOGRAPHIC OVERVIEW

Oakland is a municipality in Alameda County, California, on the eastern shore of the San Francisco Bay opposite San Francisco. The city has a total area of 78 square miles and is bordered by 19 miles of coastline to the west and hills to the east, with views of both the San Francisco Bay and the Pacific Ocean. Cities adjacent to Oakland include Berkeley to the north; San Leandro to the south; Alameda across the Oakland Estuary; Piedmont, a small city surrounded by Oakland; and Emeryville, a city along the bay between Oakland and Berkeley. Oakland is the only city in the United States with a natural saltwater lake, 115-acre Lake Merritt, wholly contained within its border.

4.2 HISTORICAL OVERVIEW

The East Bay's earliest known inhabitants were called Ohlones. They inhabited the area that is now Oakland for at least 3,500 years. They lived mainly along the creeks and shorelines, where today's names Temescal (sweathouse) and Shellmound recall their presence.

The City of Oakland was founded in 1772 and chartered in 1852. In 1820, a Spanish land grant known as Rancho San Antonio was established there. Logging began in the area in the 1840s, and, during the California Gold Rush (1849), Oakland became a transit center for goods and people. In 1849–50 Moses Chase and some associates leased and then purchased farmland and laid out the town of Clinton (later named Brooklyn). In 1851, Horace W. Carpentier started a trans-bay ferry service to San Francisco and acquired a town site in 1852 to the west of Brooklyn, naming it Oakland for the oak trees on the grassy plain. The state legislature of California incorporated the town of Oakland on May 4, 1852.

The town and its surroundings grew rapidly with the railroads, becoming a major railway station in the late 1860s and 1870s. Construction included the Oakland Long Wharf Terminus and the largest rail yards and service facilities in West Oakland, which continued to be a major local employer well into the 20th century. Oakland's rise to industrial prominence and the need for a seaport led to the digging of a shipping and tidal channel in 1902, creating the "island" of the nearby town of Alameda.

In 1906, Oakland's population doubled as many people moved from San Francisco after the earthquake and fire there. A Chevrolet plant was opened in 1915 at the southern border of Oakland. By 1920, Oakland was home to a number of manufacturing industries, including metals, canneries, bakeries, automobiles, and shipbuilding. In the 1920s, Oakland grew significantly.

During World War II, the East Bay Area was home to several war-related industries. The war attracted workers from all over the country to Oakland, many of whom were African Americans from the western south, who enjoyed great prosperity during the war years. Soon after the war, the shipbuilding and automotive industries virtually evaporated. Many of the city's wealthy residents left the city to move to the newly developed suburbs. At the end of the 1960s, however, Oakland, which had been prosperous before the war, had a population that was increasingly poor. Community groups born in the 1960s like the Black Panther Party, Oakland Community Organizations, Unity Council, Intertribal Friendship House, and many others organized and demanded protections and equal access to jobs, housing, employment, transportation, and services.

In April 2016, the City of Oakland adopted an official city motto in memory of 16-year old Lo'Eshe Lacy. The motto serves as a mantra against violence and an affirmation of the value of life. Lo'Eshe in Nigerian Igbo means "love life," a rallying cry to embody Oakland love. City messages that evoke the spirit of the community will bear #Oaklandlovelife.

4.3 SUB-AREAS

In 2019, the City of Oakland adopted a new plan for paving City streets that divided Oakland into nine areas for project planning. These areas, larger than City-defined neighborhoods but smaller than city council districts, were drawn based on considerations including street condition, population density, and equity factors. For this hazard mitigation plan, City staff determined that these areas are suitable for use as sub-areas in assessing the risk presented by natural hazards. Throughout this plan, quantitative risk assessment results are presented by sub-area where it is feasible to do so. The sub-areas are as follows (see Figure 4-1):

- Central East Oakland
- Coliseum/Airport
- Downtown
- East Oakland Hills
- Eastlake/Fruitvale
- Glenview/ Redwood Heights
- North Oakland Hills
- North Oakland/Adams Point
- West Oakland

4.4 MAJOR PAST HAZARD EVENTS

The City of Oakland was the site of the Oakland Hills Fire in 1991, which resulted in 25 deaths, 150 injuries, and over $1.5 billion in fire losses. The City also has been included in many Alameda County disaster proclamations. Since 1969, federal disaster declarations have been issued for 14 disasters affecting Alameda County, as listed in Table 4-1. While many of these events may not have directly impacted the City of Oakland, they are a testament to the frequency and types of hazard events typical for the region. Review of these events helps identify targets for risk reduction and methods to increase a community's capability to avoid large-scale events in the future.

Federal disaster declarations are typically issued for hazard events that cause more damage than state and local governments can respond to and recover from without assistance from the federal government. A federal disaster declaration puts local response reimbursement and federal recovery programs into motion to assist public entities and help disaster victims, the community and private sector. Some of the programs are matched by state programs. Many natural hazard events do not trigger federal disaster declarations but have significant impacts on the communities they affect. These events are also important to consider in establishing recurrence intervals for hazards of concern.

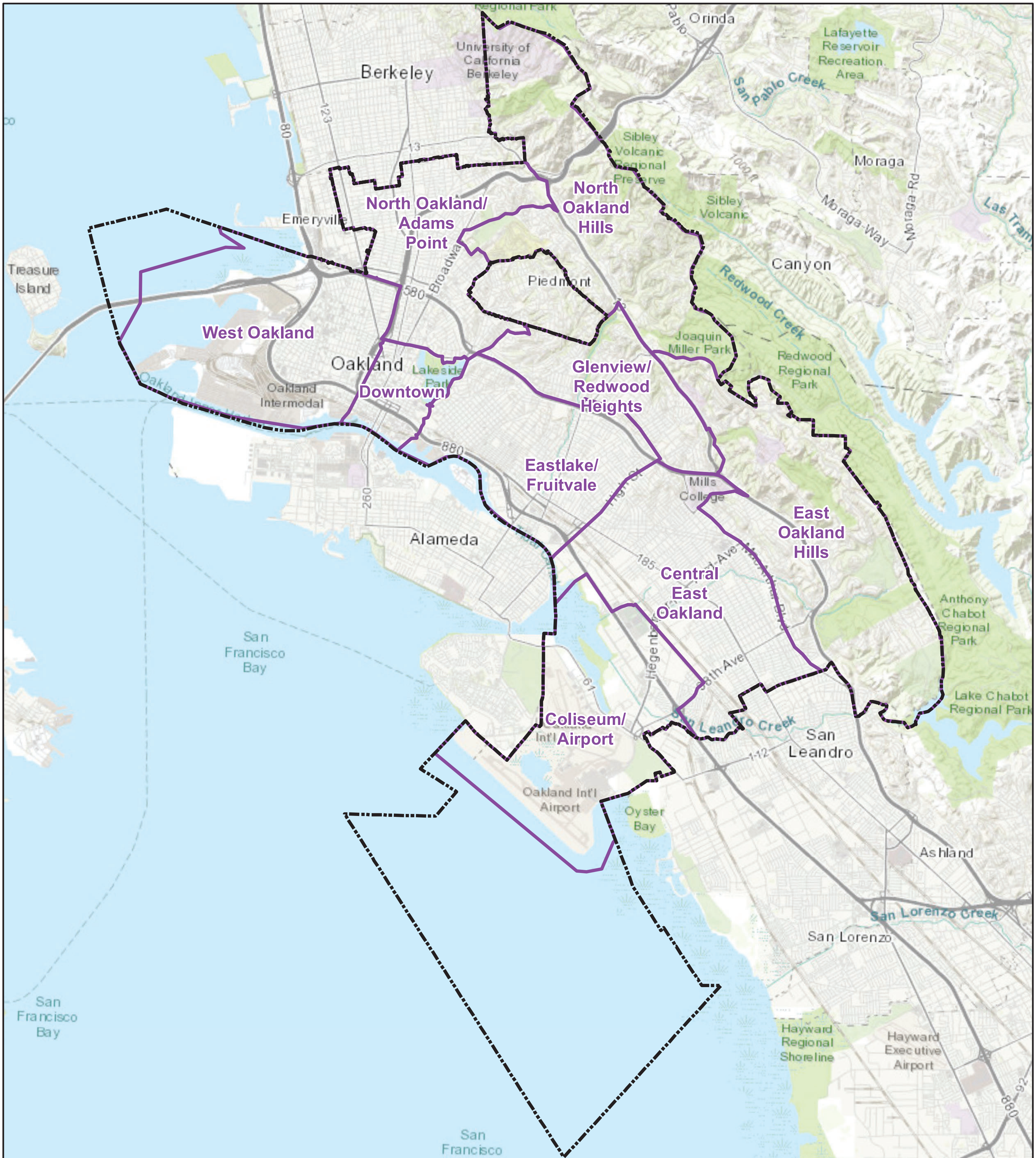


Figure 4-1. Sub-Areas Used in Hazard Risk Assessments

City Limits

Sub-Areas

N

0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland

Table 4-1. Federal Disaster Declarations for Alameda County

Type of Event	FEMA Disaster DR#	Declaration Date
COVID-19 Pandemic	4482	03/22/2020
Severe Winter Storms, Flooding, and Mudslides	4305	03/16/2017
Severe Winter Storms, Flooding, and Mudslides	4301	02/14/2017
Severe Storms, Flooding, Landslides, and Mudslides	1646	06/05/2006
Severe Storms, Flooding, Mudslides, and Landslides	1628	02/03/2006
Severe Storms/Flooding	1155	01/04/1997
Severe Winter Storms, Flooding, Landslides, Mud Flows	1046	03/12/1995
Severe Winter Storms, Flooding, Landslides, Mud Flows	1044	01/10/1995
Oakland Hills Fire	919	10/22/1991
Severe Freeze	894	02/11/1991
Loma Prieta Earthquake	845	10/18/1989
Coastal Storms, Floods, Slides, Tornadoes	677	02/09/1983
Forest, Brush Fires	295	09/29/1970
Severe Storms, Flooding	283	02/16/1970

4.5 PHYSICAL SETTING

4.5.1 Climate

Oakland has a warm-summer Mediterranean climate, with warm, dry summers and mild, wet winters. Table 4-2 lists the historical monthly averages for Oakland for low temperature, high temperature, mean temperature, and average precipitation (City of Oakland, 2020). The warmest month of the year is September and the coldest month of the year is January. The wettest month is January, with an average rainfall of 4.78 inches, and the driest is July, with an average of 0.07 inches.

Table 4-2. Oakland Historic Weather Averages and Records

Month	Average High	Average Low	Average Mean	Precipitation
January	57.2°	44.4°	50.8°	4.78”
February	61.6°	47.9°	54.8°	4.19”
March	63.3°	49.1°	56.2°	3.60”
April	66.5°	50.5°	58.5°	1.36”
May	69.0°	53.5°	61.2°	0.56”
June	71.7°	55.7°	63.7°	0.12”
July	72.6°	57.0°	64.8°	0.07”
August	73.6°	58.3°	66.5°	0.32”
September	74.6°	58.3°	66.0°	0.10”
October	72.0°	55.3°	63.6°	1.31”
November	63.9°	49.6°	56.8°	3.45”
December	57.4°	44.5°	51.0°	3.33”

4.5.2 Topography

About two-thirds of Oakland lies in the flat plain of the East Bay, with one-third rising into the foothills and hills of the East Bay range. Oaklanders refer to their city's terrain as "the flatlands" and "the hills". Oakland's highest point is near Grizzly Peak Boulevard, east of Berkeley, just over 1,760 feet above sea level.

4.5.3 Soils

Several soil types can be found in the city, varying in drainage and slope. The 1975 *Soil Survey of Alameda County* identifies seven general soil types in the area (including the City of Oakland), as summarized in Table 4-3.

Table 4-3. Identified Soil Types in Alameda County

Soil Type	Soil Description	% of Total Survey Area
Reyes-Urban land	Nearly level, very poorly drained clays on tidal flats, and urban land	23.0
Clear Lake-Omni-Urban land	Nearly level to moderately sloping, poorly drained clays and silty clay loams, and urban land; on the basin rim	17.0
Xeropsamments-Urban land-Baywood	Nearly level to moderately sloping, somewhat excessively drained sands and loamy sands, and urban land; on the coastal plain	8.0
Xerorthents-Maymen-Millsholm	Steep to very steep, well drained and somewhat excessively drained soils that have various textures; on foothills	17.0
Danville-Botella	Nearly level to moderately sloping, well drained loams and silty clay loams; on low terraces and alluvial fans	16.0
Tierra-Urban Land	Nearly level to moderately steep, moderately well drained loams, and urban land; on upland terraces	7.0
Sycamore-Yolo	Nearly level, well drained and poorly drained silt loams, on flood plains and alluvial fans	12.0

Source: U.S. Department of Agriculture, 1975

4.5.4 Geology

The planning area lies within the geologic region of California referred to as the Coast Ranges geomorphic province. The natural region of the Coast Ranges is between the Pacific Ocean and the Great Valley, extending from the Oregon border to the Santa Ynez River near Santa Barbara. Discontinuous northwest-trending mountain ranges, ridges, and intervening valleys characterize this province. Much of the Coast Range province is composed of marine sedimentary and volcanic rocks that form the Franciscan Assemblage. The Franciscan Assemblage in this region represents some of the oldest rocks in the region, and consists primarily of greenstone (altered volcanic rocks), basalt, chert (ancient silica-rich ocean deposits), and sandstone that originated as ancient sea floor sediments.

The San Francisco Bay is in a broad depression in the Franciscan bedrock resulting from an east-west expansion between the San Andreas and the Hayward fault systems. The bedrock surface can be found at elevations of 200 to 2,000 feet below mean sea level across the Bay Area. Sedimentary deposits overlie the Franciscan bedrock that originated from millions of years of erosion, deposition, and changes in sea level. Geologists categorize these sedimentary deposits into geologic formations based on the period of deposition and material type:

- The Alameda Formation is the deepest and oldest of these sedimentary deposits and consists of a mixture of clay, silt, sand, gravel, and some shells with predominantly silt and clay sediments surrounding discontinuous layers of sand and gravel.
- Overlying the Alameda Formation is the San Antonio Formation, which consists of sandy clays, gravelly clays, clayey sands, and gravels with interbedded silty clay deposits.
- Younger alluvial deposits once referred to as the Temescal Formation are deposited on top of the San Antonio and consist of sandy clays, clayey sands, sands, and gravels. The source material for these alluvial deposits comes from the Berkeley Hills.

Ruptures along the nearby San Andreas Fault caused severe earth movement in the San Francisco Bay Area in 1906 and 1989. San Andreas quakes induce creep (movement occurring on earthquake faults) in the Hayward fault, which runs directly through Oakland, Berkeley, San Jose, and other Bay Area cities.

4.6 SENSITIVE RESOURCES

4.6.1 Historic and Cultural Resources

Oakland's wealth of historic buildings and neighborhoods is matched by few other California cities. These artifacts reflect the city's rich multicultural history, from earliest times to the present. The materials and workmanship used are impossible or costly to obtain today. In 1994 the City of Oakland adopted a Historic Preservation Element as part of its General Plan. The Historic Preservation Element is based on two broad goals:

- Use historic preservation to foster economic vitality and quality of life.
- Prevent unnecessary destruction of properties of special historical, cultural, and aesthetic value.

The Element spells out these goals through policies and actions that govern how the City treats "Designated Historic Properties" (landmarks, districts, and heritage properties) and "Potential Designated Historic Properties." Potential Designated Historic Property is the broadest definition of "historic" under the Preservation Element. It is a description, not a designation. It is a category based on Planning Department survey ratings. The ratings report what the survey has found throughout Oakland, on a scale of A ("highest importance") through E ("of no particular interest"). The City considers any property that has at least a potential rating of C ("secondary importance") or that could contribute to a potential primary or secondary district to warrant consideration for possible preservation. To recognize the importance of neighborhood character and highlight restoration opportunities, this is a very inclusive category. About a fifth to a quarter of Oakland's buildings are considered to have at least some minimal historic value.

Landmarks in the city may be designated for historical, cultural, educational, architectural, aesthetic, or environmental value. They are nominated by their owners, the City, or the public and are designated after public hearings by the Landmarks Board, Planning Commission, and City Council. About 150 landmarks and preservation districts have been designated, out of nearly 100,000 buildings in Oakland. These buildings, sites, and features range from City Hall, to the home of blues musician Brownie McGhee, to the Old Survivor Redwood Tree, to the Grand Lake Theater and Roof Sign.

Officially designated Preservation Districts are also called S-7 and S-20 Zones. They are areas or neighborhoods that are recognized for the same values as individual landmarks, and they are nominated and designated in the same way, usually with active neighborhood participation. There are currently nine designated districts containing about 1,500 buildings. They include Preservation Park, Old Oakland-Victorian Row, and the Bellevue-Staten

Apartment District along Lake Merritt in Adams Point, and Sheffield Village. Also included are Oak Center Historic District and 7th Street Commercial District in West Oakland.

As the cultural center of the East Bay, Oakland is home to a symphony recognized regionally and nationally for its convergence of artistic excellence and community service, an award-winning zoo with more than 400 animals, the restored Art Deco Paramount Theater movie palace, and the renovated Fox Theater. The Oakland Museum of California has the largest collection of California art, culture and history and recently completed a $58 million renovation. Oakland's diverse population is reflected in the variety of attractions including Chinatown, the Latino-dominant Fruitvale area and the African American Museum and Library at Oakland.

4.6.2 Scenic Resources

Oakland boasts one of the highest percentages of parks and open space per capita in the nation. The waterfront city features green hills, forests, creeks, an estuary and two lakes. Oakland is at the heart of the East Bay Regional Park District, a system of 73 parks and 31 regional hiking trails covering more than 120,000 acres in Alameda and Contra Costa Counties. In the hills overlooking the San Francisco Bay, the parks offer an extraordinary variety of recreational activities, including fishing, swimming, hiking, mountain biking, picnicking, or relaxing in a natural setting. Oakland also has an extensive collection of municipal parks, recreation centers, aquatic and water activity sites, and sports fields.

The Scenic Highways Element of the City's General Plan addresses the preservation and enhancement of attractive roadways and major thoroughfares traversing the City of Oakland. This element creates policies to address the character of specific roads, including MacArthur Freeway, Skyline Boulevard/Grizzly Peak Boulevard/Tunnel Road, the Grove-Shafter Freeway, the Warren Freeway, Park Boulevard, Joaquin Miller Road, Golf Links Road, the Embarcadero, and Oak Street.

4.6.3 Natural Resources

Oakland's urban forest consists of hundreds of thousands of trees. The City maintains over 200,000 of these trees that grow in parks and along streets. A 2007 sidewalk survey identified 46,624 street trees (trees between the sidewalk and street), with many more trees in City parks and open space, on medians and streetscapes, and within the City's rights of way. The July 2015 *Oakland Urban Tree Canopy Assessment* conducted by American Forests estimates that 24.8 percent of Oakland is covered in trees. This puts Oakland in about the mid-range of cities in the Bay Area for the size of its urban forest. Oakland has held the status of a Tree City USA for 28 years. This designation is made by the National Arbor Day Foundation to communities that meet core standards for urban forestry management.

Lake Merritt in Oakland, a tidal lagoon with a 3-mile shoreline, is home to the United States' oldest designated wildlife refuge, established by state law on March 18, 1870. Lake Merritt is a tidal estuary that formed about 10,000 to 15,000 years ago when the last ice age ended. It has been extensively modified by people in the last 150 years. It is flushed twice daily by the six-hour cycle of high and low tidal flows and receives water from 62 storm drain outfalls around the lake. With water coming from the storm drains and the estuary, the lake has brackish water (a mixture of fresh and salt water) but strongly tends toward a marine (salt water) environment.

4.7 DEVELOPMENT PROFILE

4.7.1 Land Use

The City of Oakland is highly urbanized. Of the total land, over 93 percent is developed. Residential neighborhoods are spread throughout the city. Table 4-4 and Figure 4-2 summarize the area and location of current land uses in the City of Oakland.

Table 4-4. General Plan Land Use Classifications in Oakland

Land Use	Area (acres)	% of Total
Mixed Housing Residential	5993.32	16.65%
Detached Unit Residential	5808.84	16.14%
Hillside Residential	6038.45	16.78%
Urban Residential	1219.33	3.39%
Neighborhood Center Mixed Use	728.63	2.02%
Community Commercial	775.29	2.15%
Regional Commercial	634.3	1.76%
Business Mix	1360.22	3.78%
General Industry and Transportation	4816.66	13.38%
Institutional	1060.26	2.95%
Central Business District	629.58	1.75%
Housing and Business Mix	357.7	.99%
Resource Conservation	3402.1	9.45%
Urban Park and Open Space	2395.64	6.66%
EPP[a] General Commercial	52.25	.15%
EPP Heavy Industry	28.45	.08%
EPP Light Industry	153.29	.43%
EPP Mixed Use District	75.7	.21%
EPP Off-Price Retail District	24.73	.07%
EPP Parks	68.93	.19%
EPP Planned Waterfront Development	112.13	.31%
EPP Produce Market	4.34	.01%
EPP Residential Mixed Use	129.66	.36%
EPP Retail Dining Entertainment	43.35	.12%
EPP Waterfront Commercial	41.61	.12%
EPP Waterfront Mixed Use	24.3	.07%
EPP Waterfront Warehouse District	14.16	.04%
Total	**35,993.22**	**100%**

a. EPP = Estuary Policy Plan

Source: General Plan GIS Data provided by City of Oakland

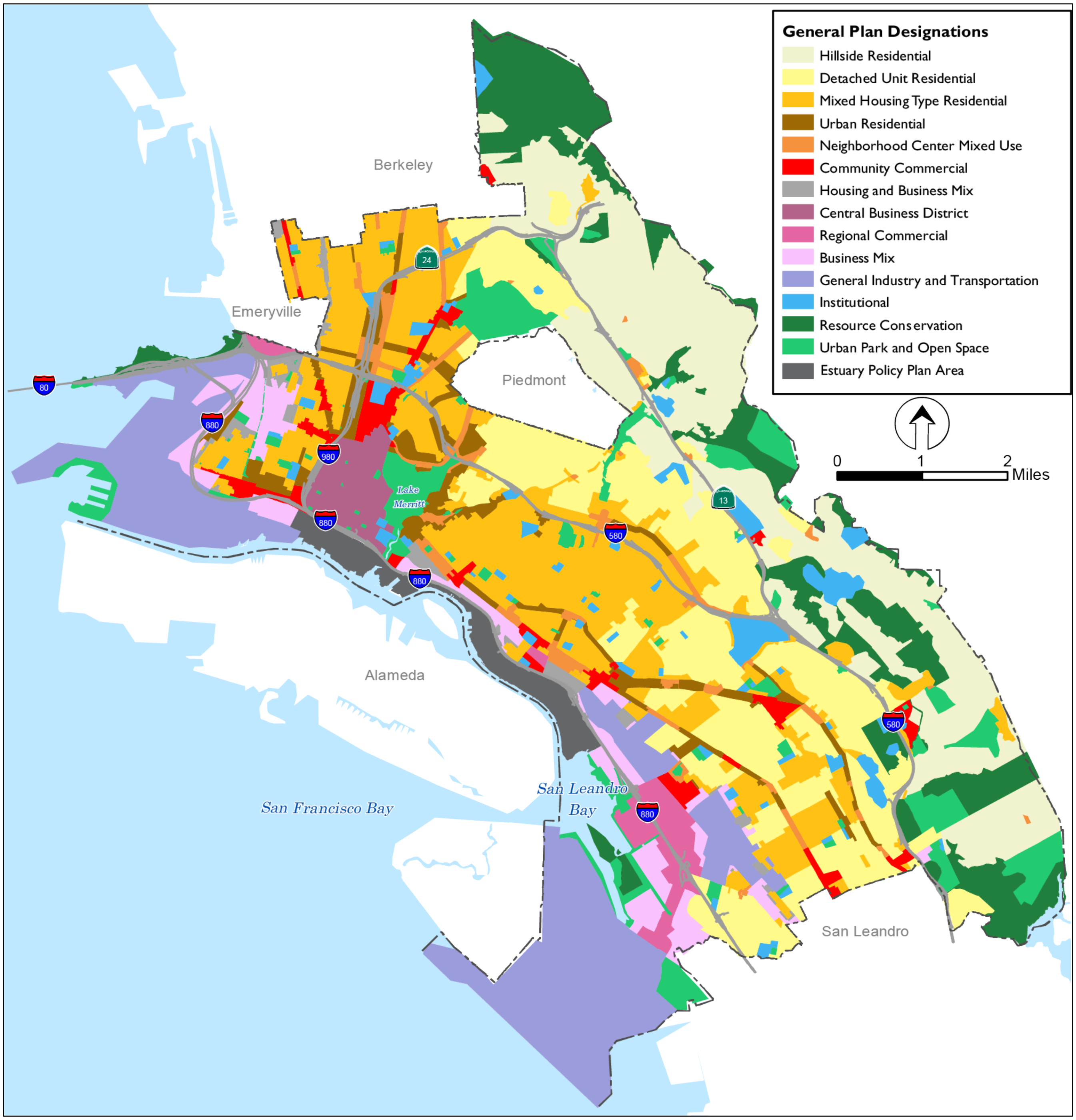


Figure 4-2. Land Use Classifications in the Planning Area

4.7.2 Building Stock

Based on assessor records, Table 4-5 and Table 4-6 show the breakdown of planning area building stock (number and estimated replacement value) by sub-area and by type of use, respectively.

Table 4-5. Distribution of Buildings in the Planning Area by Sub-Area

Sub-Area	Total # of Buildings	Total Building Value—Structure and Contents
Central East Oakland	20,615	$20.18 billion
Coliseum/Airport	946	$5.53 billion
Downtown	432	$17.90 billion
East Oakland Hills	10,110	$5.83 billion
Eastlake/Fruitvale	14,611	$17.52 billion
Glenview/ Redwood Heights	10,572	$6.08 billion
North Oakland Hills	9,442	$6.43 billion
North Oakland/Adams Point	14,966	$26.39 billion
West Oakland	4,078	$11.69 billion
Total	**85,772**	**$118 billion**

Table 4-6. Distribution of Buildings in the Planning Area by Use Type

Use Type	Number of Buildings	Estimated Total Replacement Value, Structure & Contents
Residential	85,772	$45.93 billion
Commercial	5,511	$47.68 billion
Industrial	753	$7.04 billion
Agriculture	4	$0.03 billion
Religion	531	$3.48 billion
Government	488	$5.89 billion
Education	306	$7.51 billion
Total	**93,365**	**$118 billion**

4.7.3 Critical Facilities

Critical facilities are those that are essential to the health and welfare of the population. These become especially important after a hazard event. Also included are facilities that hold significant amounts of hazardous materials with a potential to impact public welfare during a hazard event. The risk assessment for each hazard in this plan discusses potential impacts on critical facilities. This plan update uses the following definition of critical facilities:

> A structure, facility, or other improvement that, because of its function, service area, or uniqueness, provides service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic security.

The planning team and Steering Committee recommended that this plan update include a clearly defined definition of critical facilities that aligns with FEMA's "community lifelines" concept. This will position the City for future funding under FEMA grant programs and initiatives. The FEMA-defined lifeline categories are as follows:

- **Safety and Security**—Law enforcement/security, search and rescue, fire services, government service, responder safety, and imminent hazard mitigation
- **Food, Water and Shelter**—Evacuations, schools, food/potable water, shelter, durable goods, water infrastructure and agriculture
- **Health and Medical**—Medical care (hospitals), patient movement, public health, fatality management, health care and supply chain
- **Energy**—Power (grid), temporary power and fuel
- **Communications**—Infrastructure, alerts, warnings, messages, 911 and dispatch, responder communications and financial services
- **Transportation**—Highway/roadway, mass transit, railway, aviation, maritime and pipeline
- **Hazardous Materials**—Facilities, hazardous debris, pollutants, and contaminants

Table 4-7 summarizes the number of critical facilities within the planning area, based on the best data available on critical facilities at the time of this plan. The City considers this information to be subject to change as new information about critical facilities becomes available during the performance period for this plan. Due to the sensitivity of this information, a detailed list of facilities is not provided. General locations are shown on Figure 4-3 and Figure 4-4.

Table 4-7. Planning Area Critical Facilities

	Number of Critical Facilities by Lifeline Category							
	Communi-cations	Energy	Food, Water, Shelter	Hazardous Material	Health & Medical	Safety & Security	Transportation	Total
Central East Oakland	55	2	0	219	1	75	33	**385**
Coliseum/Airport	81	2	0	129	0	14	35	**261**
Downtown	154	4	0	123	1	41	28	**351**
East Oakland Hills	50	1	0	58	0	28	16	**153**
Eastlake/Fruitvale	47	2	1	212	2	60	46	**370**
Glenview/ Redwood Heights	7	2	0	64	0	22	23	**118**
North Oakland Hills	60	3	0	47	0	19	16	**145**
North Oakland/Adams Point	49	4	2	237	7	46	99	**444**
West Oakland	71	9	1	190	1	27	80	**379**
Total	**574**	**29**	**4**	**1,279**	**12**	**332**	**376**	**2,606**

4.7.4 Development Trends

The City of Oakland's General Plan governs land use decision and policymaking. This hazard mitigation plan will work together with the General Plan to support wise land use in the future by providing vital information on the risk associated with hazards within the city. The City will incorporate by reference the hazard mitigation plan in its General Plan Safety Element. This will ensure that all future trends in development can be established with the benefits of the information on risk and vulnerability to hazards identified in this plan. As the City prepares to undertake a comprehensive update to its General Plan, starting with adoption of the updated Safety Element, updated Housing Element, and new Environmental Justice Element as soon as January 2023, this hazard mitigation plan will provide critical data that informs this update and corresponding community outreach.

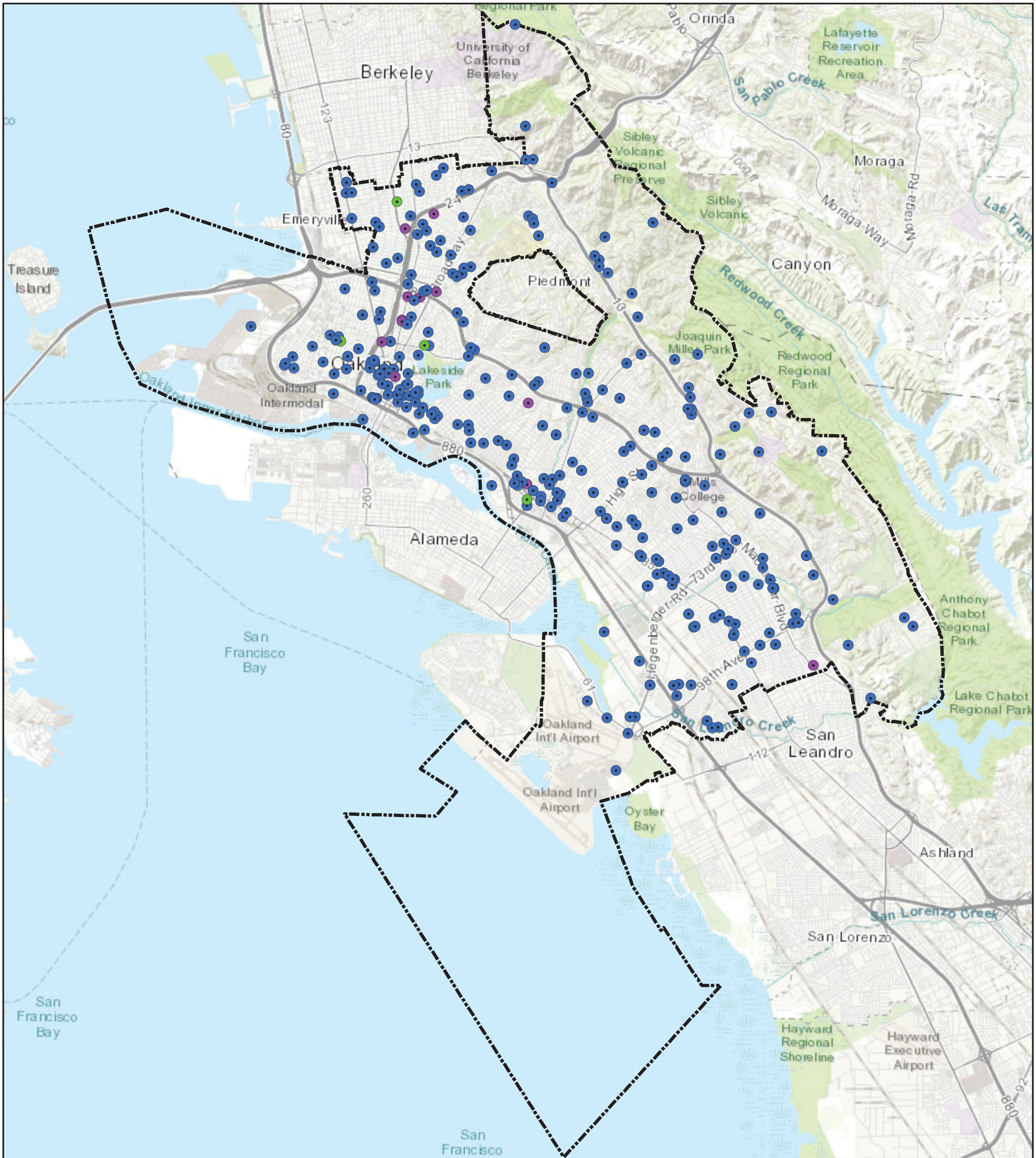


Figure 4-3. Critical Facilities (1 of 2)

Food, Water, Shelter

Health and Medical

Safety and Security

City Limits

N

0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland, Alameda Co., CA DTSC, CA ENERGY, CA WRCB, CalEPA, CALTRANS, DHS HIFLD

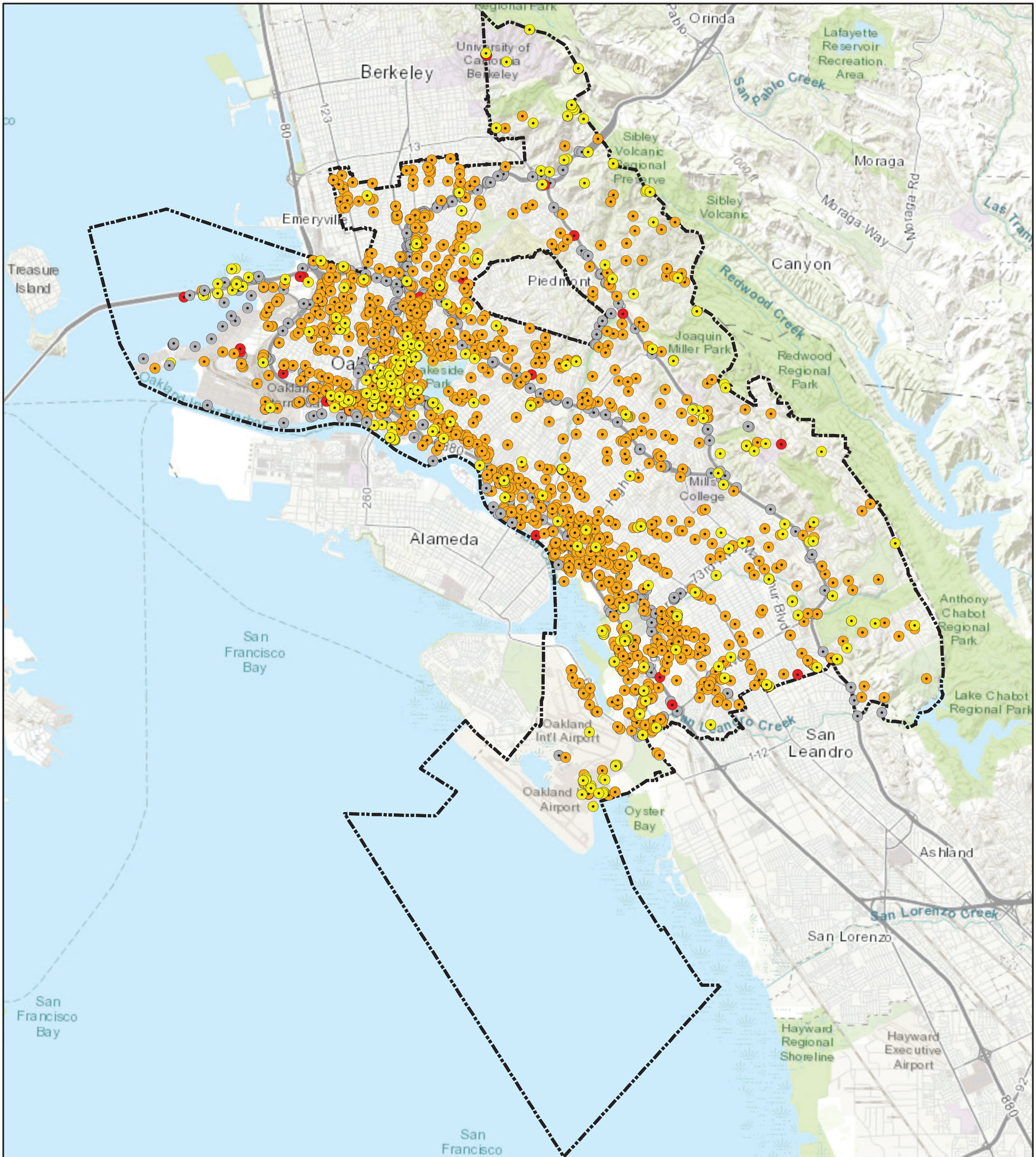


Figure 4-4. Critical Facilities (2 of 2)

Energy
Communications
Transportation
Hazardous Materials
City Limits

N
0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland, Alameda Co., CA DTSC, CA ENERGY, CA WRCB, CalEPA, CALTRANS, DHS HIFLD

The Land Use Element of the City's General Plan supports "growth in industry and commerce, providing the flexibility needed to accommodate evolving trends in retailing, entertainment, manufacturing processes, and distribution techniques while also resolving long-standing problems relating to conflicts among different land uses." The City currently has five adopted specific plans: the Broadway Valdez District Specific Plan, the Central Estuary Area Plan, the Coliseum Area Specific Plan, the Lake Merritt Station Area Plan, and the West Oakland Specific Plan. A specific plan is currently in development for Downtown Oakland.

The City developed an Estuary Policy Plan that proposes a variety of uses that can strengthen Oakland's position as an urban center, accommodate economic growth, and encourage development that complements the downtown and adjacent neighborhoods. All these plans provide guidance for the development of underutilized sites in the City with residential and commercial uses that will contribute to City revitalization and economic development.

The 2015-2023 City of Oakland Housing Element identifies areas of the city with the best potential for housing development, specifically addressing the needs of households by income level. The foundation for the Housing Element is a state-mandated requirement that all California cities provide for their fair share of the regional housing need for all income levels. In the Bay Area, assignments for each city are determined by the Association of Bay Area Governments. Under this requirement, Oakland needs to plan for 14,765 new housing units between 2014 and 2022 (City of Oakland Planning and Building Department, 2021).

4.8 DEMOGRAPHIC PROFILE

4.8.1 Population Counts

Information about population is a critical part of planning because it directly relates to land needs such as housing, industry, stores, public facilities and services, and transportation. Population changes are useful socio-economic indicators. A growing population generally indicates a growing economy, while a decreasing population may signify economic decline.

Current and Historical Population

The State of California Department of Finance reported the population of Oakland to be 433,697 as of January 1, 2020 (E-1 Population Estimates for Cities, Counties, and the State). Table 4-8 shows the population in the City of Oakland from 2000 to 2020.

Table 4-8. Annual Population Data

Year	Oakland Population	Year	Oakland Population	Year	Oakland Population
2000	399,566	**2007**	385,882	**2014**	414,091
2001	399,262	**2008**	387,554	**2015**	419,571
2002	399,296	**2009**	389,913	**2016**	425,115
2003	397,440	**2010**	391,475	**2017**	428,165
2004	394,917	**2011**	390,724	**2018**	429,145
2005	389,937	**2012**	394,694	**2019**	430,753
2006	386,350	**2013**	399,927	**2020**	433,697

Source: California Department of Finance E-4 Population Estimates, 2001-2010 & 2011-2020

Between 2000 and 2020, California's population grew by 17.5 percent while the City of Oakland's population increased by 9.8 percent. Figure 4-5 shows the planning area's annual population growth rates from 1970 to 2020 compared to those of the state. The state experienced peak population growth in 2000, while the Oakland area is currently at its peak growth rate. The state and the City both experienced a general slowing of the annual growth rate between 2000 to 2010. However, the City of Oakland's population grew by 11 percent between 2010 and 2020, while the California population only grew by 7 percent during the same period.

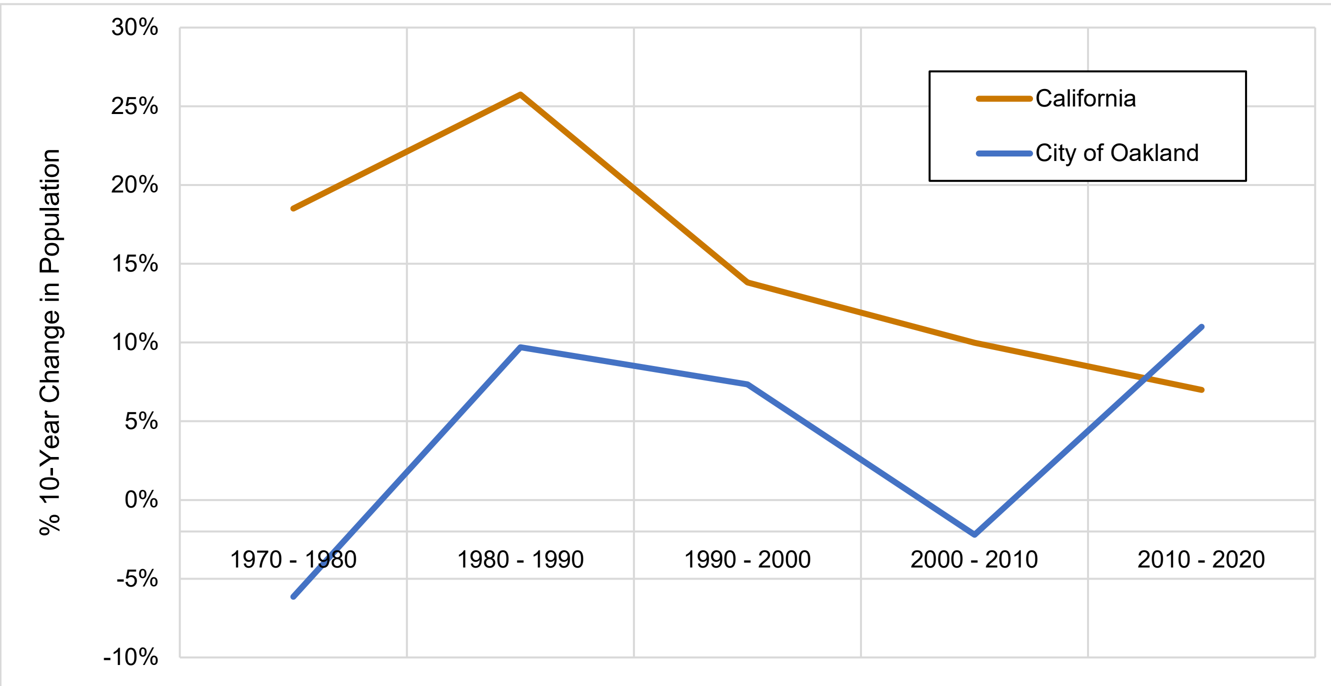


Figure 4-5. State of California and City of Oakland Population Growth by Decade

Projected Future Population

According to population projections by the California Department of Finance, Alameda County's population is expected to increase to 1.9 million by 2040. This represents about a 13 percent increase from the 2020 population of 1.68 million.

4.8.2 Indicators for Social Vulnerability

Research has established the importance of tailoring local hazard mitigation and emergency response policies to the needs of the community they serve. Some populations are at greater risk from hazard events because of decreased resources or physical abilities.

Researchers have identified the following as key dimensions of social vulnerability:

- Income
- Gender
- Race, ethnicity

- Age
- Language
- Unemployment, dependence on social services
- Renting as opposed to owning a home
- Infrastructure lifelines
- Occupation/working conditions
- Family structures
- Educational attainment level
- Disabilities or access and functional needs.

These factors indicate population groups who are more vulnerable due to lack of material, economic, and political resources. Socially vulnerable groups all experience, to some degree, more severe effects from disasters than the general population. They may vary from the general population in risk perception, living conditions, access to information before, during and after a hazard event, capabilities during an event, and access to resources for post-disaster recovery.

Identification and recognition of where vulnerable groups are located within the community is critical for building long-term community resilience. Indicators of vulnerability often overlap spatially and often in the geographically most vulnerable locations. Detailed spatial analysis to locate areas where there are higher concentrations of vulnerable community members can help to extend focused public outreach and education to these most vulnerable citizens. This knowledge results in better hazard mitigation policies because many hazards of concern occur in defined locations.

Indicators from Census data are commonly used to assess social vulnerability. For the social vulnerability component of the risk assessment for this plan, the following indicators were selected:

- **Population Under 15 Years of Age—**Children, especially in the youngest age groups, often cannot protect themselves during a disaster because they lack the necessary resources, knowledge, or life experiences to effectively cope with the situation. Hazard mitigation planning needs to be tailored such that the community is prepared to ensure that children are safe during disaster events and that families with children have access to necessary information and tools.
- **Population Over 65 years of Age—**People 65 years old and older are likely to require financial support, transportation, medical care, or assistance with ordinary daily activities, especially during disasters. They are more likely to be vision, hearing, and/or mobility impaired, more likely to experience mental impairment or dementia, and more likely to live in assisted-living facilities where emergency preparedness is at the discretion of facility operators. Hazard mitigation needs to account for such needs.
- **People of Color—**Social and economic marginalization of certain racial and ethnic groups, including real estate discrimination, has resulted in greater vulnerability of these groups to all types of hazards. Based on data from several studies, African Americans, Native Americans, and populations of Asian, Pacific Islander, or Hispanic origin are likely to be more vulnerable than the broader community. Research shows that minorities are less likely to be involved in pre-disaster planning and experience higher mortality rates during disaster events. Post-disaster recovery often exhibits cultural insensitivity. Since higher proportions of ethnic minorities live below the poverty line than the majority white population, poverty

can compound vulnerability. Hazard mitigation plans need to identify the spatial distribution of these population groups and direct resources to reduce their vulnerability to hazards.

- **Limited English-Speaking Households—**For populations with limited English proficiency, disaster communication may be difficult, especially in communities for whom translators and accurate translations of advisories may be scarce. Such households are likely to rely on relatives and local social networks (i.e., friends and neighbors) for information for preparing for a disaster event.
- **Persons with Disabilities—**Persons with disabilities or other access and functional needs are more likely to have difficulty responding to a hazard event than the general population. Family, neighbors, and local government are the first level of response to assist these individuals. Coordination of efforts to meet their access and functional needs is paramount to life safety efforts. Emergency managers need to distinguish between functional and medical needs to plan for incidents that require evacuation and sheltering. Knowing the percentage of population with access and functional needs allows emergency management personnel and first responders to anticipate the services needed by that population.
- **Families below the Poverty Level—**Economically disadvantaged families have limited ability to absorb losses due to hazard impacts. Wealth enables families to absorb and recover from losses more quickly, due to insurance, savings, and often the availability of low-cost credit. People with lower incomes tend not to have access to these resources. At the same time, poorer families are likely to inhabit poor quality housing and reside in locations that are most vulnerable to hazard events. Economically disadvantaged neighborhoods are also likely to have relatively poor infrastructure and facilities, which exacerbate the disaster consequences for residents there.
- **Renter Occupied Housing Units—** People who rent often do so because they do not have the financial resources for home ownership. They often lack access to information about financial aid during recovery. In the most extreme cases, renters lack sufficient shelter options when lodging becomes uninhabitable and limited supply causes housing costs to rise dramatically after a disaster. Renters commonly have limited opportunities for implementing mitigation measures at their home and may not have insurance to cover their personal property. Additionally, renters may not be aware of hazard risks at the property where they live. Hazard mitigation planning needs to explore ways to ensure that renters are aware of risks and opportunities available to them to mitigate known risks.

These factors are most likely to influence vulnerability and were selected based on the equity priorities established for this plan and the availability of datasets at a small enough resolution to determine probable characteristics of populations within identified hazard areas. The following sections estimate these indicators for the planning area.

Age Distribution

Based on 2019 U.S. Census estimates, 13.8 percent of the City's population is 65 or older, lower than the state average of 14.8 percent. Census data shows that 35.2 percent of Oakland's over-65 population has disabilities of some kind and 13.0 percent have incomes below the poverty level.

The Census data shows that 17.0 percent of the population is 14 or younger, slightly less than the state average of 18.7 percent. Children under the age of 18 account for 17.7 percent of individuals living in households below the poverty level.

The overall age distribution for the City is shown in Figure 4-6.

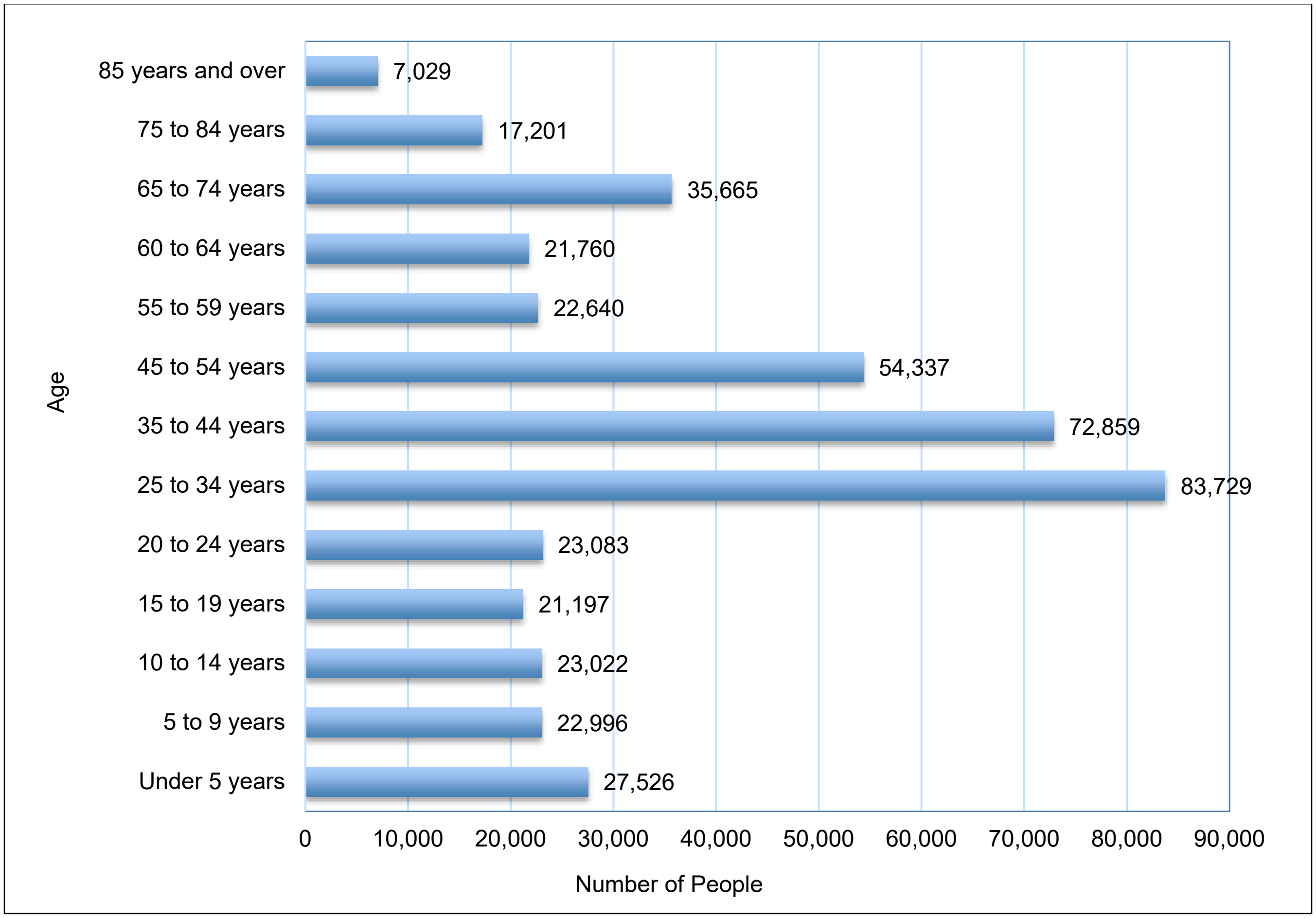


Figure 4-6. City of Oakland Age Distribution

Race, Ethnicity and Language

Oakland is one of the most ethnically diverse major cities in the country. The U.S. Census Bureau estimates that the racial composition of the City of Oakland is 34.5 percent white and 24.9 percent African American. The next largest racial groups are Some Other Race at 18.3 percent and Asian at 14.3 percent. The Hispanic or Latino population, which is classified by the U.S. Census Bureau as an ethnic designation rather than a race, is 26.8 percent of the total, with 17.6 percent identifying as Mexican in origin. Figure 4-7 shows the racial distribution in the City of Oakland.

The planning area has a 25.1 percent foreign-born population. Other than English, the most spoken languages in the City of Oakland are Spanish (21.1 percent) and Asian and Pacific Island languages (10.4 percent). The Census estimates 10.7 percent of the residents speak English "less than very well."

Persons with Disabilities or with Access and Functional Needs

According to 2019 Census estimates, persons with disabilities or with access and functional needs make up 13.4 percent of the total civilian non-institutionalized population of the City of Oakland. Within this population, 71.1 percent are not currently in the labor force, 28.3 percent live below the poverty level, and the median earnings in the past 12 months is $26,701.

Source: American Community Survey Demographic and Housing Estimates, 2019

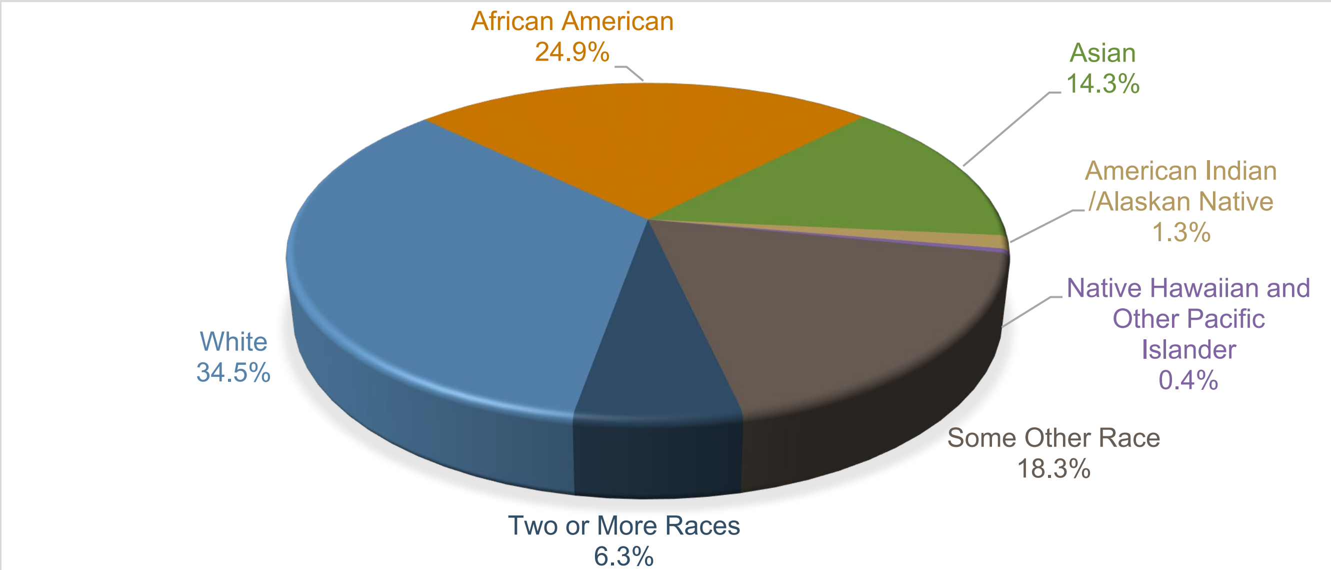


Figure 4-7. City of Oakland Race Distribution

Income

Based on 2019 Census data, per capita income in the City of Oakland was $43,191 and the median household income was $73,692. The Department of Housing and Urban Development estimated a 2020 median family income for the Oakland-Fremont Metro Fair Market Rent Area of $112,243.

Citywide, 16.7 percent of persons live at the poverty level, compared to 11.8 percent statewide.

Homeownership and Renter-Occupied Housing

According to 2019 American Community Survey estimates, there are 168,413 occupied housing units in the City of Oakland. Table 4-9 compares general demographic statistics for renter-occupied and owner-occupied housing units.

Table 4-9. Comparative Statistics for Renter-Occupied and Owner-Occupied Housing Units

	Renter-Occupied Housing Units	Owner-Occupied Housing Units
Occupied Housing Units		
Number	98,857	69,566
% of Total	58.7 percent	41.3 percent
Age of Residents		
< 35	33.4 percent	7.5 percent
Time Living at Current Residence		
Moved in in 2017 or Later	32.2 percent	13.7 percent

4.9 ECONOMY

4.9.1 Industry, Businesses, and Institutions

Figure 4-8 shows the breakdown of employment in the planning area by industry sector. The City's economy is strongly based in the education/health services sector and professional/scientific/management sector, followed by arts and entertainment, retail trade, other services, finance, and transportation. Wholesale trade and agriculture make up the smallest sectors of the local economy. Table 4-10 identifies the principal employers in the City of Oakland in 2018 as provided by the City.

4.9.2 Employment Trends

The City of Oakland's local employment base rose steadily between 2000 and 2019, largely due to the growth of the technology and health industries in Oakland and the greater Bay Area. Economic analyses have indicated that a variety of industries would be interested in locating in Oakland if better designed and located spaces were available, including clothing, food, warehousing, distribution, and logistics companies.

According to the 5-year American Community Survey (2019), about 225,010, or 64.5 percent of the City of Oakland's population 16 years old or older is in the labor force. Of the working-age population, 51.2 percent of men and 48.8 percent of women are in the labor force.

Figure 4-9 compares unemployment rates for the State of California and the City of Oakland from 2009 through 2019. Full year data for 2020, with the employment impact of the COVID-19 pandemic, was not available in time for this plan. The data shown represents mid-year (June) samples for unemployment provided by the U.S. Department of Labor Bureau of Labor Statistics. The 2019 City of Oakland unemployment rate was the lowest in 10 years at 3.6 percent. The rate peaked at 14.9 percent in 2009 and declined from then through 2019. In most years, the City unemployment rate was slightly higher than that of the state.

Figure 4-10 shows U.S. Census data for the most common types of work for the employed population of the City of Oakland. This includes wage and salary jobs, and jobs held by business owners and self-employed persons. The total job count does not include unpaid volunteers or family workers, or private household workers. In 2019, the estimated total number of employed Oakland residents was 231,125, an increase of 29.4 percent from 2010.

The 2019 U.S. Census Bureau data shows 62.6 percent of the City's population work and live in Oakland; 37.2 percent commute to other places. In 2019, 55.5 percent of Oakland commuters spent more than 30 minutes to travel to work.

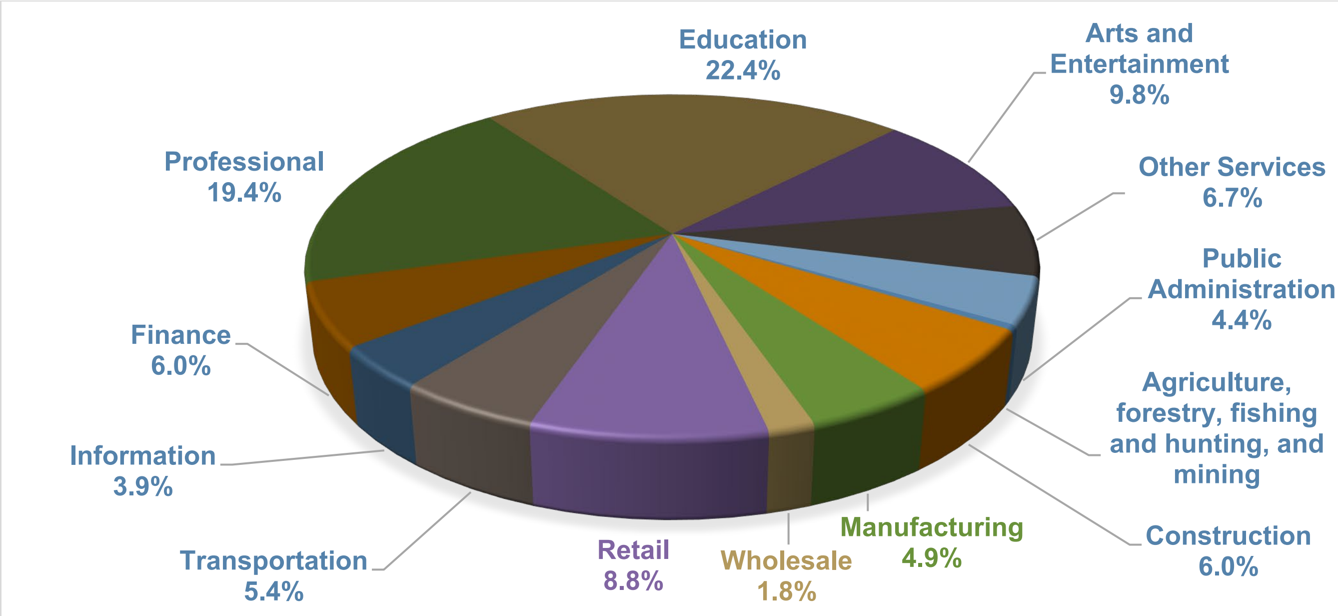


Figure 4-8. Employment in the City of Oakland by Industry Sector

Table 4-10. 2018 Principal Employers within the City of Oakland

Employer	Employer Type
Kaiser Foundation Health Plan, Hospitals, and Kaiser Permanente Medical Group	Health Care, Professional
Oakland Unified School District	Education
City of Oakland	Public Administration
Bay Area Rapid Transit (BART) District	Public Administration
State of California	Public Administration
United Parcel Service	Service
Southwest Airlines	Transportation
UCSF Benioff Children's Hospital Oakland	Health Care
Alta Bates Summit Medical Center/Sutter Health	Health Care
East Bay Municipal Utility District (East Bay MUD)	Public Administration
U.S. Postal Service	Public Administration
University of California	Education
FedEx	Service
Manos Home Care	Health Care
Pandora	Professional
Peralta Community College District	Education
East Bay Regional Park District	Public Administration

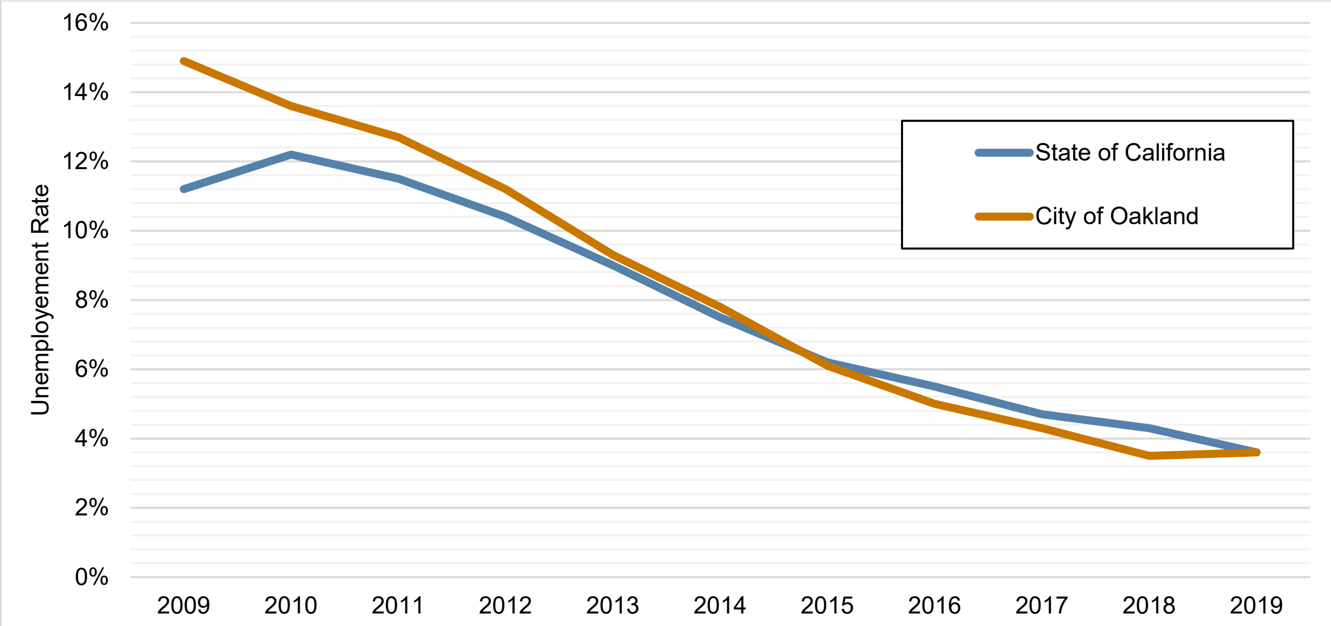


Figure 4-9. 10-Year Unemployment Rates for California and Oakland

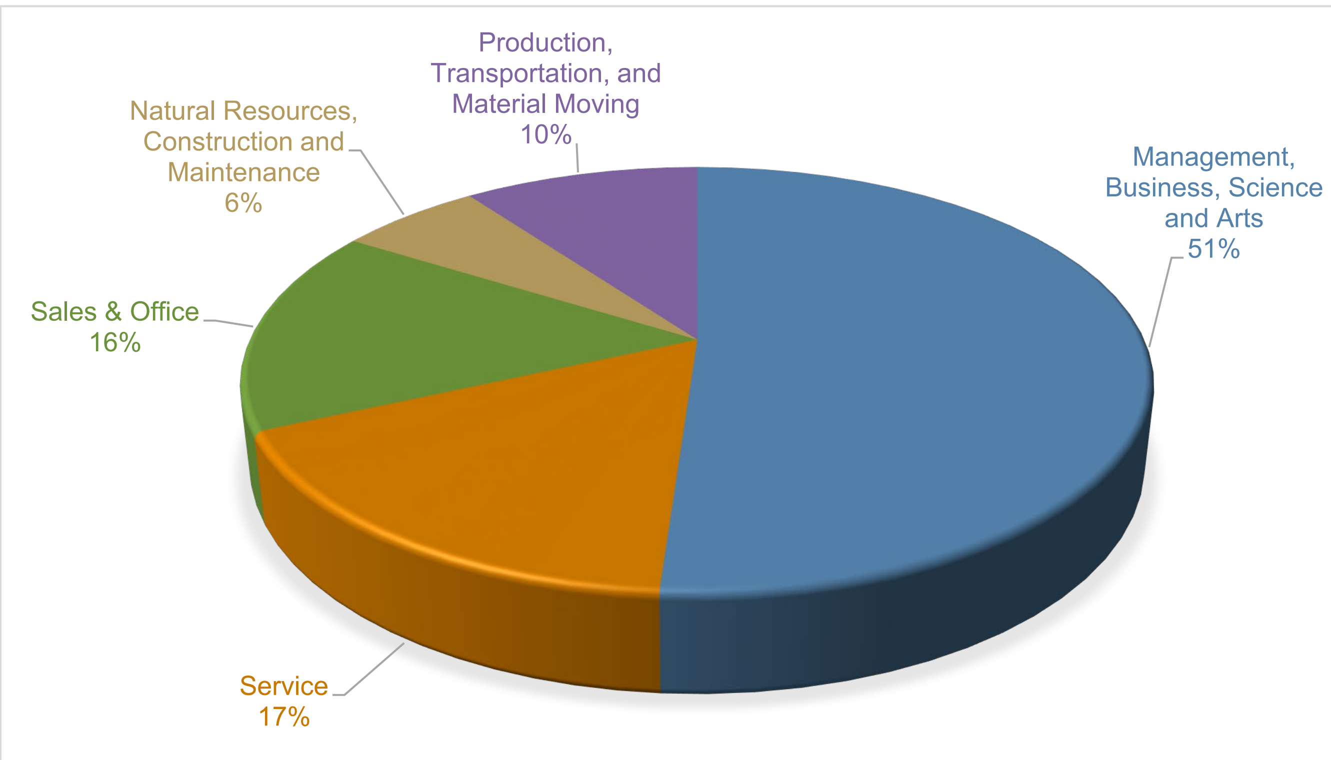


Figure 4-10. Employment in the Planning Area by Type of Work

5. REGULATIONS AND PROGRAMS

Existing laws, ordinances, plans and programs at the federal and state level can support or impact hazard mitigation actions identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). This chapter presents the relevant information for laws, plans and programs at the federal, state, and local levels.

5.1 FEDERAL AND STATE

This section summarizes federal and state programs that may interface with the actions identified in this plan. Each program enhances capabilities to implement mitigation actions or has a nexus with a mitigation action in this plan. State and federal regulations and programs that need to be considered in hazard mitigation are constantly evolving. For this plan, a review was performed to determine which regulations and programs are currently most relevant to hazard mitigation planning. The findings are summarized in Table 5-1 and Table 5-2. Short descriptions of each program are provided in Appendix B.

Table 5-1. Summary of Relevant Federal Agencies, Programs and Regulations

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
Americans with Disabilities Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Bureau of Land Management	Wildfire Hazard	The Bureau funds and coordinates wildfire management programs and structural fire management and prevention on BLM lands.
Civil Rights Act of 1964	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Clean Water Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Community Development Block Grant Disaster Resilience Program	Action Plan Funding	This is a potential alternative source of funding for actions identified in this plan.
Community Rating System	Flood Hazard	This voluntary program encourages floodplain management activities that exceed the minimum National Flood Insurance Program requirements.
Disaster Mitigation Act	Hazard Mitigation Planning	This is the current federal legislation addressing hazard mitigation planning.
Emergency Relief for Federally Owned Roads Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.
Emergency Watershed Program	Action Plan Funding	This is a possible funding source for actions identified in this plan.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
Endangered Species Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
Federal Energy Regulatory Commission Dam Safety Program	Dam Failure Hazard	This program cooperates with a large number of federal and state agencies to ensure and promote dam safety.
Federal Wildfire Management Policy and Healthy Forests Restoration Act	Wildfire Hazard	These documents mandate community-based collaboration to reduce risks from wildfire.
National Dam Safety Act	Dam Failure Hazard	This act requires a periodic engineering analysis of most dams in the country
National Environmental Policy Act	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable federal acts.
National Fire Plan	Wildfire Hazard	This plan calls for joint risk reduction planning and implementation by federal, state and local agencies.
National Flood Insurance Program	Flood Hazard	This program makes federally backed flood insurance available to homeowners, renters, and business owners in exchange for communities enacting floodplain regulations
National Incident Management System	Action Plan Development	Adoption of this system for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards is a prerequisite for federal preparedness grants and awards
National Landslide Preparedness Act	Landslide Hazard	This act authorized a national landslide hazards reduction program and a 3D elevation program, providing tools and data to assess the landside hazard.
Presidential Executive Order 11988 (Floodplain Management)	Flood Hazard	This order requires federal agencies to avoid long and short-term adverse impacts associated with modification of floodplains
Presidential Executive Order 11990 (Protection of Wetlands)	Action Plan Implementation	FEMA hazard mitigation project grant applications require full compliance with applicable presidential executive orders.
U.S. Army Corps of Engineers Dam Safety Program	Dam Failure Hazard	This program is responsible for safety inspections of dams that meet size and storage limitations specified in the National Dam Safety Act.
U.S. Army Corps of Engineers Flood Hazard Management	Flood Hazard, Action Plan Implementation, Action Plan Funding	The Corps of Engineers offers multiple funding and technical assistance programs available for flood hazard mitigation actions
U.S. Fire Administration	Wildfire Hazard	This agency provides leadership, advocacy, coordination, and support for fire agencies and organizations.
U.S. Fish and Wildlife Service	Wildfire Hazard	This service's fire management strategy employs prescribed fire throughout the National Wildlife Refuge System to maintain ecological communities.

Table 5-2. Summary of Relevant State Agencies, Programs and Regulations

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
AB 32: The California Global Warming Solutions Act	Action Plan Development	This act establishes a state goal of reducing greenhouse gas emissions to 1990 levels by 2020
AB 70: Flood Liability	Flood Hazard	A city or county may be required to partially compensate for property damage caused by a flood if it unreasonably approves new development in areas protected by a state flood control project
AB 162: Flood Planning	Flood Hazard	Cities and counties must address flood-related matters in the land use, conservation, and safety and housing elements of their general plans.
AB 747: General Plans—Safety Element	Hazard Mitigation Planning	The safety elements of cities' and counties' general plans must address evacuation routes and include any new information on flood and fire hazards and climate adaptation and resiliency strategies.
AB 2140: General Plans—Safety Element	Hazard Mitigation Planning	This bill enables state and federal disaster assistance and mitigation funding to communities with compliant hazard mitigation plans.
AB 2800: Climate Change—Infrastructure Planning	Action Plan Development	This act requires state agencies to take into account the impacts of climate change when developing state infrastructure.
Alquist-Priolo Earthquake Fault Zoning Act	Earthquake Hazard	This act restricts construction of buildings used for human occupancy on the surface trace of active faults.
California Coastal Management Program	Flood, Landslide, Tsunami and Wildfire Hazards	This program requires coastal communities to prepare coastal plans and requires that new development minimize risks to life and property in areas of high geologic, flood, and fire hazard.
California Department of Forestry and Fire Protection (CAL FIRE)	Wildfire Hazard	CAL FIRE has responsibility for wildfires in areas that are not under the jurisdiction of the Forest Service or a local fire organization.
California Department of Parks and Recreation	Wildfire Hazard	State Parks Resources Management Division has wildfire protection resources available to suppress fires on State Park lands.
California Department of Water Resources	Flood Hazard	This state department is the state coordinating agency for floodplain management.
California Division of Safety of Dams	Dam Failure Hazard	This division monitors the dam safety program at the state level and maintains a working list of dams in the state.
California Environmental Quality Act	Action Plan Implementation	This act establishes a protocol of analysis and public disclosure of the potential environmental impacts of development projects. Any project action identified in this plan will seek full California Environmental Quality Act compliance upon implementation.
California Fire Alliance	Wildfire Hazard	The alliance works with communities at risk from wildfires to facilitate the development of community fire loss mitigation plans.
California Fire Plan	Wildfire Hazard	This plan's goal is to reduce costs and losses from wildfire through pre-fire management and through successful initial response.
California Fire Safe Council	Wildfire Hazard	This council facilitates the distribution of National Fire Plan grants for wildfire risk reduction and education.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
California Fire Service and Rescue Emergency Mutual Aid Plan	Wildfire Hazard	This plan provides guidance and procedures for agencies developing emergency operations plans, as well as training and technical support.
California General Planning Law	Hazard Mitigation Planning	This law requires every county and city to adopt a comprehensive long-range plan for community development, and related laws call for integration of hazard mitigation plans with general plans.
California Multi-Hazard Mitigation Plan	Hazard Mitigation Planning	Local hazard mitigation plans must be consistent with their state's hazard mitigation plan.
California Residential Mitigation Program	Earthquake Hazard	This program helps homeowners with seismic retrofits to lessen the potential for damage to their houses during an earthquake.
California State Building Code	Action Plan Implementation	Local communities must adopt and enforce building codes, which include measures to improve buildings' ability to withstand hazard events.
Disadvantaged and Low-Income Communities Investments	Action Plan Funding	This is a potential source of funding for actions located in disadvantaged or low-income communities.
Division of the State Architect's AB 300 List of Seismically At-Risk Schools	Earthquake Hazard, Action Plan Development	The Division of the State Architect recommends that local school districts conduct detailed seismic evaluations of seismically at-risk schools identified in the inventory that was required by AB 300.
Governor's Executive Order S-13-08 (Climate Impacts)	Action Plan Implementation	This order includes guidance on planning for sea-level rise in designated coastal and floodplain areas for new projects.
Office of the State Fire Marshal	Wildfire Hazard	This office has a wide variety of fire safety and training responsibilities.
Senate Bill 92: Public Resources Portion of Biennial Budget Bill	Dam Failure Hazard	This bill requires dams (except for low-risk dams) to have emergency action plans that are updated every 10 years and inundation maps updated every 10 years, or sooner if specific circumstances change.
Senate Bill 97: Guidelines for Greenhouse Gas Emissions	Action Plan Implementation	This bill establishes that greenhouse gas emissions and the effects of greenhouse gas emissions are appropriate subjects for California Environmental Quality Act analysis.
Senate Bill 99: General Plans: Safety Element: Emergency Evacuation Routes	Action Plan Implementation	This bill requires the safety element must include information to identify residential developments in hazard areas that do not have at least two emergency evacuation routes.
Senate Bill 182: Local Government: Planning and Zoning: Wildfires	Wildfire Hazard	This bill made a number of changes to state law regarding planning for and permitting development in areas designated as very high fire risk areas.
Senate Bill 379: General Plans: Safety Element—Climate Adaptation	Action Plan Implementation	This bill requires cities and counties to include climate adaptation and resiliency strategies in the safety element of their general plans.
Senate Bill 1000: General Plan Amendments—Safety and Environmental Justice Elements	Action Plan Implementation	Under this bill, review and revision of general plan safety elements are required to address only flooding and fires (not climate adaptation and resilience), and environmental justice is required to be included in general plans.

Agency, Program or Regulation	Hazard Mitigation Area Affected	Relevance
Senate Bill 1035: Fire, Flood, and Adaptation Safety Element Updates	Action Plan Implementation	Clarifies that revisions to the Safety Element to address fire hazards, flood hazards, and climate adaptation and resilience strategies all must occur upon each revision to a Housing Element or Local Hazard Mitigation Program.
Senate Bill 1241: General Plans: Safety Element—Fire Hazard Impacts	Wildfire Hazard	This bill requires cities and counties to make findings regarding available fire protection and suppression services before approving a tentative map or parcel map.
Standardized Emergency Management System	Action Plan Implementation	Local governments must use this system to be eligible for state funding of response-related personnel costs.
Western Governors Association Ten-Year Comprehensive Strategy	Wildfire Hazard	This strategy implementation plan prepared by federal and Western state agencies outlines measures to restore fire-adapted ecosystems and reduce hazardous fuels.

5.2 CITY OF OAKLAND

This section identifies local programs, plans, and studies that define the core capabilities of the City relative to implementing the mitigation actions identified in this plan. These programs, plans and studies, as well as any hazard mitigation actions identified in any of them, are hereby integrated into this hazard mitigation plan by reference.

5.2.1 General Plan

The Planning and Building Department works with the Planning Commission and the community to make long-term plans for growth and development in Oakland. The General Plan is a comprehensive set of purposes, policies, and programs to guide the future form and development of the City. The General Plan is a strategic, long-term document that affects the lives of City residents and the business community. It is implemented by decisions that direct the allocation of public resources and that shape private development. The General Plan contains the following elements or plans that outline policies for land use and development throughout Oakland:

- **Land Use and Transportation Element—**Designates the kinds, location, and intensity of land uses, as well as appropriate zoning controls to achieve development policies. The Pedestrian and Bicycle Master Plans are considered part of this element.
- **Estuary Policy Plan**—Includes objectives and policies to enhance the Oakland waterfront as a resource for the City. The Estuary Policy Plan (EPP) serves as the Land Use Element for the Estuary shoreline area, extending from Castro Street to the East Creek Slough.
- **Historic Preservation Element**—Provides the goals, policies, and actions to encourage the preservation of older buildings, districts, and other physical features with historic value.
- **Housing Element**—Provides an assessment of the need for housing and an inventory of housing; statement of goals with regard to housing residents; and a program for providing the needed amount of housing throughout the City.
- **Noise Element**—Analyzes and quantifies the existing and projected noise levels from noise sources such as traffic and commercial and aviation activities; includes implementation measures to address any foreseeable noise problems.
- **Open Space, Conservation and Recreation Element—**Contains policies addressing the management of open land, natural resources, and parks in the City.

- **Safety Element**—Includes a policy framework to guide public decision-making with regard to safety hazards. The Safety Element addresses public safety, geological hazards, fire hazards, hazardous materials, and flooding hazards.
- **Scenic Highways—**Addresses the preservation and enhancement of attractive roadways and major thorough fares traversing the City.

This hazard mitigation plan and previous versions build upon and refine priorities first set in 2004 with the adoption of the Safety Element to the General Plan. The Safety Element is a living document used by City staff with a comprehensive discussion of natural and human-caused hazards in Oakland. It outlines measures to mitigate effects from those hazards. All mitigation strategies identified in the *2021-2026 Local Hazard Mitigation Plan* will be integrated as an implementation annex into those contained in the Safety Element. This will require a resolution by the City Council and will be based on a recommendation from the Oakland Planning Commission.

The City is preparing to comprehensively update its General Plan to guide the future of Oakland in a way that reflects community priorities and values. In alignment with state law, the initial focus will be on the Housing Element, Safety Element, and new Environmental Justice Element, followed by Land Use and Transportation Element, Open Space Element, Recreation Element, and possibly others.

5.2.2 Neighborhood and Specific Area Plans

Oakland has embarked on a series of plans for creating sustainable and vibrant neighborhoods. This program includes the development of nine neighborhood and specific area plans, which are functional components of the General Plan (see Table 5-3).

5.2.3 Title 17 Oakland Planning Code

The City of Oakland Planning Code (Title 17 of the City of Oakland Municipal Code) implements the policies of the General Plan and other City plans, policies, and ordinances. The Planning Code divides the City into zones and assigns land use and development regulations to each zone. These regulations direct the construction, nature, and extent of building use. In the event of conflict between the Oakland Planning Code and the General Plan, Chapter 17.01 establishes that the direction of the City's General Plan shall prevail over the Planning Code:

> *Until the Planning Code is fully updated, land use designations, zoning controls, and subdivision controls specified by the Planning Code and Subdivision Regulations shall apply, except where such action would expressly conflict with the Oakland General Plan. Where an express conflict does arise, the General Plan policies and land use designations shall apply. An "express conflict" shall be deemed to be any situation where a proposal clearly conforms with the General Plan but is not permitted by the portion of Zoning Regulations that have not been fully updated, or where a proposal clearly does not conform with the General Plan, but is permitted or conditionally permitted by the portion of Zoning Regulations that have not been fully updated.*

5.2.4 Soft-Story Retrofit Program

The City of Oakland's Soft Story Retrofit Program works to save lives by strengthening buildings with large ground-floor openings that are particularly prone to collapse during an earthquake. Effective January 22, 2019, Municipal Ordinance No. 13516 requires residential property owners to strengthen these vulnerable buildings with seismic retrofits.

Table 5-3. Summary of Neighborhood and Specific plans

Plan	Summary
Broadway Valdez District Specific Plan	The Broadway Valdez District Specific Plan envisions the district as a complete neighborhood that supports socially and economically sustainable mixed use development; increases the generation and capture of local sales tax revenue; celebrates the cultural and architectural influences of the neighborhood's past and present-day prosperity, and implements a green, transit-first strategy that reduces greenhouse gas emissions and the use of non-renewable resources.
Central Estuary Area Plan	The City of Oakland adopted the Central Estuary Area Plan and related environmental document, to guide future development in the Central Estuary Area, which extends from 19th Avenue to 54th Avenue and from I-880 to the Oakland Estuary.
Coliseum Area Specific Plan	The Coliseum Area Specific Plan seeks to transform the underutilized land around the Oakland-Alameda County Coliseum and Arena into a world-class sports, entertainment and science & technology district that boasts a dynamic and active urban setting with retail, entertainment, arts, culture, living, and work uses. The Plan was adopted by City Council in March 2015.
Downtown Oakland Specific Plan (Downtown Plan)	The City of Oakland is preparing a specific plan for downtown Oakland to ensure continued growth and revitalization to benefit both downtown residents and the larger community. The plan will provide sound policy guidance on development, linking land use, transportation, economic development, housing, public spaces, cultural arts, and social equity.
East Oakland Neighborhoods Initiative	The East Oakland Neighborhoods Initiative is a partnership between the City of Oakland's Bureau of Planning and 12 community-based organizations focused on equity-based planning for Deep East Oakland. These partners conducted a year of community outreach to identify the primary concerns, goals, and priorities for East Oakland residents and stakeholders. The final Community Plan contains the major findings from a year of community outreach, as well as recommended next steps.
Gateway Industrial District (portion of former Oakland Army Base)	The Gateway Industrial District is adjacent to the Port of Oakland and the community of West Oakland. The 160-acre District is designed to support the City's industrial needs and the movement of goods by way of the seaport, railroad and roadway networks while providing jobs and reducing air pollution emissions. The District was formerly part of the Oakland Army Base, which was commissioned in 1942 and closed 1999. To enable redevelopment, the City completed a major public infrastructure project in 2019, installing new roads and utilities, including bike paths and Bay Trail connections. Today, the District features new state-of-the-art warehouse and distribution facilities.
Lake Merritt Station Area Plan	The Lake Merritt Station Area Plan envisions a culturally vibrant, mixed-income, high-intensity, mixed-use neighborhood around a rejuvenated Lake Merritt BART station.
North Oakland Hills Area Specific Plan	The purpose of this Specific Plan developed in 1986 is to supplement and complement the provisions of the City's General Plan in addressing potential problems in the North Oakland Hills area. The focus of this plan is to mitigate potential problems within the area through a new "combining zone" in the City's zoning regulations, a variety of code changes and other special measures.
West Oakland Specific Plan	The purpose of the West Oakland Specific Plan is to develop comprehensive, multi-faceted strategies for facilitating the development of selected vacant and/or underutilized commercial and industrial properties within the West Oakland community.

Title 15, Chapter 15.27 establishes a program of mandatory seismic evaluation and retrofit of certain residential buildings vulnerable to earthquake damage. The program is intended to reduce earthquake-related deaths and injuries, improve the durability of Oakland's housing stock, facilitate post-earthquake emergency response, improve community stability, minimize displacement during retrofits and after an earthquake, and reduce the economic impacts of an earthquake. This regulation targets buildings with a wood-frame target story and five or more dwelling units that was constructed or permitted for construction before 1991 or designed based on a version of the Uniform Building Code from 1985 or earlier. If an owner adds dwelling units to a building so that it becomes a building with five or more units, then the building shall be considered a subject building at the time building permits are issued for the additional units.

5.2.5 Sustainability

The Sustainable Oakland Program is housed in the Environmental Services Division of Oakland Public Works. This program fosters collaboration with staff across all City departments and with community leaders and experts on equitable climate change mitigation, sequestration, and adaptation. The Sustainable Oakland program is an evolution of the Sustainable Community Development Initiative, established by Oakland's City Council in 1997, and is charged with developing plans, ensuring implementation, and tracking progress related to the Council's climate goals and targets.

Title 18 of the City's municipal code promotes economic development and enhancement of the health, safety, and welfare of residents, workers, and visitors through the integration of environmentally sustainable strategies in building construction and landscapes. The minimum standards set forth are intended to minimize the use of natural resources and the production of waste and maximize the healthfulness of enclosed environments.

5.2.6 Oakland Equity Indicators

Oakland was chosen in 2017 to be among the first cohort of five cities to develop local equity indicators, in partnership with the City University of New York's Institute for State and Local Governance and with funding from the Rockefeller Foundation. The project, a joint effort between the Resilient Oakland Office and the Department of Race and Equity, resulted in a 2018 report that provides strategies for advancing equity, selected through a focus on racial and ethnic disparities and their root causes. The purpose of the *Equity Indicators Report* is to provide a framework that City staff and community members can use to better understand the impacts of race, measure inequities, and track changes in disparities for different groups over time. This framework can then be used to guide and inform policies that address these disparities (City of Oakland, 2018a).

Indicators listed in the report are quantifiable metrics for equity in each of four topics under each of six themes. Oakland's 2018 Citywide equity score, which encompasses all indicators, was 33.5 (out of 100), demonstrating substantial room for improvement. The indicator scores by theme were as follows (City of Oakland, 2018a):

- Neighborhood and Civic Life—50.6
- Economy—41.8
- Housing—36.8
- Education—29.0
- Public Health—25.8
- Public Safety—17.3

The information in the 2018 *Equity Indicators Report* positions the City to use data to drive equity outcomes, but it is only one step in a larger effort to address inequities. To complement this quantitative baseline, the Department of Race and Equity is also working with community partners to gather qualitative data from diverse community members in Oakland. This will provide context and insights into the root causes of disparities and meaningful solutions to the problems illuminated in the *Equity Indicators Report*.

5.2.7 Equitable Climate Action Plan

In 2018, Oakland's City Council adopted a Climate Emergency and Just Transition Resolution, calling for an urgent climate mobilization effort to reverse global warming, rapidly reduce greenhouse gas emissions, and be more resilient in the face of intensifying climate impacts. This includes creating good green jobs, reducing pollution, and helping Oaklanders to thrive. The 2030 Equitable Climate Action Plan (ECAP) is the City's roadmap to bring about an equitable transition to a low-carbon economy. The goal of this plan is to identify an equitable path toward cost-effectively reducing Oakland's local climate emissions a minimum of 56 percent, transitioning away from fossil fuel dependence, and ensuring that all of Oakland's communities are resilient to the foreseeable impacts of climate change by 2030.

5.2.8 Oakland Vegetation Management Plan

The City of Oakland is developing a Vegetation Management Plan covering more than 1,400 acres of City property plus treatment areas along approximately 300 miles of roadside. Vegetation management activities conducted on these lands currently include goat grazing on nine sites covering approximately 1,300 acres, vegetation clearing along 16 roadways (58 miles), monitoring for vegetation clearance along approximately 300 miles of road within the high and very high fire hazard severity zones (16.5 square miles), and brush clearance on critical City-owned properties (332 acres). The Vegetation Management Plan describes actions that the Oakland Fire Department will take over the 10-year plan timeframe to reduce fire hazard on City-owned land and along roadways. The plan has been developed to meet the following goals:

- Reducing wildfire hazard on City-owned land and along critical access/egress routes
- Reducing the likelihood of ignitions and extreme fire behavior to enhance public and firefighter safety
- Avoiding or minimizing impacts on natural resources
- Contributing to regional efforts to reduce wildfire hazards in the Oakland Hills

5.2.9 Oakland Tree Inventory and Urban Forest Master Plan

The City of Oakland is inventorying all trees growing on sidewalks, medians, and landscaped parks. This project is funded by a grant from California Climate Investments via the California Department of Forestry & Fire Protection (CAL FIRE) and approved by City Council Resolution 87388. Data collected will include size, species, and location of each tree. Using this data and community feedback, Oakland will develop its first ever 50-Year Urban Forest Master Plan. This plan will provide a long-term vision for the management and growth of the city's urban forest. The current estimated date of completion is March 2022.

5.3 ALAMEDA COUNTY

5.3.1 Alameda County Flood Control and Water Conservation District

The Alameda County Flood Control & Water Conservation District provides flood protection for Western Alameda County residents and businesses, including the City of Oakland. The District plans, designs, constructs, and maintains flood control systems such as natural creeks, channels, levees, pump stations, dams, and reservoirs. It also cares for the natural environment through public outreach and enforcement of pollution control regulations governing waterways.

The California State Legislature created the District in 1949 at the request of Alameda County residents, primarily to build flood control infrastructure across the County. Cities and unincorporated areas have joined the District over the years in order to gain protection from devastating floods.

Today, Alameda County's flood control infrastructure protects nine zones in western Alameda County. This includes pump stations, erosion control structures, dams, and hundreds of miles of pipelines, channels, levees, and creeks. The District maintains equipment, keeps flood control channels clear of silt and debris, and evaluates impacts of new developments on creeks and channels.

As a state recognized special purpose district enabled with taxing authorities, the District generates revenue within a flood control zone. Tax and benefit assessments from properties within each zone can only be spent within that zone.

5.4 CAPABILITY ASSESSMENT

The planning team performed an inventory and analysis of existing authorities and capabilities called a "capability assessment." A capability assessment creates an inventory of a jurisdiction's codes, programs, and policies, and evaluates its capacity to carry them out. It presents a toolkit for implementing the hazard mitigation plan and for identifying opportunities to increase the City's core capabilities to support mitigation actions. The assessment identifies potential gaps in core capabilities. Filling those gaps may eventually become mitigation actions in the plan. Assessment findings were shared with City departments as they developed the recommended mitigation actions. If a department identified an opportunity to add or expand a capability, then doing so has been identified as a mitigation action. The City views each core capability to be fully adaptable as needed to meet the best interests of the City. This adaptability is an overarching City capability that is acknowledged by this reference.

5.4.1 Legal and Regulatory Capabilities

Jurisdictions have the ability to develop policies and programs and to implement rules and regulations to protect and serve residents. Local policies are typically identified in a variety of community plans, implemented via a local ordinance, and enforced through a governmental body. An assessment of legal and regulatory capabilities is presented in Table 5-4.

5.4.2 Integration Opportunity

The assessment looked for opportunities to integrate this mitigation plan with the legal/regulatory capabilities identified. Capabilities were identified as integration opportunities if they can support or enhance the actions identified in this plan or be supported or enhanced by components of this plan. The City considered actions to implement this integration. The column in Table 5-4 labeled "Integration Opportunity" in this table identifies capabilities that can support or be supported by components of this plan. Where "yes" is indicated in this column, the City has considered actions to integrate these capabilities with the plan.

5.4.3 Development and Permitting Capability

Jurisdictions regulate land use through the adoption and enforcement of zoning, subdivision, and land development ordinances, building codes, building permit ordinances, and floodplain and stormwater management ordinances. When effectively prepared and administered, these regulations can lead to hazard mitigation. Development and permitting capabilities are presented in Table 5-5.

Table 5-4. Legal and Regulatory Capability

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Codes, Ordinances & Requirements				
Building Code	Yes	No	Yes	No
Comment: Oakland Code of Ordinances (OCOO), Chapter 15.04, Article I, Ord. No. 13576 amends the 2019 editions of the CA Building Standards Code, which is based on the 2019 International Building Code.				
Zoning Code	Yes	No	Yes	Yes
Comment: Oakland Planning Code, Chapter 17, Articles 1-158, Ord. 12054 § 2, 1998 ***Integration Opportunity*:** Future updates to the Planning Code could consider including the hazard specific data included in this hazard mitigation plan for appropriate standards to mitigate future risk				
Subdivisions	Yes	No	No	Yes
Comment: OCOO, Chapter 16, Article 4-36, 16.04.010 – outlines purpose, Prior code § 7-4.01 ***Integration Opportunity*:** Future updates to Chapter 16 may consider provisions for sub-dividing land in known hazard areas assessed under this hazard mitigation plan.				
Stormwater Management	Yes	No	No	Yes
Comment: OCOO, Chapter 13, Article 13.14.010 – storm drainage standards, Ord. No. 12916, § 1, 2-17-2009 ***Integration Opportunity*:** City-owned facilities constructed under this code may be eligible for FEMA Hazard Mitigation Assistance (HMA) grants. Future updates to this plan should consider eligible stormwater management activities as potential actions.				
Post-Disaster Recovery	Yes	No	No	Yes
Comment: OCOO, Title 8 (Health and Safety), Chapter 8.50 (Emergency Services Organization and Disaster Council). Ord. No. 13437, § 2, adopted June 20, 2017. Section 8.50.060 adopts the City's "Emergency Plan" which included recovery components. ***Integration Opportunity*:** Future updates to the City's "Emergency Plan" should consider utilizing information from this mitigation plan on risk and vulnerability to inform the recovery components of that plan.				
Real Estate Disclosure	No	No	Yes	No
Comment: State of California Natural Hazards Disclosure Act, effective 6/1/1998 (California Civil Code Section 1003) states that real estate sellers and brokers are legally required to disclose if a property being sold lies within one or more state or locally mapped hazard areas.				
Growth Management	Yes	No	Yes	Yes
Comment: OCOO, Title 17, Chapter 17.01, Codified through Ordinance No. 13611, enacted July 28, 2020. (Supp. No. 53, 12-20). The General Plan is the blueprint for land use in the City of Oakland. It includes maps that show the location and intensity of specific land uses, as well as land use policies that guide future decisions about growth. The Land Use and Transportation element, including the land use map, was approved in March 1998, and last amended in 2014. ***Integration Opportunity:*** General Plan and the Hazard Mitigation plan are already linked by reference pursuant to AB 2140. Future updates of either plan will inform each other.				
Site Plan Review	Yes	No	No	No
Comment: OCOO, Title 17, Chapter 17.136. Ord. No. 13357, § 3 (Exhibit A), 2-16-2016; prior planning code § 9300				
Environmental Protection	Yes	No	No	Yes
Comment: OCOO, Chapter 17.158, Article 1-2, Ord. 11766 § 2 (part), 1994: prior planning code § 1000 ***Integration Opportunity*:** The City could consider integrating the policies and implementation actions from the Environmental Element as potential actions for this plan.				
Flood Damage Prevention	Yes	No	No	Yes
Comment: *Ordinance 10956, adopted 3/8/1988 and amended by ordinance 12960, adopted July 21, 2009* ***Integration Opportunity***: The City should review and update as deemed feasible its regulatory floodplain administration program in coordination with FEMA Region IX and the state Department of Water Resources.				

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Emergency Management	Yes	No	Yes	Yes
Comment: OCOO, Chapter 8.50, Article 8.50.010, Ord. No. 13437, § 2, 6-20-2017 ***Integration Opportunity***: Future updates to the City's "Emergency Plan" should consider utilizing information from this mitigation plan on risk and vulnerability to inform components of that plan				
Climate Change	Yes	No	No	Yes
Comment: OCOO, Title 18 Sustainability. Ord. No. 13040, § 4, 10-19-2010. This Chapter is intended to promote economic development and enhance the health, safety, and welfare of residents, workers, and visitors through the integration of environmentally sustainable strategies in building construction and landscapes in the City. The minimum standards set forth are intended to minimize the use of natural resources and the production of waste and maximize the healthfulness of enclosed environments. ***Integration Opportunity***: This code provision is a regulatory capability of the City to mitigate the impacts from climate change, which could be actions identified in this plan.				
Planning Documents				
General Plan	Yes	No	Yes	Yes
Is the plan compliant with Assembly Bill 2140? Yes				
Comment: ***Integration Opportunity***: Mitigation plan components should inform future updates to the General Plan Safety Element.				
Capital Improvement Plan	Yes	No	No	Yes
How often is the plan updated? Every two years				
Capital facilities the plan addresses: Builds or provides upgrades to City facilities, transportation (streets/sidewalks) and public spaces				
Comment: 2019-21 Capital Improvement Program (CIP), 2019-21 CIP Adopted Budget ***Integration Opportunity***: City should consider the inclusion of HMA grant eligible projects contained in the CIP as mitigation actions for this plan				
ADA Curb Ramp Transition Plan	Yes	No	YES	Yes
Comment: Sets forth policy and plans how the City addresses curb ramp access and construction.				
ADA Buildings & Facilities Transition Plan	Yes	No	Yes	Yes
Comment: Sets forth policy and plans how the City addresses access barriers to City-owned buildings and facilities.				
Floodplain Management Plan	No	Yes	No	No
Comment: The East Bay Municipal Utility District (EBMUD) 2015 Urban Water Management Plan discusses the Mokelumne Watershed & Hydrology				
Stormwater Plans	Yes	No	No	Yes
Comment: September 2019 Green Stormwater Infrastructure Plan ***Integration Opportunity:*** Green infrastructure projects identified in this plan could be carried over as mitigation actions in this plan.				
Urban Water Management Plan	No	Yes	No	Yes
Comment: East Bay Municipal Utility District 2015 Urban Water Management Plan ***Integration Opportunity:*** HMA eligible projects identified in this plan that impact the City of Oakland could be included in this plan in partnership with EBMUD.				
Economic Development Plan	Yes	No	No	Yes
Comment: 2018-2020 Economic Development Strategy ***Integration Opportunity:*** Information from both plans should be used to inform each other's goals, objectives and implementation strategies.				

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Community Wildfire Protection Plan	Pending	No	No	Yes
Comment: Oakland Vegetation Management Plan (Notice of Determination in Spring 2021) describes the actions that the Oakland Fire Department will take over the 10-year plan timeframe to reduce fire hazard on city-owned land and along roadways in Oakland's very high fire hazard severity zone. ***Integration Opportunity***: Actions identified in this plan should be considered for inclusion in this or future updates to the hazard mitigation plan.				
Forest Management Plan	Pending	No	No	Yes
Comment: In Process: Oakland Tree Inventory and Urban Forest Master Plan (started 01/02/2020, to be finished on 03/30/2022) ***Integration Opportunity***: Information on wildfire risk and vulnerability and mitigation strategies to mitigate that risk could be utilized to inform this plan.				
Shoreline Management Plan	Yes	No	No	No
Comment: Estuary Policy Plan (June 1999)				
Climate Action Plan	Yes	No	Yes	Yes
Comment: 2030 Equitable Climate Action Plan establishes actions that the City will take by 2030 to equitably reduce Oakland's climate emissions and adapt to a changing climate. ***Integration Opportunity***: Both plans should inform future updates to each plan				
Other Relevant Plans	Yes	No	No	Yes
Comment: Sanitary Sewer Master Plan (started Feb 2020) seeks to reduce stormwater intrusion and overflows to protect public health Oakland Preliminary Sea-level rise Road Map (Fall 2017) Resilient Oakland Playbook (October 2016)				
Response/Recovery Planning				
Emergency Operations Plan	Yes	No	No	Yes
Comment: Oakland Emergency Operations Plan (2012) ***Integration Opportunity***: Risk and vulnerability information in the hazard mitigation plan can inform future updates to the Emergency Operation Plan.				
Threat & Hazard Identification & Risk Assessment	No	Yes	No	No
Comment: Member of Bay Area Urban Area Security Initiative				
Post-Disaster Recovery Plan	Yes	No	No	Yes
Comment: The City has a recovery plan that was developed in 2017. ***Integration Opportunity:*** Updating the recovery plan has been identified as an action in this plan update				
Continuity of Operations Plan	Yes	No	No	Yes
Comment: Several continuity of operations plans were published in 2013 and updated in 2017, but never published. Additionally, five departments never developed a plan. The City is currently working with staff to develop and updated continuity of operations plans. ***Integration Opportunity:*** This was an identified action in the 2016 hazard mitigation plan that has been carried over to this plan update				
Public Health Plan	No	Yes	No	No
Comment: Alameda County Community Health Improvement Plan: https://acphd.org/chip/ and the Alameda County Disaster Preparedness Health Coalition (https://acphd.org/dphc/)				

Table 5-5. Development and Permitting Capability

Criterion	Response
Does the City issue development permits? • **If no, who does? If yes, which department?**	Yes Planning/Building
Does the City have the ability to track permits by hazard area?	Yes, but currently do not exercise that capability, with the exception of new development within a FEMA-designated floodplain.
Does the City have a buildable lands inventory?	No

5.4.4 Administrative and Technical Capabilities

Legal, regulatory, and fiscal capabilities provide the backbone for successfully developing a mitigation strategy; however, without appropriate personnel, the strategy may not be implemented. Administrative and technical capabilities focus on the availability of personnel resources responsible for implementing all the facets of hazard mitigation. These resources include technical experts, such as engineers and scientists, as well as personnel with capabilities that may be found in multiple departments, such as grant writers. An assessment of administrative and technical capabilities is presented in Table 5-6.

Table 5-6. Administrative and Technical Capability

Staff/ Personnel Resources	Available? (Yes or No)	Department or Agency (Positions)
Planners or engineers with knowledge of land development and land management practices	Yes	Planning & Building
Engineers or professionals trained in construction practices related to buildings and/or infrastructure	Yes	Planning & Building
Planners or engineers with an understanding of natural hazards	No	None in-house but could contract for this service
Floodplain Manager	Yes	City Engineer, Department of Transportation
Surveyors	Yes	Public Works Department
Personnel skilled or trained in GIS Applications	Yes	Planning & Building, Public Works, Information Technology, Transportation
Scientist familiar with local natural hazards	No	None in-house but could contract for this service
Emergency manager	Yes	Jessica Feil, EMSD Manager
Grant writers	No	None in-house but could contract for this service
Staff with expertise or training in benefit/cost analysis	No	None in-house but could contract for this service

5.4.5 Fiscal Capabilities

Assessing a jurisdiction's fiscal capability provides an understanding of the ability to fulfill the financial needs associated with hazard mitigation projects. This assessment identifies both outside resources, such as grant-funding eligibility, and local jurisdictional authority to generate internal financial capability, such as through impact fees. An assessment of fiscal capabilities is presented in Table 5-7.

Table 5-7. Fiscal Capability

Financial Resources	Accessible or Eligible to Use (Yes or No)
Community Development Block Grants	Yes
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	Yes, with a 2/3 voter-approved majority
User Fees for Water, Sewer, Gas or Electric Service	No. City relies on outside sources (PG&E and EBMUD) for these
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	Yes, but have not done so historically
Withhold Public Expenditures in Hazard-Prone Areas	No
State-Sponsored Grant Programs	Yes
Development Impact Fees	Yes

5.4.6 Participation in Other Programs

Other programs, such as the Community Rating System and Firewise USA, can enhance a jurisdiction's ability to mitigate, prepare for, and respond to natural hazards. These programs indicate a jurisdiction's desire to go beyond minimum requirements set forth by local, state, and federal regulations in order to create a more resilient community. These programs complement each other by focusing on communication, mitigation, and community preparedness to save lives and minimize the impact of natural hazards on a community. Classifications under various community mitigation programs are presented in Table 5-8.

Table 5-8. Community Classifications

	Participating (Yes or No)	Classification	Date Classified
FIPS Code	06-53000		
DUNS#	05-067-2427		
Community Rating System	No	N/A	N/A
Building Code Effectiveness Grading Schedule	Yes	3/3	3/3/2019
Public Protection	Yes	2/2	N/A
Firewise	No	N/A	N/A
Storm Ready	No	N/A	N/A
Tsunami Ready	No	N/A	N/A

5.4.7 National Flood Insurance Program Compliance

Flooding is the costliest natural hazard in the United States and, with the promulgation of recent federal regulation, homeowners throughout the country are experiencing increasingly high flood insurance premiums. Community participation in the National Flood Insurance Program (NFIP) opens up opportunity for additional grant funding associated specifically with flooding issues. Assessment of the jurisdiction's current NFIP status and compliance provides planners with a greater understanding of the local flood management program, opportunities for improvement, and available grant funding opportunities. Information on NFIP compliance is presented in Table 5-9.

Table 5-9. National Flood Insurance Program Compliance

What local department is responsible for floodplain management?	This will be overseen by the City Manager's Office until the administration of the City's floodplain can be refined
Who is your floodplain administrator? (department/position)	City Manager until the City identifies an appropriate floodplain administrator
Are any certified floodplain managers on staff in your jurisdiction?	No
What is the date of adoption of your flood damage prevention ordinance?	Ordinance 10956, adopted 3/8/1988 and amended by ordinance 12960, adopted July 21, 2009
When was the most recent Community Assistance Visit (CAV) or Community Assistance Contact?	According to the California Department of Water Resources (DWR), the last CAV was 9/26/2017
Does your jurisdiction have any outstanding NFIP compliance violations that need to be addressed?	Yes. As of 3/10/2021, this CAV was still open pending resolution of noted violation. The 2017 CAV was performed by FEMA staff.
• **If so, please state what they are**	As of this plan update, the City is working with FEMA Region IX staff to address the noted violations
Do your flood hazard maps adequately address the flood risk within your jurisdiction?	As of this plan update, the City has no noted issues with the current effective FIRMs for the City
• **If no, please state why**	--
Does your floodplain management staff need any assistance or training to support its floodplain management program?	Yes
• **If so, what type of assistance/training is needed?**	City is experiencing turnover in floodplain administration staff. New staff will need to be educated on the City's noted violations identified in the 2017 CAV.
Does your jurisdiction participate in the Community Rating System (CRS)?	No
• **If so, is your jurisdiction seeking to improve its CRS Classification?**	N/A
• **If not, is your jurisdiction interested in joining the CRS program?**	Not at this time
How many flood insurance policies are in force in your jurisdiction? [a]	558
• **What is the insurance in force?**	$142,523,500
• **What is the premium in force?**	$512,598
• **How many total loss claims have been filed in your jurisdiction?** [a]	224
• **How many claims are still open or were closed without payment?**	Unknown
• **What were the total payments for losses?**	$297,352

a. According to FEMA statistics as of 12/21/2020

5.4.8 Public Outreach Capability

Regular engagement with the public on issues regarding hazard mitigation provides an opportunity to directly interface with community members. Assessing this outreach and education capability illustrates the connection between the government and community members, which opens a two-way dialogue that can result in a more resilient community based on education and public engagement. An assessment of education and outreach capabilities is presented in Table 5-10.

Table 5-10. Education and Outreach

Do you have a public information officer or communications office?	Yes
Do you have personnel skilled or trained in website development?	Yes
Do you have hazard mitigation information available on your website? • **If yes, please briefly describe.**	Yes https://www.oaklandca.gov/topics/2016-2021-local-hazard-mitigation-plan
Do you utilize social media for hazard mitigation education and outreach? • **If yes, please briefly describe.**	Yes Nextdoor, Facebook, Twitter
Do you have any resident boards or commissions that address issues related to hazard mitigation?	To be determined
Do you have any other programs already in place that could be used to communicate hazard-related information? • **If yes, please briefly describe.**	To be determined
Do you have any established warning systems for hazard events? • **If yes, please briefly describe.**	Yes AC Alert, GovDelivery, Emergency Sirens (tested first Wed of every month)

5.4.9 Adaptive Capacity

An adaptive capacity assessment evaluates a jurisdiction's ability to anticipate impacts from future conditions. By looking at public support, technical adaptive capacity, and other factors, jurisdictions identify their core capability for resilience against issues such as sea-level rise. The adaptive capacity assessment provides jurisdictions with an opportunity to identify areas for improvement by ranking their capacity high, medium, or low. Tetra Tech, as a technical consultant with subject-matter expertise in this field, performed a third-party review of the City's programs, as presented in Table 5-11.

Table 5-11. Adaptive Capacity for Climate Change

Adaptive Capacity Assessment Questions	Local Rating
TECHNICAL CAPACITY	
Jurisdiction-level understanding of potential climate change impacts *Comment:* Oakland 2030 ECAP	Medium
Jurisdiction-level monitoring of climate change impacts *Comment:* 2018 Greenhouse Gas Emissions Report; Energy and Climate Action Plan (2017-2018 update)	Medium
Technical resources to assess proposed strategies for feasibility and externalities *Comment:* CURB Analysis (https://www.oaklandca.gov/resources/curb-analysis). Also, the ECAP and Racial Equity Impact Assessment and Implementation Guide provide high level of analysis for feasibility and externalities	Medium
Jurisdiction-level capacity for development of greenhouse gas emissions inventory *Comment:* Oakland Greenhouse Gas Emissions Inventory (https://www.oaklandca.gov/resources/oakland-greenhouse-gas-emissions-inventory-reports)	High
Capital planning and land use decisions informed by potential climate impacts *Comment:* ECAP - Transportation and Land Use (https://www.oaklandca.gov/topics/transportation-and-land-use). Climate scoring is done as part of the City's Capital Improvements Program. Measure KK Infrastructure Bond (2016) also has a special call out ($25 million) for climate projects. This is very high by City standards.	High
Participation in regional groups addressing climate risks *Comment:* City has active participation in the Bay Area Climate Adaptation Network, NorCal Resilience Network, Green Cities California, and the Urban Sustainability Directors Network.	Medium

Adaptive Capacity Assessment Questions	Local Rating
IMPLEMENTATION CAPACITY	
Clear authority/mandate to consider climate change impacts during public decision-making processes	Medium
Comment: Recent legislation in California requires that greenhouse gas emissions and climate change be addressed by state and regional agencies, specifically greenhouse gas reduction targets established by Executive Order S-3-05, Assembly Bill 32 (AB 32), and Senate Bill 375 (SB 375).	
Identified strategies for greenhouse gas mitigation efforts	High
Comment: ECAP	
Identified strategies for adaptation to impacts	High
Comment: ECAP	
Champions for climate action in local government departments	High
Comment: Office of Sustainability; Chief Resilience Officer	
Political support for implementing climate change adaptation strategies	Medium
Comment: City Council support; Mayor support	
Financial resources devoted to climate change adaptation	Medium
Comment: ECAP	
Local authority over sectors likely to be negatively impacted	Low-Medium
Comment: High level of control over buildings and energy sectors. Medium for waste. Low for transportation and climate adaptation.	
PUBLIC CAPACITY	
Residents' knowledge and understanding of climate risk	Medium
Comment: ECAP, public outreach and participation. The City has multiple active community groups focused on climate issues, and The Yale Program on Climate Change Communication ranks Alameda County as among the most concerned about climate change in the nation (Yale, 2020).	
Residents' support of adaptation efforts	Medium
Comment: ECAP community engagement, youth input, Community Advisory Committee	
Residents' capacity to adapt to climate impacts	Low
Comment: Overall cost of living in Oakland, rent-burdened residents, etc.	
Local economy current capacity to adapt to climate impacts	Medium
Comment: ECAP; green jobs training program needs to be highlighted	
Local ecosystems capacity to adapt to climate impacts	Medium
Comment: ECAP; park land and open space acreage	

High—The capacity exists and is in use.
Medium—The capacity may exist but is not used or could use some improvement.
Low—The capacity does not exist or could use substantial improvement.
Unsure—Not enough information is known to assign a rating.

City of Oakland 2021 – 2026 Hazard Mitigation Plan

PART 2—RISK ASSESSMENT

6. HAZARDS OF CONCERN, RISK ASSESSMENT METHODOLOGY

Risk assessment is the process of estimating the potential loss of life, personal injury, economic injury, and property damage resulting from identified hazards. The process focuses on the following elements:

- **Hazard identification**—Use all available information to determine what types of hazards may affect a jurisdiction, how often they can occur, and their potential severity.
- **Exposure identification—**Estimate the total number of people and properties in the jurisdiction that are likely to experience a hazard event if it occurs.
- **Vulnerability identification and loss estimation**—Assess the impact of hazard events on the people, property, environment, economy, and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.

The risk assessment for this hazard mitigation plan evaluates the risk of natural hazards prevalent in the planning area and meets requirements of the Disaster Mitigation Act (44 CFR, Section 201.6(c)(2)). To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

6.1 IDENTIFIED HAZARDS OF CONCERN

The Steering Committee considered the full range of natural hazards that could affect the planning area and then listed hazards that present the greatest concern. The process incorporated a review of state and local hazard planning documents as well as information on the frequency of, magnitude of, and costs associated with hazards that have struck the planning area or could do so. Anecdotal information regarding natural hazards and the perceived vulnerability of the planning area's assets to them was also used. Based on the review, this plan addresses the following hazards of concern (presented in alphabetical order; the order of listing does not indicate the hazards' relative severity):

- Dam failure
- Drought
- Earthquake
- Flood
- Landslide
- Sea-level rise
- Severe weather
- Tsunami/seiche
- Wildfire

The hazard mitigation plan includes a discussion of climate change, but it is not treated as a stand-alone hazard. Instead, a review is provided on the ways in which climate change could affect the planning area's exposure and vulnerability to the other identified hazards of concern.

An additional chapter provides a profile of "hazards of interest," defined as hazards that may impact the planning area but whose risk is difficult to quantify due to a lack of data or well-established assessment parameters (hazardous materials, public health incidents, and terrorism). That chapter provides a profile of these hazards but does not assess them to the same level of detail as the primary hazards of concern. The hazards of interest are not included in the risk ranking for this plan.

6.2 RISK ASSESSMENT TOOLS

6.2.1 Mapping

National, state, county, and city databases were reviewed to locate available spatially based data relevant to this planning effort. Maps were produced using geographic information system (GIS) software to show the spatial extent and location of hazards when such datasets were available. These maps are included in the hazard profile chapters of this document. Sources and methods used to generate the maps are described in Appendix C.

6.2.2 Modeling

Overview

FEMA developed the standardized GIS-based software program Hazards U.S. (Hazus) to estimate losses caused by earthquakes, hurricanes and floods and identify areas that face the highest risk and potential for loss. Hazus is used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facilities, transportation and utility infrastructure, and multiple models to estimate potential losses from natural disasters. The program maps and calculates hazard data and damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that they can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Levels of Detail for Evaluation

Hazus provides default data for inventory, vulnerability, and hazards; these default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. These data are derived from national databases and describe in general terms the characteristic parameters of the planning area.
- **Level 2**—More-accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics, and building inventory, as well as data on utilities and critical facilities. This information is needed in a GIS format.
- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

6.3 RISK ASSESSMENT APPROACH

The risk assessments in this plan describe the risks associated with each identified natural hazard of concern. The following steps were used to define the risk of each hazard:

- **Identify and profile each hazard**—The following information is given for each hazard:
  - A summary of previous local events associated with the hazard
  - Geographic areas most affected by the hazard
  - Estimated event frequency
  - A qualitative assessment of the potential severity of events associated with the hazard
  - Warning time likely to be available for response
- **Determine exposure to each hazard**—Exposure was assessed by overlaying hazard maps with an inventory of critical facilities, structures, and systems to estimate which of them would be exposed to each hazard.
- **Assess the vulnerability of exposed facilities**—Vulnerability of exposed structures and infrastructure was evaluated by estimating potential impacts on people and damage to property and the environment in the event a hazard incident.

The risk assessments performed for this plan evaluated risk citywide for individual sub-areas.

6.3.1 Hazard Profile Development

Hazard profiles were developed through web-based research and review of previously developed reports and plans, including community general plans and state and local hazard mitigation plans. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others.

6.3.2 Exposure and Vulnerability

Flood, Dam Failure, Earthquake, and Tsunami

Community exposure and vulnerability to the following hazards were evaluated using Hazus:

- **Dam Failure, Flood, and Tsunami**—A Level 2 user-defined analysis was performed for general building stock, and for community lifelines (dam failure and flood only). Current mapping for the planning area was used to delineate hazard areas for flood, dam failure, and tsunami and estimate potential losses. To estimate damage that would result from these inundation-based hazards, Hazus uses pre-defined relationships between water depth at a structure and resulting damage, with damage given as a percent of total replacement value. Curves defining these relationships have been developed for damage to structures and for damage to typical contents within a structure. By inputting inundation depth data and known property replacement cost values, dollar-value estimates of damage were generated.

- **Earthquake**—A Level 2 analysis was performed to assess earthquake exposure and vulnerability for three scenario events and one probabilistic event:
  - A Magnitude-7.05 event on the Hayward Fault with an epicenter 5 miles east of downtown Oakland.
  - A Magnitude-7.38 event on the San Andreas Fault with an epicenter in the Lower Crystal Springs Reservoir in San Mateo County.
  - A Magnitude-6.86 event on the Calaveras Fault with an epicenter 3 miles west of central Pleasanton.
  - The standard Hazus 100-year probabilistic event.

Wherever possible, the Hazus data for these risk assessments was enhanced using GIS data from local, state, and federal sources.

Wildfire, Landslide, Sea-Level Rise, and Severe Weather

Historical datasets were not adequate to model future losses for most of the hazards of concern. However, areas and inventory susceptible to some of the hazards of concern were mapped by other means to evaluate exposure. A qualitative analysis was conducted for other hazards using the best available data and professional judgment.

Drought

The risk assessment methodologies used for this update focus on damage to structures. Because drought does not impact structures, the risk assessment for this hazard was more limited and qualitative than the assessment for the other hazards of concern.

6.4 SOURCES OF DATA USED

6.4.1 Building and Cost Data

Replacement cost is the cost to replace the entire structure with one of equal quality and utility. Replacement cost is based on industry-standard cost-estimation models published in the 2020 edition of *RS Means Square Foot Costs*. It is calculated using the RS Means square foot cost for a structure, which is based on the Hazus occupancy class (i.e., multi-family residential or commercial retail trade), multiplied by the square footage of the structure from the tax assessor data. The construction class and number of stories for single-family residential structures also factor into determining the square foot costs.

Replacement cost values and detailed structure information derived from parcel and tax assessor data provided by the City of Oakland were loaded into Hazus. When available, an updated inventory was used in place of the Hazus defaults for community lifelines.

6.4.2 Hazus Data Inputs

The following hazard datasets were used for the Hazus Level 2 analysis conducted for the risk assessment:

- **Flood**—The effective Digital Flood Insurance Rate Map (DFIRM) for the planning area was used to delineate flood hazard areas and estimate potential losses from the FEMA 1-percent-annual chance and

0.2-percent-annual-chance (100- and 500-year) flood events. Using the DFIRM floodplain boundaries and base flood elevation information, and the U.S. Geological Survey (USGS) 3-meter National Elevation Dataset, water depth grids were generated and integrated into the Hazus model.

- **Dam Failure**—Dam failure inundation area boundaries data for Lake Temescal (CA00160), Central (CA00162), Chabot (CA00165), Dunsmuir (CA00174), and New Upper San Leandro (CA1082) were provided by the California Department of Water Resources. Associated inundation depth grid data were also provided for all dams except Lake Temescal. A depth grid for Lake Temescal was created using the inundation area boundary and the USGS 3-meter National Elevation Dataset. The individual dam depth grids were combined using the maximum depth where the dam inundation areas overlapped, and the combined depth grid was integrated into the Hazus model.
- **Tsunami**—Tsunami hazard area data were provided by the California Geological Survey. The Hazus analysis was performed by the California Governor's Office of Emergency Services (Cal OES). The analysis, for the 975-year average return period modeled tsunami hazard data for Alameda County, was run as tsunami only (distant source tsunami hazard) with no earthquake hazard included.
- **Earthquake**—Earthquake ShakeMaps and probabilistic data prepared by the USGS were used for the analysis of this hazard. A National Earthquake Hazard Reduction Program (NEHRP) soils map from the California Department of Conservation, the Association of Bay Area Government's liquefaction susceptibility data, and susceptibility to deep-seated landslides data from the California Geological Survey were also integrated into the Hazus model.

6.4.3 Other Local Hazard Data

Locally relevant information on hazards was gathered from a variety of sources. Frequency and severity indicators include past events and the expert opinions of geologists, emergency management specialists, and others. Data sources for specific hazards were as follows:

- **Wildfire**—Wildfire severity and wildland urban interface data were acquired from California Department of Forestry and Fire Protection (CAL FIRE). Very high and high fire severity zones within the interface and intermix zones were used in the exposure analysis.
- **Landslide**—Susceptibility to deep-seated landslides data were provided by the California Geological Survey. Areas categorized as very high and high susceptibility (categories X, XI, VIII, and VII) were used in the exposure analysis.
- **Sea-level rise**—Adapting to Rising Tides sea-level rise data were provided by the San Francisco Bay Conservation and Development Commission. Sea-level rises of 48 inches, representing the year 2050, and 108 inches, representing the year 2100, were used for the exposure analysis.
- **Severe Weather**—No GIS format severe weather area datasets were identified for the City of Oakland.

6.4.4 Data Source Summary

Table 6-1 summarizes the data sources used for the risk assessment for this plan.

Table 6-1. Hazus Model Data Documentation

Data	Source	Date	Format
Property parcel data including building information (use code, square footage, year built)	Alameda County	2020	Digital (GIS)
Building footprints	City of Oakland	Unknown	Digital (GIS)
Soft story buildings	City of Oakland	2021	Digital (spreadsheet)
Building replacement (square foot) costs	RS Means	2020	Digital (pdf)
City of Oakland DOT Planning Areas	City of Oakland	Unknown	Digital (GIS)
Population data	FEMA Hazus version 4.2 SP03	2010	Digital (GIS and tabular)
CA State dam breach inundation maps (inundation boundaries and depth grids)	California Department of Water Resources	2018-20	Digital (GIS)
ShakeMap – Calaveras (No) M6.86	USGS	2017	Digital (GIS)
ShakeMaps – Hayward M7.05	USGS	2018	Digital (GIS)
ShakeMaps – San Andreas (Peninsula) M7.38	USGS	2017	Digital (GIS)
NEHRP soils (VsMapV3_Geology)	California Department of Conservation	2015	Digital (GIS)
Liquefaction susceptibility	ABAG (USGS)	2006	Digital (GIS)
NEHRP Soils	California Geological Survey	2015	Digital (GIS)
Digital Flood Insurance Rate Map (DFIRM) – Alameda County effective 12/21/2018, latest letter of map revision effective 3/16/2020	FEMA	2020	Digital (GIS)
Susceptibility to deep-seated landslides	California Geological Survey	2011	Digital (GIS)
Adapting To Rising Tides Bay Area Sea Level Rise & Mapping Project: Alameda County/SF Bay	San Francisco Bay Conservation and Development Commission	2017	Digital (GIS)
Wildland Urban Interface, Wildland Urban Intermix, and Wildfire Influence Zones developed for the Fire and Resource Assessment Program (FRAP) 2015 Assessment	California Department of Forestry and Fire Protection	2015	Digital (GIS)
National Elevation Data 3 meter or better	USDA/NRCS - National Geospatial Center of Excellence	Unknown	Digital (GIS)

Data	Source	Date	Format
CRITICAL FACILITIES			
Aviation facilities, City halls, Dialysis centers, Fire stations, Hospitals, Police stations, Post offices, Schools	Alameda County	Downloaded 2020	Digital (GIS)
Hazardous Waste Tracking System active facilities	California Department of Toxic Substance Control	Downloaded 2020	Digital (GIS)
Electric substations, Natural gas stations, Power plants	California Energy Commission	Downloaded 2020	Digital (GIS)
Wastewater treatment plants	California State Water Resources Control Board	Downloaded 2020	Digital (GIS)
Chemical hazards	California Environmental Protection Agency	Downloaded 2020	Digital (GIS)
Hospital heliports, Local bridges, Ports, Rail stations	California Department of Transportation	Downloaded 2020	Digital (GIS)
BART stations, City bridge, City facilities, Sirens, State bridges	City of Oakland	Provided 2020	Digital (GIS or spreadsheet)
Cellular towers, Colleges and universities, FM transmission towers, Land mobile broadcast towers, Land mobile commercial transmission towers, Local emergency operations centers, Local law enforcement locations, Microwave service towers, Port facilities, AM transmission towers, Veterans Health Administration medical facilities,	Homeland Infrastructure Foundation-Level Data	Downloaded 2020	Digital (GIS)

6.5 LIMITATIONS

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following:

- Approximations and simplifications necessary to conduct a study
- Incomplete or outdated inventory, demographic or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed
- The amount of advance notice residents have to prepare for a specific hazard event

These factors can affect loss estimates by a factor of two or more. Therefore, potential exposure and loss estimates are approximate and should be used only to understand relative risk.

7. DAM FAILURE

7.1 GENERAL BACKGROUND

7.1.1 Definition and Classification of Dams

A dam is an artificial barrier that has the ability to store water, wastewater, or liquid-borne materials for many reasons—flood control, human water supply, irrigation, livestock water supply, energy generation, containment of mine tailings, recreation, or pollution control. Many dams fulfill a combination of these functions. They are an important resource in the United States (ASDSO, 2013). In California, dams are regulated by the state Division of Safety of Dams. Additional regulatory oversight of dams is cited in Chapter 5 and described in Appendix B. The California Water Code (Division 3) defines a dam as any artificial barrier, together with appurtenant works, that does or may impound or divert water, and that either:

- Is 25 feet or more in height from the natural bed of the stream or watercourse at the downstream toe of the barrier (or from the lowest elevation of the outside limit of the barrier if it is not across a stream channel or watercourse) to the maximum possible water storage elevation; or
- Has an impounding capacity of 50 acre-feet or more.

Dams can be classified according to their purpose, the construction material or methods used, their slope or cross-section, the way they resist the force of the water pressure, or the means used for controlling seepage. Materials used to construct dams include earth, rock, tailings from mining or milling, concrete, masonry, steel, timber, plastic, rubber, and combinations of these.

7.1.2 Causes of Dam Failure

Dam failure can cause massive destruction to the ecosystems and communities located downstream. Partial or full failure can occur as a result of one or a combination of the following reasons:

- Overtopping caused by floods that exceed the dam capacity (inadequate spillway capacity)
- Prolonged periods of rainfall and flooding
- Deliberate acts of sabotage (terrorism)
- Structural failure of materials used in dam construction
- Movement and/or failure of the foundation supporting the dam
- Settlement and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate or negligent operation, maintenance, and upkeep

- Failure of upstream dams on the same waterway
- Earthquake (liquefaction/landslides).

Many dam failures in the United States have been secondary results of other disasters. The most common causes are earthquakes, landslides, extreme storms, equipment malfunction, structural damage, foundation failures, and sabotage. Poor construction, lack of maintenance and repair, and deficient operational procedures are preventable or correctable by a program of regular inspections. Terrorism and vandalism are serious concerns that all operators of public facilities must plan for; these threats are under continuous review by public safety agencies.

7.1.3 Planning Requirements

State of California

All dams whose inundation areas may impact the planning area have emergency action plans (EAPs) on file. The EAPs must include the following (Cal OES, 2018a):

- Emergency notification flow charts
- Information on a four-step response process
- Description of agencies' roles and actions in response to an emergency incident
- Description of actions to be taken in advance of an emergency
- Inundation maps
- Additional information such as revision records and distribution lists.

After the EAPs are approved by the state, the law requires dam owners to send the approved EAPs to relevant stakeholders. Local public agencies can then adopt emergency procedures that incorporate the information in the EAP in a manner that conforms to local needs and includes methods and procedures for alerting and warning the public and other response and preparedness related items (State of California, 2018).

FEMA Guidance for Flood Mapping

FEMA's *Federal Guidelines for Inundation Mapping of Flood Risks Associated with Dam Incidents and Failures* is part of the National Dam Safety Program, a partnership of states, federal agencies, and other stakeholders formed to encourage individual and community responsibility for dam safety. Under this program, states are responsible for regulating non-federal dams. The guidelines provide information for federal and state agencies, local governments, dam owners, and emergency management officials to use for reducing flood hazards and the resulting potential for economic damage and loss of life. It is a resource for developing state-specific guidelines for dam safety and as a reference manual for mapping dam breach inundation zones (FEMA, 2013).

7.1.4 Rating Dam Hazards

Dam failure can be catastrophic to all life and property downstream. The Division of Safety of Dams has developed a hazard potential classification system for state-jurisdiction dams, as shown on Table 7-1. This system is modified from federal guidelines, which recommend three-tier classification. The California system adds a fourth hazard classification of "extremely high." Dams classified as extremely high hazard may impact highly populated areas or critical infrastructure or have short evacuation warning times (DSOD, 2019).

Table 7-1. State of California Downstream Hazard Potential Classification

Hazard Classification	Potential Downstream Impacts on Life and Property
Low	No probable loss of human life and low economic and environmental losses. Losses are expected to be principally limited to the owner's property.
Significant	No probable loss of human life but can cause economic loss, environmental damage, impacts to critical facilities, or other significant impacts.
High	Expected to cause loss of at least one human life.
Extremely High	Expected to cause loss of at least one human life and one of the following: result in an inundation area with a population of 1,000 or more; or, result in the inundation of facilities or infrastructure, the inundation of which poses a significant threat to public safety as determined by the department on a case-by-case basis.

Source: DSOD, 2019

7.1.5 Secondary Hazards

Dam failure can cause landslides, bank erosion, and destruction of downstream habitat. Dam failure may worsen the severity of a drought by releasing water that might have been used as a potable water source.

7.2 HAZARD PROFILE

The Safety Element of the Oakland General Plan describes the dam failure hazard Oakland faces as follows (City of Oakland, 2012):

> *According to inundation maps developed by dam owners to fulfill requirements of the Dam Safety Act, there are 13 active dams, reservoirs and clearwells that, in case of failure, would cause flooding in Oakland. (Additionally, there are small ponds and water tanks scattered throughout the city, the failure of which could result in the sudden release of a sizable volume of water. Failure of such a facility in the Oakland hills could cause isolated damage to structures downhill)….*
>
> *Flooding from dam failure, while unlikely, could have catastrophic impacts on portions of North and East Oakland. The dam and reservoir failures resulting in the largest flooded areas in Oakland would be those of Central reservoir and of Lake Chabot, Lake Temescal and Upper San Leandro reservoir dams. Of particular concerns are the Lake Temescal dam, since it straddles the main trace of the Hayward fault, and the Lake Chabot dam, which is located only one-quarter mile east of the fault. In the event of dam failure, Lake Temescal's waters would follow the Temescal stream course, inundating an area one block wide north of Highway 24 to College Avenue that would then broaden to several blocks wide west of College. Failure of the Lake Chabot dam (and of the Upper San Leandro reservoir dam) would inundate much of the Brookfield Village district and the industrial areas near the airport (as well as a large portion of San Leandro). The risk posed by dam failures is mitigated by the regulatory safeguards in place and should be weighed not only against the extremely rare occurrence of dam failure in the United States but also against the significant benefits provided by water-storage facilities.*

In addition to the specific dams and reservoirs listed in the Safety Element, the East Bay Municipal Utility District (EBMUD) has identified the Dunsmuir Reservoir as having a sizable mapped failure inundation area within the city limits. EBMUD also reports that failure of the Upper San Leandro reservoir dam would inundate the airport itself, as well as the surrounding industrial areas (EBMUD, 2021).

7.2.1 Past Events

No dam failure events have directly impacted the City of Oakland, but California has had about 45 failures of non-federal dams. Below is a partial list of significant dam failures in California.

Oroville Dam, 2017

In February 2017, heavy rain in Northern California caused the water level to rise to a dangerous level in the Oroville Dam in the Sierra Nevada foothills. The state released water down the main spillway to relieve the pressure. A crack appeared in the spillway and grew into a 250-foot crater. Officials shut off water to the main spillway, but the reservoir continued to fill. The state released small amounts of water, which further eroded the spillway's hole. The erosion threatened to undercut the dam, which could send a 30-foot wall of water downstream; 188,000 people were evacuated. Officials further released 100,000 cubic feet per second of water down the main spillway, damaging it further. The dam held, and the reservoir eventually dropped below 850 feet.

Pacoima Dam, 1994

The Pacoima Dam in Los Angeles County was damaged during the 1994 Northridge earthquake. The dam received enormous ground accelerations, which reached a peak level of twice the force of gravity. The dam's location was approximately 8 miles from the epicenter. Thirteen additional dams in the greater Los Angeles area moved or cracked during the earthquake, however, none were severely damaged, in part due to completion of retrofitting pursuant to the 1972 State Dam Safety Act.

Multiple Dams, San Fernando Earthquake, 1971

The February 9, 1971, San Fernando earthquake damaged the following dams:

- **Lower San Fernando Dam—**Perched above the densely populated San Fernando Valley, the 142-foot-high, 2,100-foot-long Lower San Fernando Dam held a reservoir 1.6 miles long, and up to 130 feet deep. The quake shook loose a massive slide in the upstream slope of the Lower San Fernando Dam that lowered the crest about 30 feet and carried away much of upstream concrete facing of the dam. Eighty-thousand people were evacuated from an 11-square-mile area while the water behind the earthen dam was lowered over a three-day period. The dam could not be repaired to safely hold its water supply and the $33 million Los Angeles Dam was built to replace it in 1975-76.
- **Van Norman Dam—**Van Norman Lake reportedly sank 1 foot, causing the evacuation of several thousand people from their homes south of the dam in north Los Angeles. A 60-foot section of the concrete dam at the lake's southern edge collapsed, and portions were reported as still crumbling during the evacuation. The dam held back more than 6 billion gallons of water.
- **Hansen Dam—**The Hansen Dam, located in north Los Angeles, suffered cracks during the earthquake.

Baldwin Hills Reservoir Collapse, 1963

On December 14, 1963, the dam at the head of Cloverdale Road broke in the Baldwin Hills section of Los Angeles. Lost homes, ruined property, and even death resulted from a river of rushing water from the broken dam. Automobiles, fragments of houses, and chunks of concrete were carried along the flood's path and deposited on the ruins of Village Green. Eighteen persons were rescued by helicopter and flown out to a safety.

St. Francis Dam, 1928

The most catastrophic dam failure in California's history was that of the St. Francis Dam in Los Angeles County in March 1928. This failure resulted in the deaths of more than 450 people and destruction of nearly 1,000 homes and buildings. Numerous roads and bridges were destroyed or damaged beyond repair. California's Division of Safety of Dams came into existence as a direct result of this catastrophe.

7.2.2 Location

List of High-Hazard Dams

Not all dams identified in the City's Safety Element are designated high-risk under state guidelines. According to California's Division of Safety of Dams, five dams rated as extremely high risk under California's hazard potential classification system are in the planning area or have inundation areas that extend into the planning area. These dams are listed in Table 7-2. Their locations are shown on Figure 7-1.

Table 7-2. High-Hazard Dams in the Planning Area or with Inundation Areas that Include Areas in Oakland

Name	ID Number	Owner	Year Built	Dam Type	Crest Length (feet)	Height (feet)	Storage Capacity (acre-feet)	Downstream Hazard	Condition Assessment
Central	CA00162	East Bay Municipal Utility District	1910	Earth	929	55	472	Extremely High	Satisfactory
Chabot	CA00165	East Bay Municipal Utility District	1875	Earth	500	135	10,350	Extremely High	Satisfactory
Dunsmuir Reservoir	CA00174	East Bay Municipal Utility District	1968	RECT[a]	2,275	30	201	Extremely High	Satisfactory
New Upper San Leandro	CA1082	East Bay Municipal Utility District	1977	Earth	1,430	182	38,905	Extremely High	Satisfactory
Lake Temescal	CA00160	East Bay Regional Park District	1869	Earth	650	116	200	Extremely High	Satisfactory

a. RECT = reinforced concrete tank.
Source: DSOD, 2019; U.S. Army Corps of Engineers, 2018; EBMUD, 2021

Source: DSOD, 2021

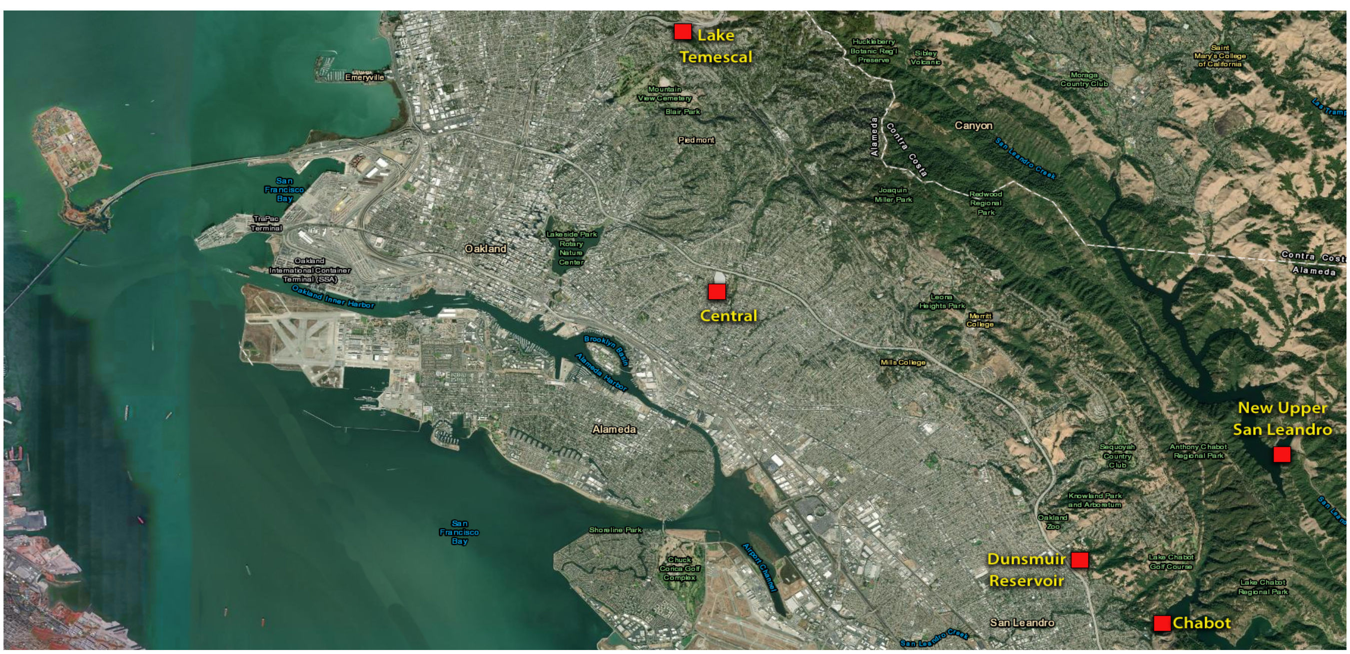


Figure 7-1. Locations of Extremely-High-Hazard Dams in the Planning Area

Inundation Mapping

A key element of EAPs required for dams in California is a map defining the potential downstream inundation should the dam fail. As required by California Water Code section 6161, the Division of Safety of Dams approves inundation maps prepared by licensed civil engineers and submitted by dam owners for extremely high, high, and significant hazard dams and their critical appurtenant structures. Inundation maps approved by Division of Safety of Dams provide general information for emergency planning and are used to develop emergency action plans. Evacuation zones and timing are determined by local emergency managers who are responsible for specific evacuation planning.

Digital data indicating worst-case inundation areas for the five extremely-high-hazard dams listed in Table 7-2 were used for the Hazus-based quantitative assessment of dam failure risk for this hazard mitigation plan. The assessment of exposure and vulnerability to the dam failure hazard used a combined dam failure inundation area consisting of the mapped worst-case inundation areas of all five dams. This combined area is shown in Figure 7-2.

7.2.3 Frequency

Large-scale dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes and excessive rainfall. A Stanford University study found an average of nearly 10 dam failures per year nationwide over a period of record from 1848 through 2017 (Stanford University, 2018).

All dams face a “residual risk” of failure, which represents the risk that conditions may exceed those for which the dam was designed. For example, dams may be designed to withstand a “probable maximum precipitation,” defined as the greatest depth of precipitation for a given duration that is expected at a particular location. The chance of a precipitation event of a greater magnitude than that represents residual risk for such dams. This represents a theoretical probability of future occurrence for a dam failure event, though the probability of an event exceeding the assumed maximum is not generally calculated as part of dam design.

7.2.4 Severity

Dam failure can be catastrophic to all life and property downstream. California’s hazard ratings, as described in Table 7-1 describe the potential consequences of dam failure based on hazard ratings. For the five dams assessed in this plan, with hazard ratings of extremely high, complete failure is expected to cause loss of at least one human life and inundate an area with a population of 1,000 or more or critical facilities whose inundation poses a significant threat to public safety.

The Stanford University study of dam failures nationwide found that many failures were of small dams, with limited flooding or downstream impact. More than 96 percent of the failures did not result in life-safety consequences or significant property damage (Stanford University, 2018).

7.2.5 Warning Time

The potential for personal injury or loss of life in the event of a dam failure is affected by the amount of warning time and the capacity of evacuation routes available to those living in inundation areas. Warning time depends on the cause of the failure. In case of extreme precipitation, evacuations can be implemented with sufficient time. In the event of a structural failure due to earthquake, there may be no warning time. The USGS Earthquake Hazards Program has several dam-safety related earthquake programs, including dam-specific earthquake monitoring programs in California to help monitor safety concerns following seismic events.

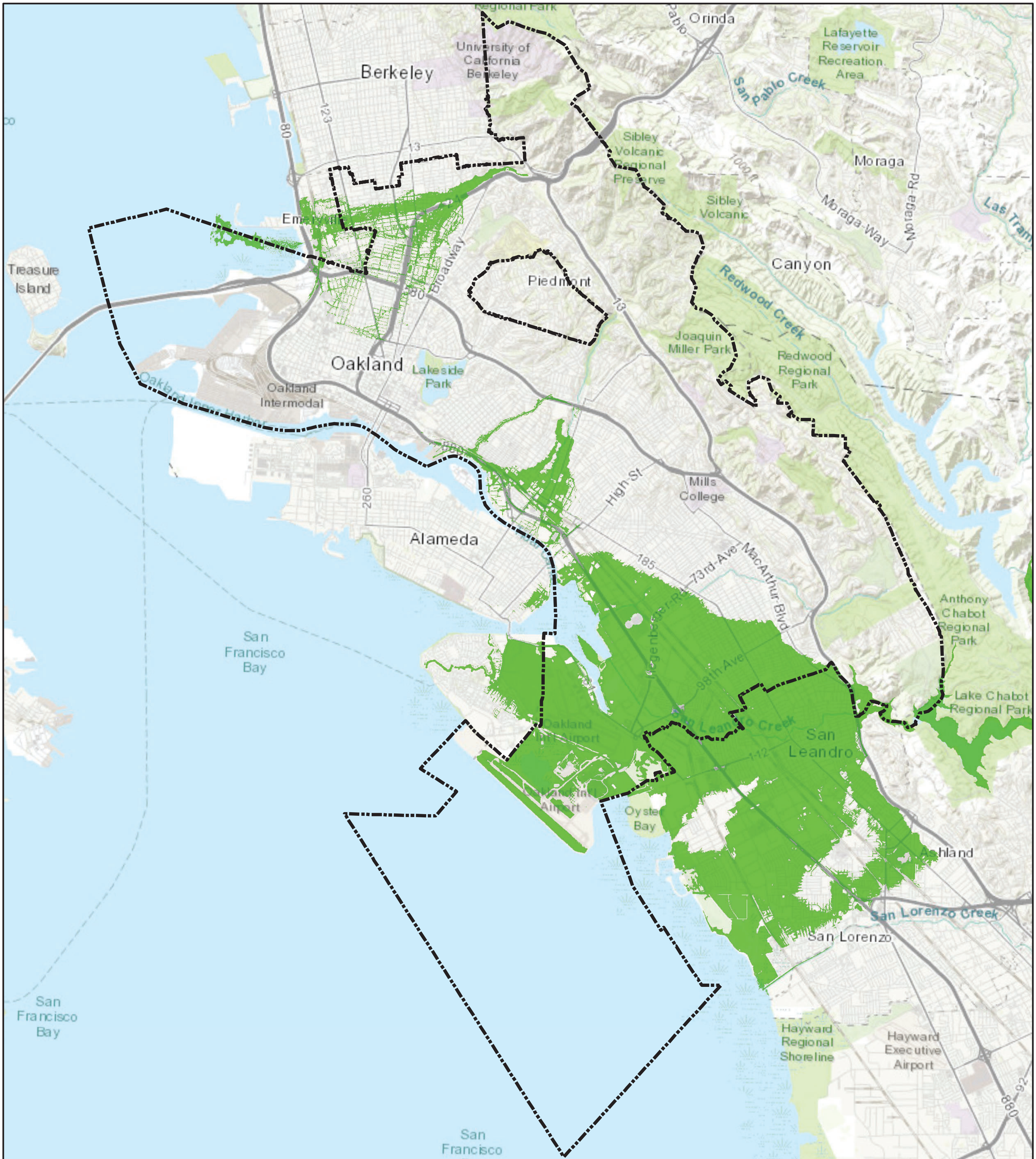


Figure 7-2. Combined Dam Failure Inundation Mapping

Data Sources: Esri Basemap, City of Oakland, CA DWR

A dam's structural type affects warning time. Earthen dams do not tend to fail completely or instantaneously. Once a breach is initiated, discharging water erodes the breach until the reservoir is empty or the breach resists further erosion. Concrete dams also tend to begin with a partial breach. The time of breach formation ranges from a few minutes to a few hours (U.S. Army Corps of Engineers, 1997).

7.3 EXPOSURE

Exposure to the dam failure hazard was assessed through a spatial analysis. Dam inundation areas for which inundation mapping was available were combined into a single inundation area (Figure 7-2). This area was overlaid with planning area general building stock, Census data at the block level, and critical facility locations.

7.3.1 Population

Total Exposed Population

The estimated total population living in the evaluated dam failure inundation zone is 65,933 (15.8 percent of the total City population). This estimate was developed by multiplying the total planning area population by the percentage of residential buildings that are within the mapped inundation zone. See Appendix E for a breakdown by sub-area.

Socially Vulnerable Populations

The socially vulnerable populations exposed to the dam failure hazard were estimated based on data for the Census-defined blocks that lie at least partially within the mapped dam failure inundation zone. Because many of those Census blocks extend outside the inundation zone, the estimates are greater than the actual exposed populations, but they provide reasonable relative data for use in mitigation planning. Table 7-3 summarizes the estimated socially vulnerable populations.

7.3.2 Property

Buildings

Table 7-4 summarizes the Hazus-estimated number and value of properties within the mapped dam failure inundation zone. See Appendix E for a breakdown by sub-area.

Land Use

Some land uses are more vulnerable to dam failure inundation, such as single-family homes, while others are less vulnerable, such as agricultural land or parks. Hazus defines an occupancy class for buildings in its inventory. These occupancy classes provide an indication of land use within the mapped hazard area. Table 7-5 shows the occupancy class of all buildings in the combined dam failure inundation area. See Appendix E for a breakdown by sub-area.

Table 7-3. Relative Exposure of Socially Vulnerable Populations in Dam Failure Inundation Zone

	Number[a]	% of Total in Hazard Area
Exposed Population by Age		
Over 65 Years	9,950	8.5%
Under 16	28,742	24.6%
Exposed Population by Race[b]		
White	19,065	16.3%
Black or African American	35,006	30.0%
American Indian and Alaska Native	421	0.4%
Asian	12,483	10.7%
Native Hawaiian and Other Pacific Islander	752	0.6%
Some other race	308	0.3%
Exposed Population by Ethnicity		
Hispanic or Latino (of any race)	45,490	38.9%
Exposed Households by Income		
Households with Income Below $50,000	23,807	59.8%
Totals Used for Calculating Percentages[a]		
Population	116,835	
Households	39,816	

a. Note that the methodology used for this analysis overestimates exposed population and households. Results presented in this table should be used to evaluate relative exposure between groups rather than absolute numbers of exposed persons or households.
b. Race data shown are as-is output from Hazus, suitable for comparing exposure between groups listed. Data are for persons identifying as one race only, and do not add up to the total exposed population.

Table 7-4. Exposure and Value of Structures in Dam Failure Inundation Zone

Inundated area (acres)	11,347
Number of Buildings Exposed	14,632
Value of Exposed Structures	$10,640,151,005
Value of Exposed Contents	$9,599,597,717
Total Exposed Property Value	**$20,239,748,722**
Total Exposed Value as % of Planning Area Total	*17.2%*

Table 7-5. Building Occupancy Classes in Dam Failure Inundation Areas

	Combined Dam Inundation Area	
Building Occupancy Class	Building Count	% of total Exposed
Residential	13,037	89.09
Commercial	1,004	6.86
Industrial	319	2.18
Agriculture	1	0.01
Religion	82	0.56
Government	159	1.08
Education	30	0.22
Total	**14,632**	**100**

The assessment of land use based on building occupancy classes does not provide an indication of parks and open space areas, which account for approximately 7 percent of the total area for the City. The amount of the dam inundation area that contains vacant, developable land is not known. This would be valuable information for gauging the future development potential of the dam inundation area.

7.3.3 Critical Facilities

Figure 7-3 shows critical facilities located in the dam inundation zone by facility type and river system. The total count of critical facilities in the dam failure inundation zone (668) represents 26 percent of the planning area total of 2,606.

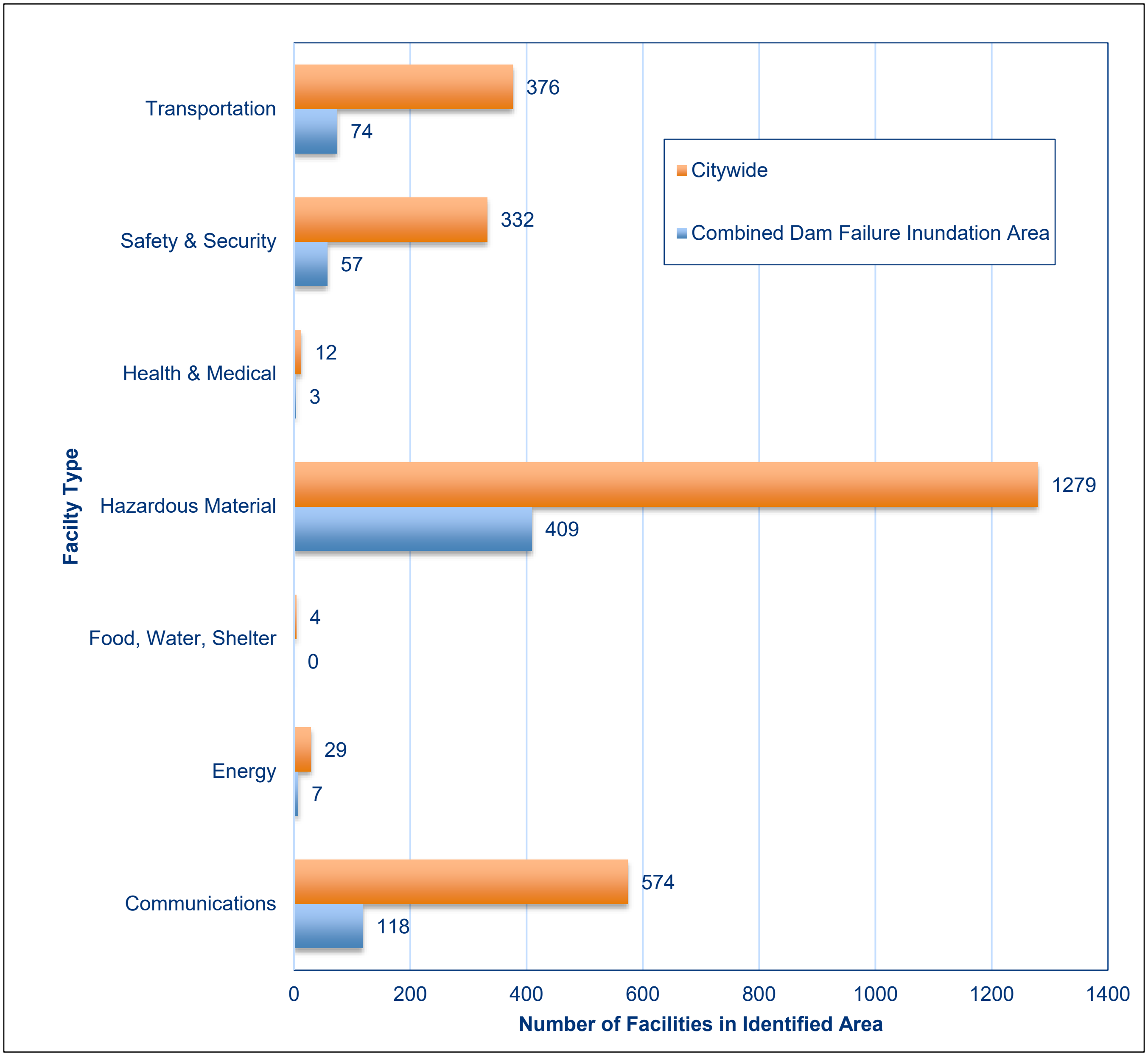


Figure 7-3. Critical Facilities in the Combined Dam Failure Inundation Zone and Citywide

7.3.4 Environment

The combined inundation area used for this risk assessment covers nearly 23 percent of the City of Oakland. It is reasonable to assume that a similar portion of the City's undeveloped natural areas would be within the inundation area and therefore exposed to the dam failure hazard.

7.4 VULNERABILITY

7.4.1 Population

The Level 2 Hazus analysis estimated the following broad impacts of the assessed dam failure on persons and households:

- Displaced Population—46,119
- Number of Residents Requiring Short-Term Shelter—4,268

See Appendix E for a breakdown by sub-area.

7.4.2 Property

Hazus draws from historical flood insurance claim data to generate depth/damage "function curves" that allow estimates of the percentage of damage to structures and their contents based on the structure type and the predicted depth of flooding. For this analysis, local data on buildings was used instead of the default inventory provided with Hazus. Table 7-6 shows the estimated dam failure impacts on structures in the planning area. See Appendix E for a breakdown by sub-area.

Table 7-6. Loss Estimates for Dam Failure

Buildings Impacted	12,476
Value of Structures Damaged	$2,174,507,165
Value of Contents Damaged	$4,132,038,155
Total Value (Structure and Contents) Damaged	**$6,306,545,320**
% of Total Value Damaged	5.4%

7.4.3 Critical Facilities

Hazus was used to estimate the level of potential damage to critical facilities exposed to the dam failure inundation risk. The analysis uses depth/damage function curves to estimate the percent of damage to critical facility buildings and contents. Table 7-7 summarizes the results. The damage estimates shown represent the average percent damage for all affected facilities in each category.

Transportation routes are vulnerable to dam inundation and have the potential to be destroyed, trapping evacuees in the dam inundation zone. This includes all roads, railroads, and bridges in the path of the dam inundation. Bridges in need of repair may be vulnerable during a dam failure and not withstand the water surge. Critical electrical, communications, gas and water infrastructure also could be damaged.

Table 7-7. Potential Damage to Critical Facilities in Dam Failure Inundation Zone

	Number of Facilities Affected	Average % of Total Value Damaged	
		Structure	Content
Safety and Security	51	15.59	65.37
Food, Water and Sheltering	0	N/A	N/A
Health and Medical	2	8.51	33.06
Energy	7	21.08	37.06
Communications	101	16.51	N/A
Transportation	73	5.38	52.59
Hazardous Materials	389	20.71	37.12
Total / Average	**623**	**14.63**	**45.04**

7.4.4 Environment

The environment would be vulnerable to a number of risks in the event of dam failure. The inundation could introduce foreign elements into local waterways. This could result in destruction of downstream habitat and could have detrimental effects on many species of animals.

7.5 FUTURE TRENDS IN DEVELOPMENT

Dam failures are low-probability, high-consequence events. Land use will be directed by the City of Oakland General Plan and zoning ordinance. Dam inundation is not currently a stand-alone hazard in the Safety Element, but flooding is. The City has established comprehensive policies regarding sound land use in identified flood hazard areas. Most of the areas vulnerable to the more severe impacts from dam failure intersect the mapped flood hazard areas. Flood-related policies in the General Plan will help to reduce the risk associated with the dam failure hazard for all future development in the City. Any new development outside of a flood hazard area will most likely not include provisions that would mitigate the impacts from a dam failure.

7.6 SCENARIO

Scenarios that could cause a dam failure include an earthquake that leads to liquefaction around a dam, extreme weather that causes a rapid rise in the reservoir level behind a dam, or human activity such as a terrorist attack that triggers a catastrophic dam failure.

While probability of dam failure is low, probability of flooding associated with changes in dam operational parameters in response to extreme rainfall events is higher. Dam designs and operations are developed based on hydrographs from historical records. If these hydrographs change significantly over time due to effects of climate change, current dam designs and operations may become overwhelmed. Specified release rates and impound thresholds may have to be changed, which could result in increased discharges downstream of these facilities, thus increasing probability and severity of inundation.

7.7 ISSUES

The most significant issue associated with dam failure involves the exposed population and property throughout the city. Depending on the amount of water behind the dam, inundation from a failure could be catastrophic. There is often limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes or severe weather, which limits their predictability and compounds the hazard. Important issues associated with dam failure hazards include the following:

- The protocol for notification of downstream residents of imminent dam failure is the responsibility of the dam owner/operators in cooperation with downstream local emergency management authorities such as the City of Oakland.
- FEMA guidance for dam failure mapping indicates that the probable maximum flood is the typical flood used for mapping the inundation area associated with a hydrological dam failure (FEMA, 2013). While the probable maximum flood represents a worst-case scenario, it is generally the event with the lowest probability of occurrence.
- The concept of residual risk associated with structural flood control projects should be considered in the design of capital projects and the application of land use regulations.
- Addressing security concerns and the need to inform the public of the risk associated with dam failure is a challenge for public officials.
- California's AB 2800 requires engineers and climate scientists to collaborate to help the state design and build infrastructure that will withstand the unavoidable impacts of a changing climate.
- Now that hazard mapping of state regulated dams is publicly available, communication of this risk as it pertains to the City of Oakland should be incorporated into relevant plans and programs.

8. DROUGHT

8.1 GENERAL BACKGROUND

8.1.1 Drought Types

Drought is a significant decrease in water supply relative to what is typical in a given location. It is a normal phase in the climate cycle of most regions, originating from a deficiency of precipitation over an extended period of time, usually a season or more. This leads to a water shortage for some activity, group or environmental sector. Drought can be characterized based on various impacts or measurements:

- Meteorological measurements such as rainfall deficit compared to normal or expected rainfall
- Agricultural impacts due to reduced rainfall and water supply (e.g., crop loss, herd culling, etc.)
- Hydrological measurements of stream flows, groundwater, and reservoir levels relative to normal conditions
- Direct and indirect socio-economic impacts on society and the economy (e.g., increased unemployment due to failure of an industry because of drought).

Droughts are climatic patterns that occur over long periods of time as the result of many causes. Global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast result in warm, dry air and reduced precipitation. Anomalies of precipitation and temperature may last from several months to several decades. How long they last depend on interactions between the atmosphere and the oceans, soil moisture and land surface processes, topography, internal dynamics, and the accumulated influence of global weather systems.

8.1.2 Monitoring and Categorizing Drought

NOAA Drought Indices

The National Oceanic and Atmospheric Administration (NOAA) has developed several indices to measure drought impacts and severity and to map their extent and locations:

- The ***Crop Moisture Index*** measures short-term drought weekly to assess impacts on agriculture.
- The ***Palmer Z Index*** measures short-term drought on a monthly scale.
- The ***Palmer Drought Severity Index*** is based on long-term weather patterns. The intensity of drought in a given month is dependent on current weather plus the cumulative patterns of previous months. Weather patterns can change quickly, and the Palmer Drought Severity Index can respond fairly rapidly.

- The ***Palmer Hydrological Drought Index*** quantifies hydrological effects (reservoir levels, groundwater levels, etc.), which take longer to develop and last longer. This index responds more slowly to changing conditions than the Palmer Drought Index.
- The ***Standardized Precipitation Index*** considers only precipitation. A value of zero indicates the median precipitation amount; the index is negative for drought and positive for wet conditions. The Standardized Precipitation Index is computed for time scales ranging from one month to 24 months.

Maps of these indices show drought conditions nationwide at a given point in time. They are not necessarily indicators of any given area's long-term susceptibility to drought. Recent examples of these maps are shown on Figure 8-1 through Figure 8-5.

Source: National Weather Service, 2021

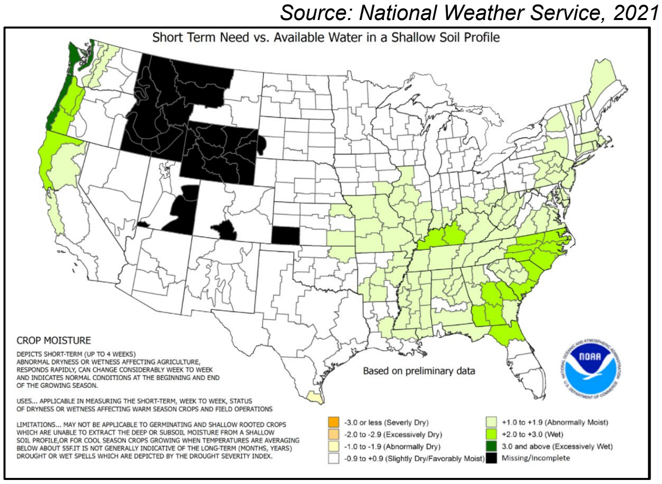


Figure 8-1. Crop Moisture Index (Week Ending February 06, 2020)

Source: National Centers for Environmental Information, 2021a

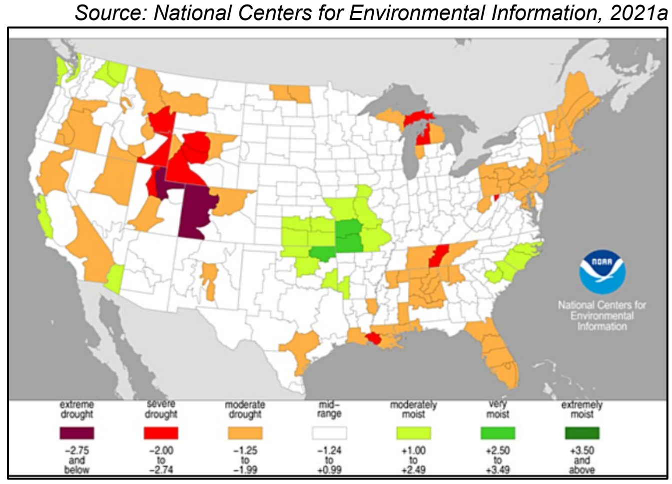


Figure 8-2. Palmer Z Index Short-Term Drought Conditions (January 2021)

Source: National Centers for Environmental Information, 2021b

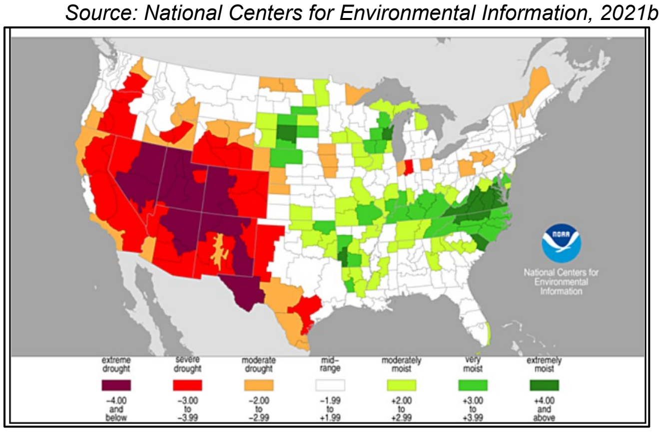


Figure 8-3. Palmer Drought Severity Index (January 2021)

Source: National Centers for Environmental Information, 2021c

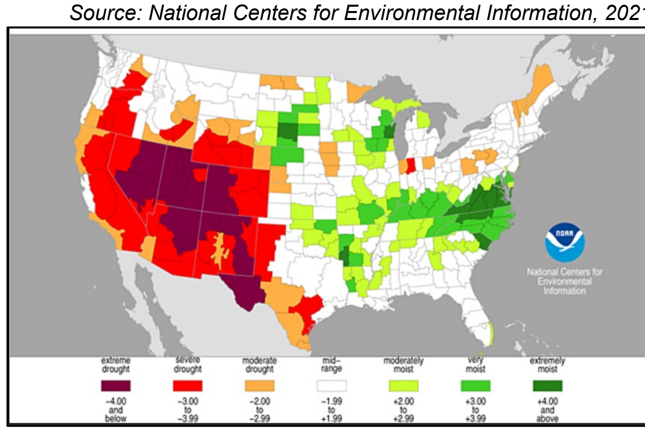


Figure 8-4. Palmer Hydrological Drought Index (January 2021)

Source: National Centers for Environmental Information, 2021d

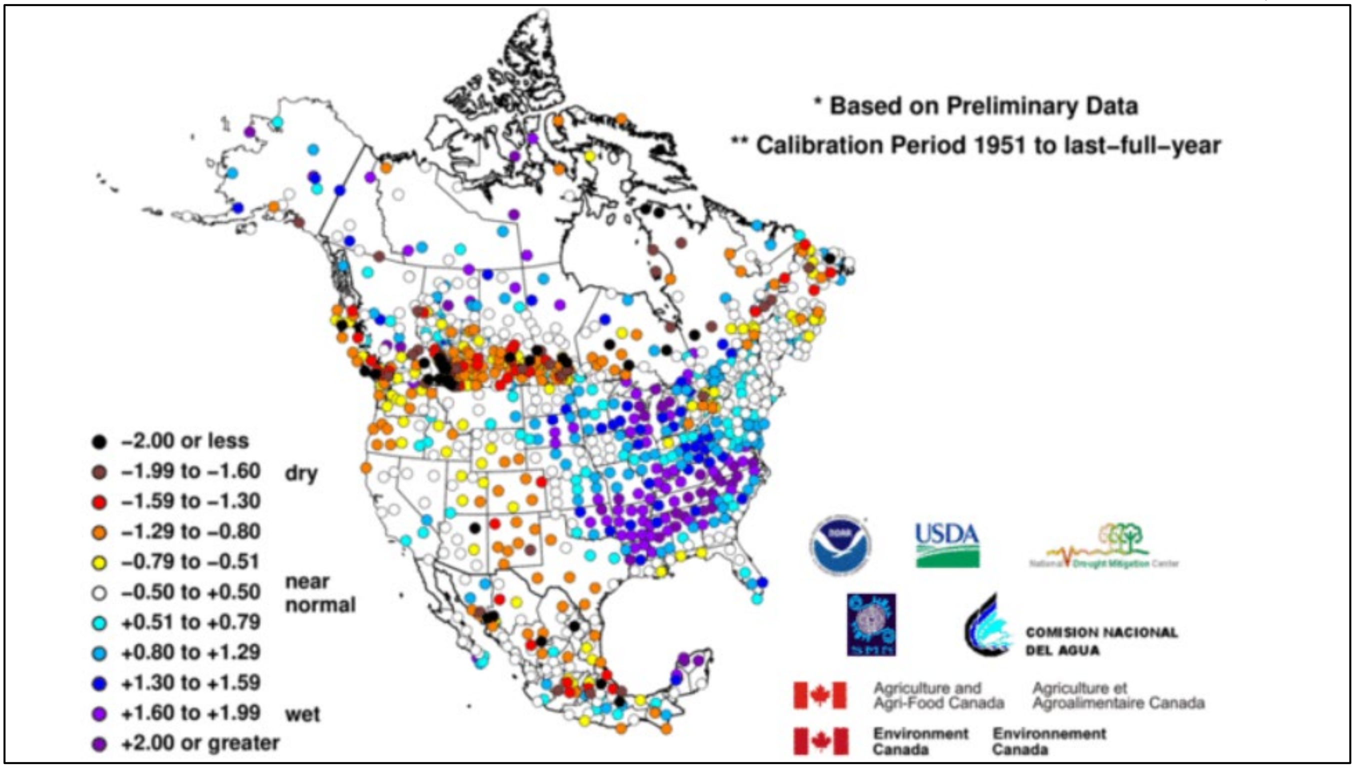


Figure 8-5. 24-Month Standardized Precipitation Index Ending December 2020

U.S. Drought Monitor

The U.S. Drought Monitor (USDM) is a map that is updated weekly to show the location and intensity of drought across the country. The USDM uses a five-category system:

- D0—Abnormally Dry
  - Short-term dryness slowing planting, growth of crops
  - Some lingering water deficits
  - Pastures or crops not fully recovered
- D1—Moderate Drought
  - Some damage to crops, pastures
  - Some water shortages developing
  - Voluntary water-use restrictions requested
- D2—Severe Drought
  - Crop or pasture loss likely
  - Water shortages common
  - Water restrictions imposed
- D3—Extreme Drought
  - Major crop/pasture losses
  - Widespread water shortages or restrictions

- D4—Exceptional Drought
  - Exceptional and widespread crop/pasture losses
  - Shortages of water creating water emergencies

The USDM categories show experts' assessments of conditions related to drought. These experts check variables including temperature, soil moisture, water levels in streams and lakes, snow cover, and meltwater runoff. They also check whether areas are showing drought impacts such as water shortages and business interruptions. Associated statistics show what proportion of various geographic areas are in each category of dryness or drought, and how many people are affected. U.S. Drought Monitor data go back to 2000.

8.1.3 Drought Impacts

Drought can have a widespread impact on the environment and the economy, although it typically does not result in loss of life or damage to structures, as do other natural disasters. The National Drought Mitigation Center uses three categories to describe likely drought impacts:

- **Economic Impacts**—These impacts of drought cost people (or businesses) money. Farmers' crops are destroyed; low water supply necessitates spending on irrigation or drilling of new wells; water-related businesses (such as sales of boats and fishing equipment) may experience reduced revenue.
- **Environmental Impacts**—Plants and animals depend on water. When a drought occurs, their food supply can shrink, and their habitat can be damaged.
- **Social Impacts**—Social impacts include public safety, health, conflicts between people when there is not enough water to go around, and changes in lifestyle.

The demand that society places on water systems and supplies—such as expanding populations, irrigation, and environmental needs—contributes to drought impacts. Drought can lead to difficult decisions regarding the allocation of water, as well as stringent water use restrictions, water quality problems, and inadequate water supplies for fire suppression. There are also issues such as growing conflicts between agricultural uses of surface water and in-stream uses, surface water and groundwater interrelationships, and the effects of growing water demand on uses of water.

Vulnerability of an activity to drought depends on its water demand and the water supplies available to meet the demand. The impacts of drought vary between sectors of the community in both timing and severity:

- **Water supply—**The water supply sector encompasses urban and rural drinking water systems that are affected when a drought depletes ground water supplies due to reduced recharge from rainfall.
- **Agriculture and commerce—**The agriculture and commerce sector includes the reduction of crop yield and livestock sizes due to insufficient water supply for crop irrigation and maintenance of ground cover for grazing.
- **Environment, public health, and safety—**The environmental, public health, and safety sector focuses on wildfires that are both detrimental to the forest ecosystem and hazardous to the public. It also includes the impact of desiccating streams, such as the reduction of in-stream habitats for native species.

8.1.4 California Drought Response

Defined Drought Stages

During critically dry years, the California State Water Resources Control Board can mandate water entitlements on water right holders to address statewide water shortages. Table 8-1 shows the state drought management program stages mandated to water right holders.

Table 8-1. State Drought Management Program

Drought Stage	State Mandated Customer Demand Reduction	Rate Impacts
Stage 0 or 1	<10%	Normal rates
Stage 2	10 to 15%	Normal rates; Drought surcharge
Stage 3	15 to 20%	Normal rates; Drought surcharge
Stage 4	>20%	Normal rates, Drought surcharge

Future Water Conservation in California

California's 2005 Water Plan and subsequent updates indicate that water demand in the state will increase through 2030. The Department of Water Resources predicts a modest decrease in agricultural water use, but an urban water use increase of 1.5 to 5.8 million acre-feet per year (DWR 2005). The 2013 update to the Water Plan explores measures, benchmarks, and successes in increasing agricultural and urban water use efficiency.

Assembly Bill 1668 and Senate Bill 606, both passed in 2018, are jointly designed to overhaul California's approach to conserving water. Both bills were enacted with contingencies toward each other—addressing water conservation and drought resilience across the state. Both were adopted in response to the governor's Executive Order B-37-16 "Making Water Conservation a California Way of Life" which directs permanent changes to use water more wisely, eliminate water waste, strengthen local drought resistance, and improve agricultural water use efficiency and drought planning. With an aim to make water conservation a way of life in California, Executive Order B-37-16 requires the following:

- The State Water Resources Control Board will maintain urban water use reporting requirements and prohibitions on wasteful practices such as watering during or after rainfall, hosing off sidewalks and irrigating ornamental turf on public street medians.
- The state will continue its work to coordinate a statewide response on the bark beetle outbreak in drought-stressed forests that has killed millions of trees across California.

SB 606 requires the State Water Resources and Control Board and DWR to adopt water efficiency regulations, outlines requirements for urban water suppliers, including urban drought risk assessments, and implements penalties for violations. The law contains directives on water shortage planning and water loss reporting for urban wholesale water suppliers, and offers a bonus incentive for potable reuse water.

AB 1668 requires the State Water Resources Control Board, in coordination with the DWR, to adopt water efficiency standards and regulations; drought and water shortage contingency plan guidance; specified standards for per capita daily indoor residential water use; and performance measures for commercial, industrial, and institutional water use.

Long-term urban water use efficiency standards must be established by June 30, 2022. Those standards will include components for indoor residential use, outdoor residential use, water losses and other uses. Regarding indoor residential use, the new laws set a standard of 55 gallons per person, per day through January 1, 2025. After that date, the amount will be incrementally reduced over time.

The legislation also specifies penalties on local water suppliers for violations to these standards. Starting in 2027, local water suppliers' failure to comply with the Water Resources Control Board's adopted long-term standards could result in fines of $1,000 per day during non-drought years and $10,000 per day during declared drought emergencies and certain dry years.

8.1.5 Secondary Hazards

The secondary impact most commonly associated with drought is wildfire. A prolonged lack of precipitation dries out vegetation, which becomes increasingly susceptible to ignition as the duration of the drought extends.

Drought also is often accompanied by extreme heat, exposing people to the risk of sunstroke, heat cramps and heat exhaustion. Pets and livestock are also vulnerable to heat-related injuries. Crops can be vulnerable as well.

8.2 HAZARD PROFILE

The Safety Element of the Oakland General Plan describes the drought hazard as a component of wildfire hazards.

8.2.1 Local Water Supply and Use

The East Bay Municipal Utility District (EBMUD) is the primary water purveyor for the City of Oakland. EBMUD's water system serves approximately 1.4 million people in a 332-square-mile area extending from Crockett on the north to San Lorenzo and the San Ramon Valley on the south (encompassing the major cities of Oakland and Berkeley) and from San Francisco on the west to Walnut Creek on the east. EBMUD's water supply begins at the Mokelumne River watershed in the Sierra Nevada and extends 90 miles to the East Bay.

8.2.2 Past Events

The California Department of Water Resources has historical state hydrologic data back to the early 1900s (DWR, 2017). The hydrologic data show multi-year droughts from 1912 to 1913, 1918 to 1920, 1922 to 1924 and 1928 to 1934. The following sections describe droughts in California since then, all of which impacted the City of Oakland to some degree.

1976 to 1977 Drought

California had a severe drought due to lack of rainfall during the winters of 1976 and 1977. 1977 was the driest period on record in California to that time, with the previous winter recorded as the fourth driest. The cumulative impact led to widespread water shortages and severe water conservation measures throughout the state. Only 37 percent of the average Sacramento Valley runoff was received. A federal disaster declaration was declared, which included Alameda County.

1987 to 1992 Drought

California received precipitation well below average levels for four consecutive years. By February 1991, all 58 counties in California were suffering from drought conditions. Urban areas as well as rural and agricultural areas were impacted.

2007 to 2009 Drought

The governor proclaimed a statewide drought emergency on June 4, 2008 after spring 2008 was the driest spring on record and snowmelt runoff was low. On February 27, 2009, the governor proclaimed a state of emergency for the entire state as the severe drought conditions continued widespread impacts and the largest court-ordered water restriction in state history (at the time).

2012 to 2017 Drought

California's most recent drought set several records:

- The period from 2012 to 2014 ranked as the driest three consecutive years for statewide precipitation.
- 2014 set new climate records for statewide average temperatures and for record-low water allocations in the State Water Project and federal Central Valley Project.
- 2013 set minimum annual precipitation records for many communities.

On January 17, 2014, the governor declared a state of emergency for drought throughout California. This declaration followed release of a report that stated that California had had the least amount of rainfall in its 163-year history. Californians were asked to voluntarily reduce their water consumption by 20 percent. Drought conditions worsened into 2015. On April 1, 2015, following the lowest snowpack ever recorded, the governor announced actions to save water, increase enforcement to prevent wasteful water use, streamline the state's drought response, and invest in new technologies to make California more drought-resilient. The governor directed the State Water Resources Control Board to implement mandatory water reductions in cities and towns across California to reduce water usage by 25 percent on average.

The statewide hydrologic drought from 2012 through 2016 included the driest four-year statewide precipitation on record (2012 – 2015) and the smallest Sierra-Cascades snowpack on record (2015, with 5 percent of average). It was marked by extraordinary heat: 2014, 2015 and 2016 were California's first, second and third warmest year in terms of statewide average temperatures.

On April 7, 2017 the governor ended the drought state of emergency in most of California, following unprecedented water conservation and plentiful winter rain and snow.

8.2.3 Location

Drought is a regional phenomenon. A drought that affects the planning area would affect the entirety of the area simultaneously and has the potential to impact every person in the city directly or indirectly as well as adversely affecting the local economy.

8.2.4 Frequency

Drought has a high probability of occurrence in the planning area. From January 2000 to January 2021, some part of Alameda County experienced a USDM rating of D1 or higher in 553 out of 1,095 weeks—slightly more than one out of every two weeks (see Figure 8-6). The planning area has also been included in USDA drought disaster declarations in four of the past seven years. Historical drought data for the planning area indicate there have been eight significant multi-year droughts in the last 20 years (2000 to 2020), amounting to a severe drought every 5 to 6 years on average.

Source: U.S. Drought Monitor, 2020

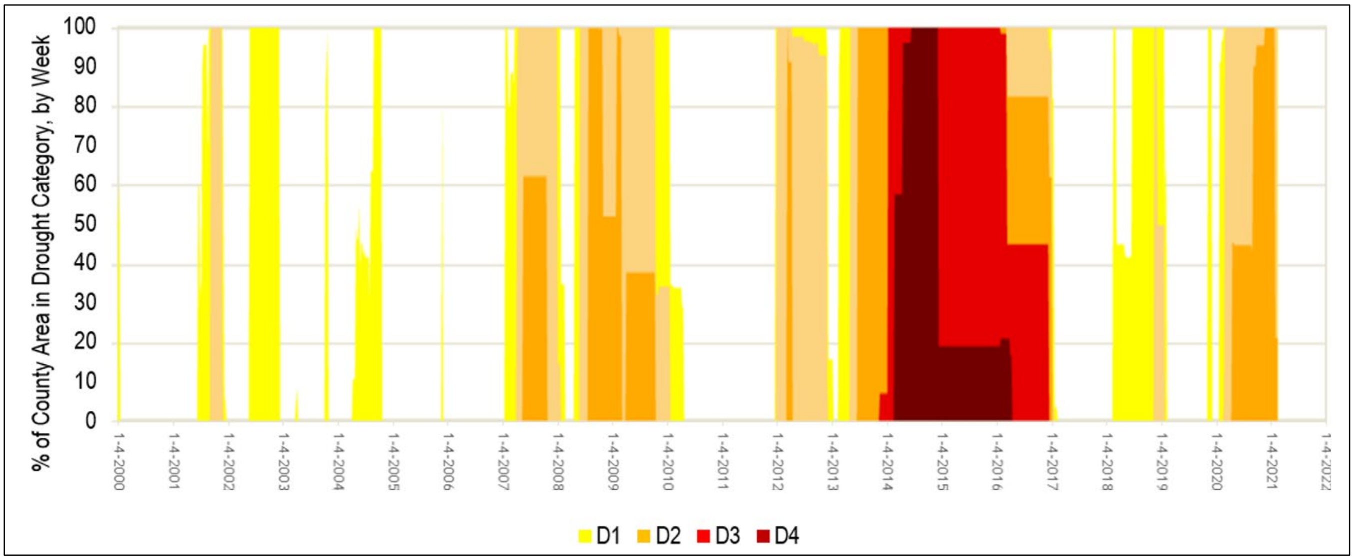


Figure 8-6. Percent of Alameda County Affected by Each USDM Rating, 2000 – 2021

8.2.5 Severity

The severity of any given drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts.

U.S. Drought Monitor Ratings

Alameda County has a history of severe droughts. As shown in Figure 8-6, at least part of the county has experienced extreme (D3) or exceptional (D4) droughts more than once since 2000.

Drought Impact Reporter

The National Drought Mitigation Center developed the Drought Impact Reporter in response to the need for a national drought impact database for the United States. Information comes from a variety of sources: on-line, drought-related news stories and scientific publications, members of the public who visit the website and submit a drought-related impact for their region, members of the media, and staff of government agencies. The database is being populated beginning with the most recent impacts and working backward in time.

The Drought Impact Reporter indicates 159 impacts from drought that specifically affected Alameda County from January 2010 through December 2020 (Drought Impact Reporter, 2020). Most reports (155 out of 161) are based on media reports. The following are the reported numbers of impacts by category (some incidents are assigned to more than one impact category):

- Agriculture—37
- Business and Industry—8
- Energy—5
- Fire—16
- Plants and Wildlife—33
- Relief, Response, and Restrictions—98
- Society and Public Health—61
- Tourism and Recreation—7
- Water Supply and Quality—103

8.2.6 Warning Time

Droughts are climatic patterns that occur over long periods of time. Only generalized warning can take place due to the numerous variables that scientists have not pieced together well enough to make accurate and precise predictions.

Empirical studies conducted over the past century have shown that meteorological drought is never the result of a single cause. It is the result of many causes, often synergistic in nature. These include global weather patterns that produce persistent, upper-level high-pressure systems along the West Coast with warm, dry air resulting in less precipitation.

At this time, scientists do not know how to predict drought more than a month in advance for most locations. Predicting drought depends on the ability to forecast precipitation and temperature. Anomalies of precipitation and temperature may last from several months to several decades.

8.3 EXPOSURE AND VULNERABILITY

All of Oakland is exposed and vulnerable to drought events. Drought can affect a wide range of economic, environmental, and social activities. Its impacts can span many sectors of the economy because water is integral to the ability to produce goods and provide services. The impacts can reach well beyond the area undergoing physical drought. Vulnerability of an activity to drought depends on its water demand and the water supplies available to meet the demand.

8.3.1 Population

Drought can affect people's health and safety, including health problems related to low water flows, poor water quality, or dust. Drought can also lead to loss of human life (National Drought Mitigation Center, 2017). Other possible impacts include recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and hygiene; compromised food and nutrition; and increased incidence of illness and disease (Centers for Disease Control and Prevention, 2012). Droughts can also lead to reduced local firefighting capabilities.

8.3.2 Property

No structures will be directly affected by drought conditions. Droughts can have significant impacts on landscapes, which could cause a financial burden to property owners. However, these impacts are not considered critical in planning for impacts from the drought hazard.

8.3.3 Critical Facilities

Critical facilities as defined for this plan will continue to be operational during a drought. A benefit of water conservation in the City is delaying the need for sewer facility expansions by reducing wastewater discharge into the sewer collection and treatment system. The risk to the planning area's critical facilities inventory will be largely aesthetic. For example, when water conservation measures are in place, landscaped areas will not be watered and may die. These aesthetic impacts are not considered significant.

8.3.4 Environment

Groundwater and Streams

Drought generally does not affect groundwater sources as quickly as surface water supplies, but groundwater supplies generally take longer to recover. Reduced precipitation during a drought means that groundwater supplies are not replenished at a normal rate. This can lead to a reduction in groundwater levels and problems such as reduced pumping capacity or wells going dry. Shallow wells are more susceptible than deep wells. Reduced replenishment of groundwater affects streams. Much of the flow in streams comes from groundwater, especially during the summer when there is less precipitation and after snowmelt ends. Reduced groundwater levels mean that even less water will enter streams when stream flows are lowest. Where stream flows are reduced, development that relies on surface water may seek to establish new groundwater wells, which could further increase groundwater depletion.

Other Potential Losses

Environmental losses from drought are associated with damage to plants, animals, wildlife habitat, and air and water quality; forest and range fires; degradation of landscape quality; loss of biodiversity; and soil erosion. Some of the effects are short-term and conditions quickly return to normal following the end of the drought. Other environmental effects linger for some time or may even become permanent. Although environmental losses are difficult to quantify, growing public awareness and concern for environmental quality has forced public officials to focus greater attention and resources on these effects. The following are potential impacts of drought:

- Wildlife habitat may be degraded through the loss of wetlands, lakes and vegetation. The degradation of landscape quality, including increased soil erosion, may lead to a more permanent loss of biological productivity.
- Drought conditions greatly increase the likelihood of wildfires, the major threat to timber resources.
- Water shortages and severe drought conditions would have a significant impact on Native American tribes' way of life in fishing and farming subsistence.

- Scenic resources in the City are vulnerable to the increased likelihood of wildfires associated with droughts.
- Drying up or dying off of forests could reduce ecological and eco-tourist values.
- Any shortage of water supply can have significant economic impacts.

8.3.5 Economic Impact

Economic impact will be largely associated with industries that use water or depend on water for their business. For example, landscaping businesses were affected in the droughts of the past as the demand for service significantly declined because landscaping was not watered. Agricultural industries will be impacted if water usage is restricted for irrigation.

A prolonged drought can affect a community's economy significantly. Increased demand for water and electricity may result in shortages and higher costs of these resources. Industries that rely on water for business may be impacted the most (e.g., landscaping businesses). Although most businesses will still be operational, they may be affected aesthetically—especially the recreation and tourism industry. Moreover, droughts within another area could affect food supply and price for City residents.

8.4 FUTURE TRENDS IN DEVELOPMENT

The City of Oakland has a General Plan that includes policies directing land use and dealing with issues of water supply and the protection of water resources. This plan provides the capability at the local level to protect future development from the impacts of drought. The City reviewed its General Plan under the capability assessment performed for this effort. Deficiencies identified by this review can be addressed by mitigation actions to increase the capability to deal with future trends in development.

The City of Oakland applies several standard conditions of approval for development projects to further address drought-related issues. These conditions involve landscape planning and use of recycled water. Details are provided in Appendix D.

8.5 SCENARIO

An extreme, multiyear drought associated with record-breaking rates of low precipitation and high temperatures—such as the most recent drought across the State of California—is the worst-case scenario. Combinations of low precipitation and high temperatures could occur over several consecutive years. Intensified by such conditions, water use could exceed the reserve supply in the planning area. If such conditions persisted for several years, the economy of the City could experience setbacks, especially in water dependent industries. Surrounding communities, also in drought conditions, could increase their demand for water supplies relied on by the City of Oakland, causing social and political conflicts. This potential increase in demand would also likely have a disproportionate impact on vulnerable communities in the city.

8.6 ISSUES

The planning team has identified the following drought-related issues:

- Identification and development of alternative water supplies and water shortage response actions (such as presented in EBMUD's *Water Shortage Contingency Plan* and *Urban Water Management Plan*)
- Large residential populations stressing the water supply
- The use of groundwater recharge techniques to stabilize the groundwater supply
- The probability of increased multi-year drought and durations due to climate change, and the associated need to consider long-term conservation measures
- Loss of much of the water transported from aqueducts to leaks and evaporation
- Recycled water opportunities
- The capture and storage of urban runoff
- The wildfire risk associated with trees that are dead or dying because of drought conditions

9. EARTHQUAKE

9.1 GENERAL BACKGROUND

An earthquake is the vibration of the earth's surface following a release of energy in the earth's crust. This energy can be generated by a sudden dislocation of the crust or by a volcanic eruption. Most destructive quakes are caused by dislocations of the crust. The crust may first bend and then, when the stress exceeds the strength of the rocks, break and snap to a new position. In the process of breaking, vibrations called "seismic waves" are generated. These waves travel outward from the source of the earthquake at varying speeds.

9.1.1 Earthquake Location

The location of an earthquake is commonly described by its focal depth and the geographic position of its epicenter. The focal depth of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates (the focus or hypocenter). The epicenter of an earthquake is the point on the Earth's surface directly above the hypocenter.

9.1.2 Earthquake Geology

Tectonic Plates

The Earth's crust, which is the rigid outermost shell of the planet, is broken into seven or eight major tectonic plates (depending on how they are defined) and many minor plates. Where the plates meet, they move in one of three ways along their mutual boundary: convergent (two plates moving together), divergent (two plates moving apart), or transform (two plates moving parallel to one another). Earthquakes, volcanic activity, mountain-building, and oceanic trench formation occur along these plate boundaries. Subduction is a geological process that takes place at convergent boundaries of tectonic plate, in which one plate moves under another. Regions where this process occurs are known as subduction zones, and they have the potential to generate highly damaging earthquakes.

California is seismically active because of movement of the North American Plate, east of the San Andreas Fault, and the Pacific Plate to the west, which includes the state's coastal communities. The transform (parallel) movement of these tectonic plates against one another creates stresses that build as the rocks are gradually deformed. The rock deformation, or strain, is stored in the rocks as elastic strain energy. When the strength of the rock is exceeded, rupture occurs along a fault. The rocks on opposite sides of the fault slide past each other as they spring back into a relaxed position. The strain energy is released partly as heat and partly as elastic waves called seismic waves. The passage of these seismic waves produces the ground shaking in earthquakes.

Faults

Geologists have found that earthquakes reoccur along faults, which are zones of weakness in the earth's crust. When a fault experiences an earthquake, there is no guarantee that all the stress has been relieved. Another earthquake can still occur. In fact, relieving stress along one part of a fault may increase it in another part.

Faults are more likely to have future earthquakes on them if they have more rapid rates of movement, have had recent earthquakes along them, experience greater total displacements, and are aligned so that movement can relieve the accumulating tectonic stresses. Geologists classify faults by their relative hazards. "Active" faults, which represent the highest hazard, are those that have ruptured to the ground surface during the Holocene period (about the last 11,000 years). "Potentially active" faults are those that displaced layers of rock from the Quaternary period (the last 1,800,000 years) (California Department of Conservation, 2003).

Determining if a fault is "active" or "potentially active" depends on geologic evidence, which may not be available for every fault. The majority of the seismic hazards are on well-known active faults. However, inactive faults, where no displacements have been recorded, also have the potential to reactivate or experience displacement along a branch sometime in the future. An example of a fault zone that has been reactivated is the Foothills Fault Zone. The zone was considered inactive until evidence of an earthquake (approximately 1.6 million years ago) was found near Spenceville, California. Then, in 1975, an earthquake occurred on another branch of the zone near Oroville, California (now known as the Cleveland Hills Fault). The State Division of Mines and Geology indicates that increased earthquake activity throughout California may cause tectonic movement along currently inactive fault systems.

9.1.3 Earthquake-Related Hazards

According to the U.S. Geological Survey (USGS) Earthquake Hazards Program, an earthquake hazard is anything associated with an earthquake that may affect resident's normal activities. This includes the following:

- **Surface Faulting**—Displacement that reaches the earth's surface during slip along a fault. Commonly occurs with shallow earthquakes, those with an epicenter less than 12 miles deep.
- **Ground Motion (shaking)**—The movement of the earth's surface from earthquakes or explosions. Ground motion or shaking is produced by waves that are generated by sudden slip on a fault or sudden pressure at the explosive source and travel through the earth and along its surface.
- **Landslid**e—A movement of surface material down a slope.
- **Liquefaction**—A process by which water-saturated sediment temporarily loses strength and acts as a fluid. Earthquake shaking can cause this effect.
- **Tectonic Deformation**—A change in the original shape of a material due to stress and strain.
- **Tsunami**—A sea wave of local or distant origin that results from large-scale seafloor displacements associated with large earthquakes, major submarine slides, or violent underwater volcanic eruptions.

9.1.4 Earthquake Classifications

Earthquakes are typically classified in one of two ways: By the amount of energy released, measured as magnitude; or by the impact on people and structures, measured as intensity.

Magnitude

An earthquake's magnitude is a measure of the energy released at the source of the earthquake. Magnitude is commonly expressed by ratings on the moment magnitude scale (M_W), the most common scale used today (USGS, 2017). This scale is based on the total moment release of the earthquake (the product of the distance a fault moved and the force required to move it). The scale is as follows:

- Great—Mw > 8
- Major—Mw = 7.0 – 7.9
- Strong—Mw = 6.0 – 6.9
- Moderate—Mw = 5.0 – 5.9
- Light—Mw = 4.0 – 4.9
- Minor—Mw = 3.0 – 3.9
- Micro—w < 3

Intensity

The most commonly used intensity scale is the modified Mercalli intensity scale. Ratings of the scale as well as the perceived shaking and damage potential for structures are shown in Table 9-1. The modified Mercalli intensity scale is generally represented visually using shake maps, which show the expected ground shaking at any given location produced by an earthquake with a specified magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A shake map shows the variation of ground shaking in a region immediately following significant earthquakes (for technical information about shake maps see USGS, 2018).

Table 9-1. Mercalli Scale and Peak Ground Acceleration Comparison

Modified Mercalli Scale	Perceived Shaking	Potential Structure Damage		Estimated PGA[a] (%g)
		Resistant Buildings	Vulnerable Buildings	
I	Not Felt	None	None	<0.17%
II-III	Weak	None	None	0.17% - 1.4%
IV	Light	None	None	1.4% - 3.9%
V	Moderate	Very Light	Light	3.9% - 9.2%
VI	Strong	Light	Moderate	9.2% - 18%
VII	Very Strong	Moderate	Moderate/Heavy	18% - 34%
VIII	Severe	Moderate/Heavy	Heavy	34% - 65%
IX	Violent	Heavy	Very Heavy	65% - 124%
X – XII	Extreme	Very Heavy	Very Heavy	>124%

a. PGA = peak ground acceleration. Measured in percent of g, where g is the acceleration of gravity

Sources: USGS, 2008; USGS, 2010

9.1.5 Ground Motion

Earthquake hazard assessment is based on expected ground motion. During an earthquake when the ground is shaking, it also experiences acceleration. The peak acceleration is the largest increase in velocity recorded by a particular station during an earthquake. Estimates are developed of the annual probability that certain ground motion accelerations will be exceeded; the annual probabilities can then be summed over a time period of interest.

The most commonly mapped ground motion parameters are horizontal and vertical peak ground accelerations (PGA) for a given soil type. PGA is a measure of how hard the earth shakes, or accelerates, in a given geographic area. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. PGA is measured in g (the acceleration due to gravity) or expressed as a percent acceleration force of gravity (%g). These readings are recorded by state and federal agencies that monitor and predict seismic activity.

Maps of PGA values form the basis of seismic zone maps that are included in building codes such as the International Building Code. Building codes that include seismic provisions specify the horizontal force due to lateral acceleration that a building should be able to withstand during an earthquake. PGA values are directly related to these lateral forces that could damage "short period structures" (e.g. single-family dwellings). Longer period response components determine the lateral forces that damage larger structures with longer natural periods (apartment buildings, factories, high-rises, bridges). Table 9-1 lists damage potential and perceived shaking by PGA factors, compared to the Mercalli scale.

9.1.6 USGS Earthquake Mapping Programs

ShakeMaps

The USGS Earthquake Hazards Program produces maps called ShakeMaps that map ground motion and shaking intensity following significant earthquakes. ShakeMaps focus on the ground shaking caused by the earthquake, rather than on characteristics of the earthquake source, such as magnitude and epicenter. An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust.

A ShakeMap shows the extent and variation of ground shaking immediately across the surrounding region following significant earthquakes. Such mapping is derived from peak ground motion amplitudes recorded on seismic sensors, with interpolation where data are lacking based on estimated amplitudes. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. In addition to the maps of recorded events, the USGS creates the following:

- Scenario ShakeMaps of hypothetical earthquakes of an assumed magnitude on known faults
- Probabilistic ShakeMaps, based on predicted shaking from all possible earthquakes over a 10,000-year period. In a probabilistic map, information from millions of scenario maps are combined to make a forecast for the future. The maps indicate the ground motion at any given point that has a given probability of being exceeded in a given timeframe, such as a 100-year (1-percent-annual chance) event.

National Seismic Hazard Map

National maps of earthquake shaking hazards provide information for creating and updating seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities and land use planning. After thorough review of the studies, professional organizations of engineers update the seismic-risk maps and seismic design requirements contained in building codes (Brown et al., 2001). The USGS updated the National Seismic Hazard Maps in 2018. New seismic, geologic, and geodetic information on earthquake rates and associated ground shaking were incorporated into these revised maps. The 2018 map, shown in Figure 9-1, represents the best available data as determined by the USGS.

Source: USGS, 2018

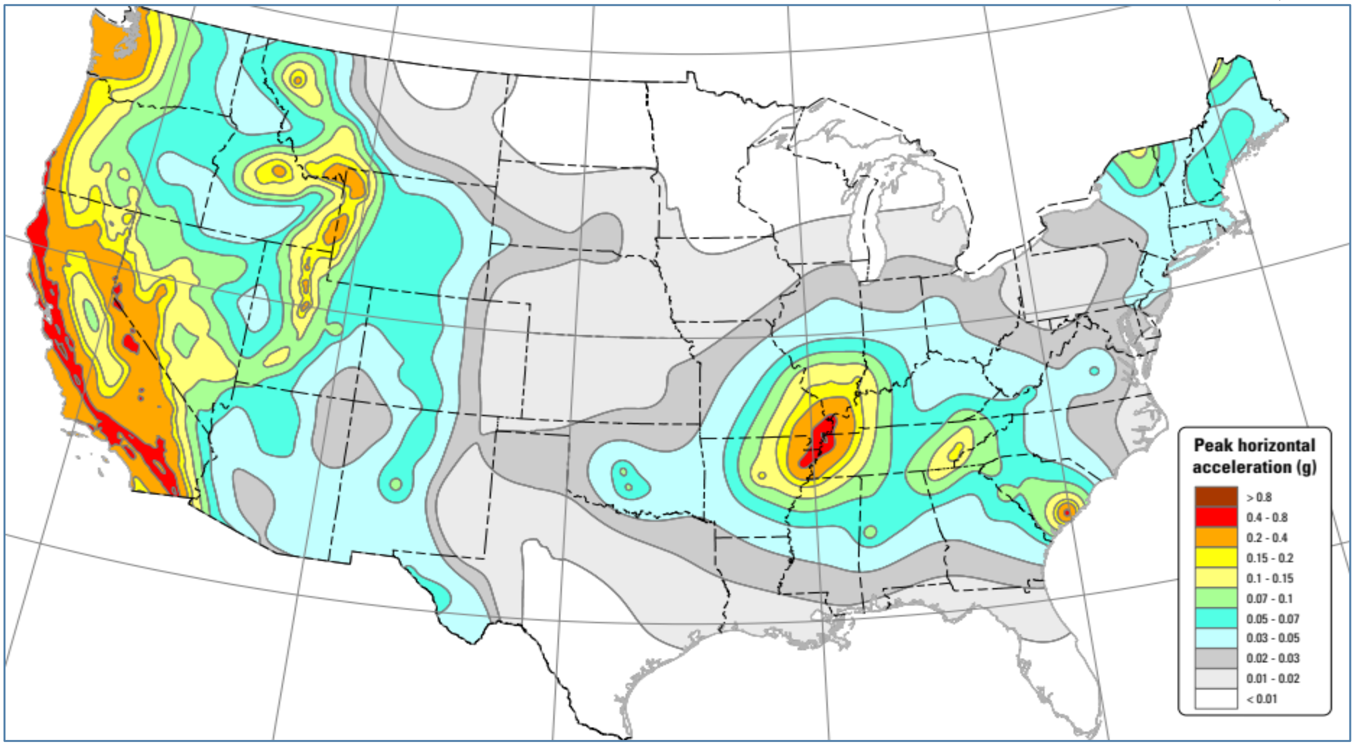


Figure 9-1. Peak Acceleration with 10% Probability of Exceedance in 50 Years, NEHRP Class B/C Soils

9.1.7 Liquefaction and Soil Types

Soil liquefaction occurs when water-saturated sands, silts or gravelly soils are shaken so violently that the individual grains lose contact with one another and float freely in the water, turning the ground into a pudding-like liquid. Building and road foundations lose load-bearing strength and may sink into what was previously solid ground. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. The Safety Element of the Oakland General Plan describes the hazard of earthquake-induced liquefaction as follows (City of Oakland, 2012):

> *The rapid transformation of sediment from a solid state into a fluid state, which causes the soil to lose cohesiveness and become incapable of carrying significant loads; it causes sediment to behave as quicksand, and results in structures settling, tipping or—in the case of underground tanks, for example—rising buoyantly. Its potential to occur is a function of the intensity of the ground shaking and the underlying geologic conditions. In general, liquefaction is less destructive than ground shaking; however, in certain areas, it has occasionally resulted in substantial damage to property from the failure of structural foundations.*

A program called the National Earthquake Hazard Reduction Program (NEHRP) creates maps based on soil characteristics to help identify locations subject to liquefaction. NEHRP soil types define the locations that will be significantly impacted by an earthquake. Table 9-2 summarizes NEHRP soil classifications. NEHRP Soils B and C typically can sustain ground shaking without much effect, dependent on the earthquake magnitude. The areas that are commonly most affected by ground shaking have NEHRP Soils D, E and F. In general, these areas are also most susceptible to liquefaction. The areas that are most affected by ground shaking have NEHRP Soils D, E and F.

Table 9-2. NEHRP Soil Classification System

NEHRP Soil Type	Description	Mean Shear Velocity to 30 m (m/s)
A	Hard Rock	1,500
B	Firm to Hard Rock	760-1,500
C	Dense Soil/Soft Rock	360-760
D	Stiff Soil	180-360
E	Soft Clays	< 180
F	Special Study Soils (liquefiable soils, sensitive clays, organic soils, soft clays >36 m thick)	

9.1.8 Secondary Hazards

Earthquakes can cause large and sometimes disastrous mudslides. Building and road foundations can lose load-bearing strength and may sink into what was previously solid ground. Earthen dams and levees are highly susceptible to seismic events, and the impacts of their failures can be considered secondary risks for earthquakes.

Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment.

9.2 HAZARD PROFILE

The Safety Element of the Oakland General Plan describes the following risks to Oakland from earthquakes (City of Oakland, 2012):

> *The City of Oakland lies within the San Andreas fault system, the largest one in California and the one with potential for the strongest earthquakes. More specifically, the city straddles the Hayward fault, a "branch" fault of the larger system. The Hayward fault runs along the southwestern base of the East Bay hills and parallels State Highway 13, making it an approximate physical boundary between the low-lying, urbanized portions of Oakland to the west and the less developed, upland areas to the east. The fault's two segments, each approximately 30 miles long, extend from the Warm Springs district of Fremont to Oakland, and from Oakland to Point Pinole. The Hayward fault is believed to accumulate strain at one of the highest rates in the Bay Area, suggesting that it is one of the faults in the region most likely to generate a large earthquake. In fact, the fault is one of the most hazardous in the world because of its high "slip rate;" its demonstrated ability to generate large, surface-rupturing earthquakes; and, most importantly, its location through a heavily urbanized area.*

9.2.1 Past Events

Table 9-3 lists the earthquakes of magnitude 5.0 or greater that have occurred within 100 miles of Oakland since 1980. The sections below provided further detail on the most significant events in that period, as well as a major local earthquake from 1868.

Table 9-3. Earthquakes Within 100-mile Radius of Oakland

Date	Magnitude	Event ID	Epicenter Location	Fault Line
January 24, 1980	5.8	1050040	7.5 miles southeast of Mount Diablo, in Livermore Valley	Greenville-Mount Diablo
January 27, 1980	5.4	1050437	7 miles south of 1/24/1980 epicenter	Greenville-Mount Diablo
April 4, 1984	6.2	17204	9.9 miles northeast of San Jose	Calaveras
January 26, 1986	5.5	64626	6.2 miles southeast of Hollister	San Andreas
March 31, 1986	5.7	68932	Alum Rock, CA	
June 13, 1988	5.3	10087352	10 miles northeast of San Jose	Calaveras
June 27, 1988	5.3	10139668	Los Gatos, CA	San Andreas
August 8, 1989	5.4	10089897	Los Gatos, CA	San Andreas
October 18, 1989	6.9	216859	56 miles south of San Francisco	San Andreas
April 18, 1990	5.4	20091154	Watsonville, CA	San Andreas
October 31, 2007	5.45	40204628	Alum Rock, CA	Calaveras
August 24, 2014	6.02	72282711	South Napa, CA	West Napa

Source: Northern California Earthquake Data Center, 2020

1868 Hayward Earthquake

On October 21, 1868, a magnitude 6.8 earthquake struck the San Francisco Bay Area along the Hayward fault. It was considered the "Great Earthquake" until 1906. Although the region was sparsely populated, the quake on the Hayward Fault was one of the most destructive in California's history. It destroyed downtown Hayward, killing five people and, injuring 30, and it caused damage throughout the area. San Francisco suffered $350,000 in property damage.

1989 Loma Prieta Earthquake

Alameda County and the City of Oakland have been impacted by one major federal disaster declaration for earthquakes—the 1989 Loma Prieta Earthquake. The Loma Prieta Earthquake was a 6.9 magnitude earthquake that struck the Bay Area for 20 seconds on Tuesday, October 17, 1989. The epicenter was on the San Andreas fault roughly 56 miles south of San Francisco and 10 miles northeast of Santa Cruz, near Mt. Loma Prieta in the Santa Cruz Mountains. The focal depth was 11 miles (typical California earthquake focal depths are 4 to 6 miles).

This earthquake ruptured the southernmost 30 miles of the break that caused the 1906 San Francisco Earthquake. A magnitude 5.2 aftershock occurred 2 or 3 minutes after the main shock. In the week following the earthquake, 20 aftershocks of magnitude 4.0 or greater and more than 300 of magnitude 2.5 or greater were recorded. The aftershock zone stretched 25 miles, from north of Los Gatos near Highway 17 to south of Watsonville near Highway 101.

This earthquake killed 63 people, injured 3,757, and displaced 12,053. Notable damage included the collapse of the elevated Cypress Structure section of Interstate 880 in Oakland, the collapse of a section of roadbed on the Bay Bridge, and extensive damage to downtown Santa Cruz and San Francisco's Marina District. The Bay Bridge was unusable for a month. Damage and business interruption estimates reached as high as $10 billion, with direct damage estimated at $6.8 billion. The earthquake damaged 18,306 houses and destroyed 963. It damaged 2,575 businesses and destroyed 147 (California Department of Conservation, 2021).

2007 Alum Rock Earthquake

The Alum Rock Earthquake was a 5.6 magnitude event that occurred 5 miles from Alum Rock, California on October 30, 2007. The quake was located at a depth of about 5 miles on the Calaveras Fault. The event caused strong shaking in the epicentral region with over 60,000 felt reports, extending beyond Santa Rosa to the northwest, the Sierras to the east, and King City to the south. Ground shaking also reached San Francisco and Oakland. Effects included broken windows and shelving, but no major damage or loss of life was reported. The quake was the largest to hit the Bay Area at that time since the Loma Prieta earthquake.

2014 South Napa Earthquake

The Napa Valley was shaken by a magnitude 6.0 earthquake on August 24, 2014. This was the largest in the San Francisco Bay Area in over 25 years, and the first since the Magnitude-7.9 earthquake in 1906 to rupture on the surface. The South Napa Earthquake caused extensive damage through both ground shaking and surface cracking. Ongoing fault movement along the surface continued for several months and caused further damage to foundations and structures. One person was killed and 200 injured, and total damage in the southern Napa Valley and Vallejo areas was in the range of $362 million to $1 billion. The quake was felt widely throughout the region, with people reporting its effects more than 200 miles south of Napa and as far east as the Nevada border. Amtrak suspended service through the Bay Area so tracks could be inspected.

9.2.2 Location

Major Faults

Oakland is within a region that is well known for its many active faults. The Hayward Fault is the major tectonic boundary that runs along the East Bay Hills. Figure 9-2 shows the regional faults closest to the city.

San Andreas

The San Andreas fault is a continental transform fault that extends roughly 800 miles through California. It forms the tectonic boundary between the Pacific Plate and the North American Plate, and its motion is right-lateral strike-slip (horizontal). The fault divides into three segments, each with different characteristics and a different degree of earthquake risk. The San Andreas Fault has the potential for experiencing a major to great event, with a magnitude up to 8.1.

Hayward

The Hayward Fault runs along the foot of the East Bay hills. USGS studies show that Hayward Fault quakes have repeatedly jolted the region in the past and that the fault may be ready to produce an earthquake of magnitude 6.8 to 7.0.

Calaveras

The Calaveras fault system stretches 80 miles from south of Hollister to the Danville-Walnut Creek area. Based on present creep rates, the fault can be divided into two overall segments: the Calaveras segment south of the Calaveras Reservoir and the San Ramon segment between Sunol and Danville.

Figure 9-2. Earthquake Faults

Most researchers believe that strain accumulated along the Calaveras south of Calaveras Reservoir is transferred to the Hayward fault on the Mission Hills fault. Despite the apparent lessened activity on the northernmost trace of the Calaveras segment, it does appear to have spawned a Magnitude 6.9 earthquake on July 3, 1861, causing continuous ground rupture 6 to 8 miles long between the Amador Valley and Danville.

The San Ramon segment is the dominant structural feature of the Amador and San Ramon Valleys, forming their western boundaries and creating the structural barrier that comprises the Livermore Basin. This segment of the fault is typified by minor seismic activity and an apparently low slip rate. In much of the segment, its surface trace is uncertain because it appears to be buried beneath massive ancient landslides, earth/debris flow deposits and colluvium.

NEHRP Soil Type and Liquefaction Mapping

Figure 9-3 shows NEHRP soil classifications in the City of Oakland. Figure 9-4 shows areas in that have moderate, high, or very high susceptibility to liquefaction.

9.2.3 Frequency

In 2007, earthquake scientists led by the USGS, the California Geological Survey, and the Southern California Earthquake Center estimated that there is a 63 percent probability of a magnitude 6.7 or greater earthquake in the Bay Area in the next 30 years. Although the hazard is spread throughout the Bay Area, some faults are more likely to rupture than others. The two faults in the San Francisco Bay Area most likely to have a damaging earthquake are the Hayward-Rodgers Creek fault system (31 percent) and the San Andreas Fault (21 percent). The East Bay has a higher earthquake hazard than the San Francisco Peninsula due to the Hayward-Rogers Creek Fault and the higher number of faults that traverse the East Bay.

9.2.4 Severity

The USGS has created ground motion maps based on current information about fault zones. These maps show the PGA that has a certain probability (2 percent or 10 percent) of being exceeded in a 50-year period. The map shows that for Oakland and the greater San Francisco Bay Area, the PGA with a 10-percent probability of exceedance in 50 years ranges from 0.4g to 0.8g (see Figure 9-5).

USGS scenario-based and probabilistic ShakeMaps also indicate expected ground acceleration for earthquake events that have the potential to occur for a given area. The scenarios assessed for this plan are shown in Table 9-4.

Table 9-4. Earthquakes Modeled for Risk Assessment

Event	Magnitude	Focal Depth	Epicenter Location	Map Figure
M7.05 Hayward Fault	7.05	8.0	N37.80 W122.18	Figure 9-6
M7.38 San Andreas Fault	7.38	7.8	N37.52 W122.36	Figure 9-7
M6.8 Calaveras Fault	6.86	10.4	N37.65 W121.93	Figure 9-8
100-Year Probabilistic	N/A	N/A	N/A	Figure 9-9

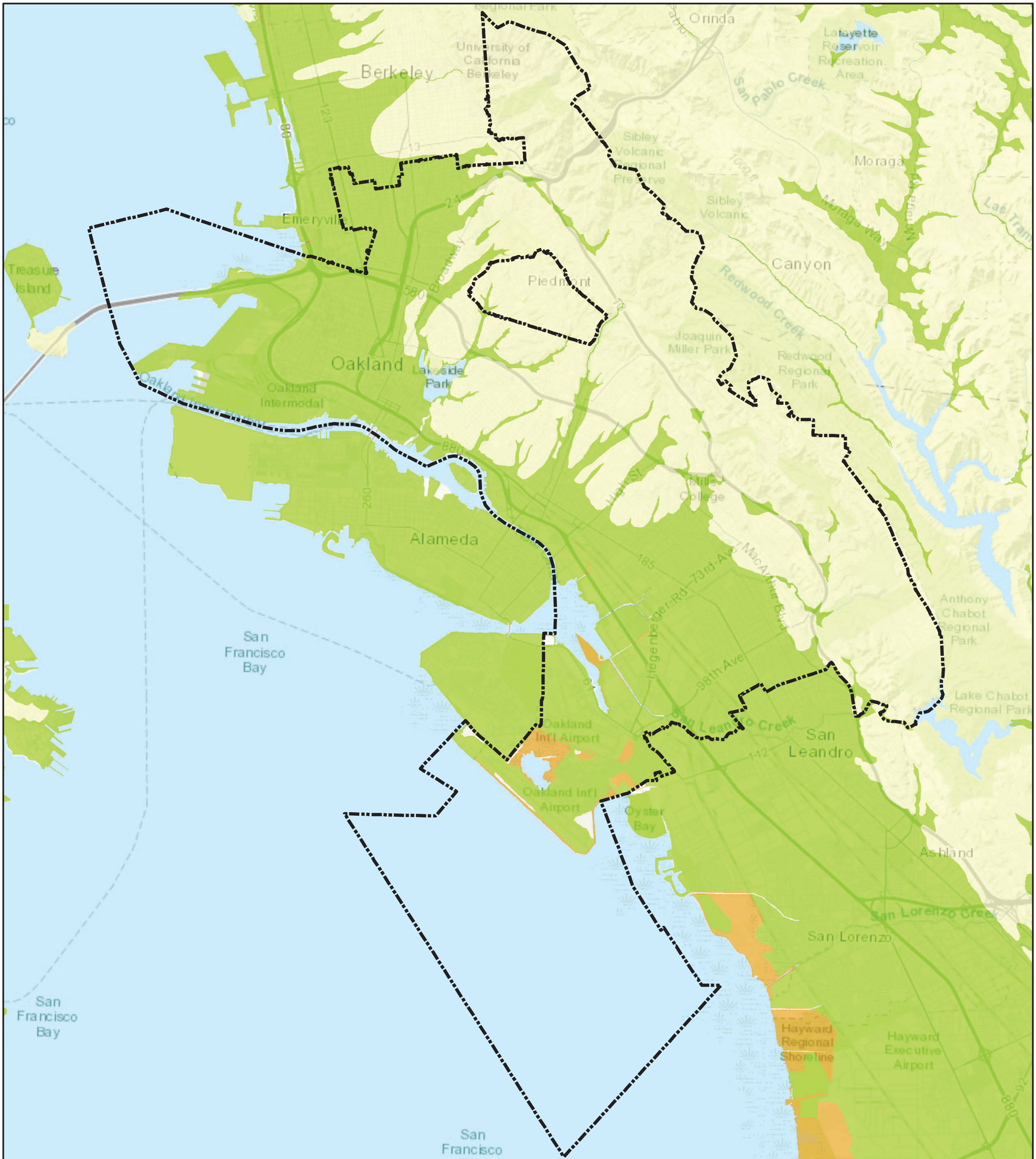


Figure 9-3. Planning Area NEHRP Soil Classifications

C (Dense soil/soft rock)

E (Soft clay)

D (Stiff soil)

City Limits

Data Sources: Esri Basemap, City of Oakland, CGS

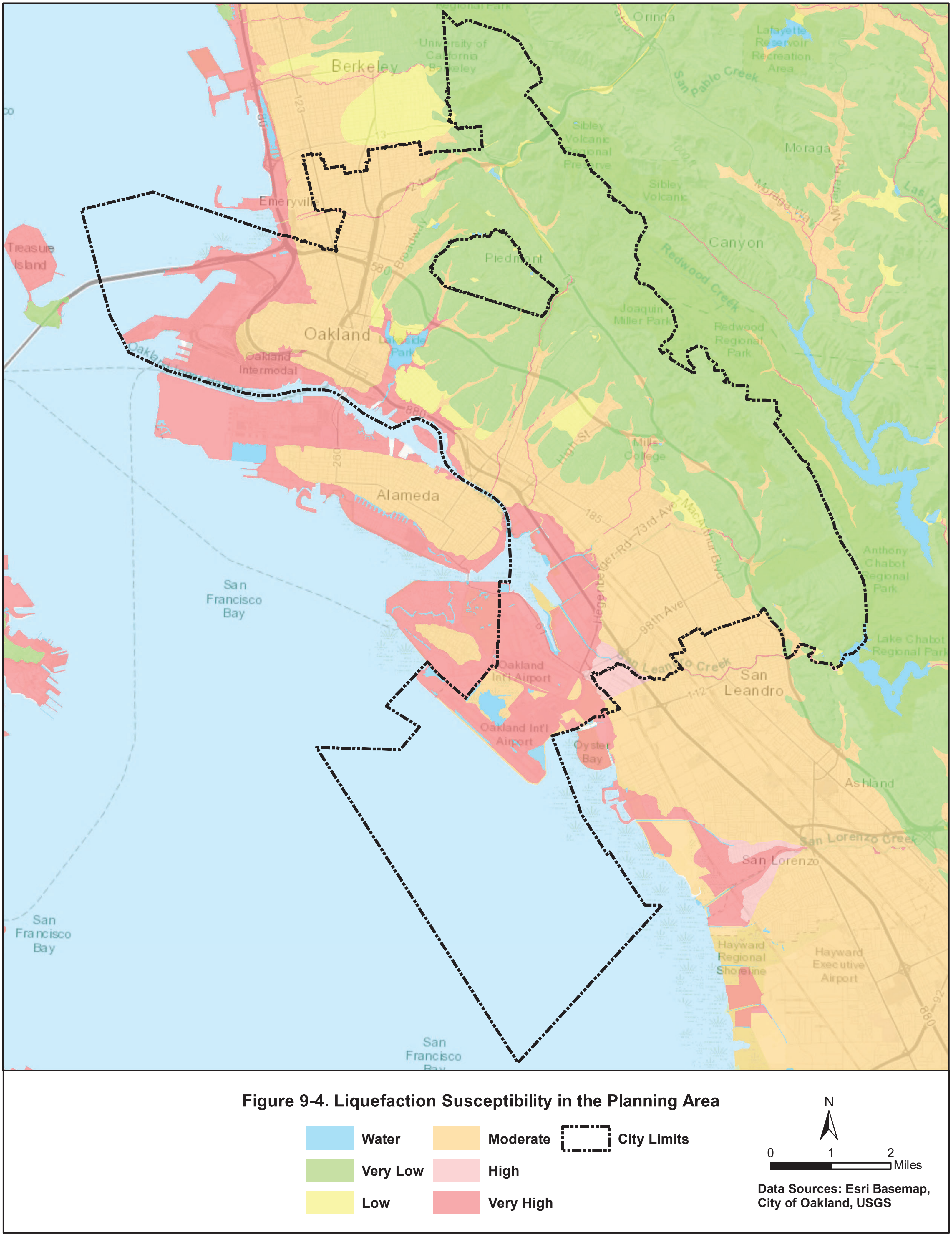


Figure 9-4. Liquefaction Susceptibility in the Planning Area

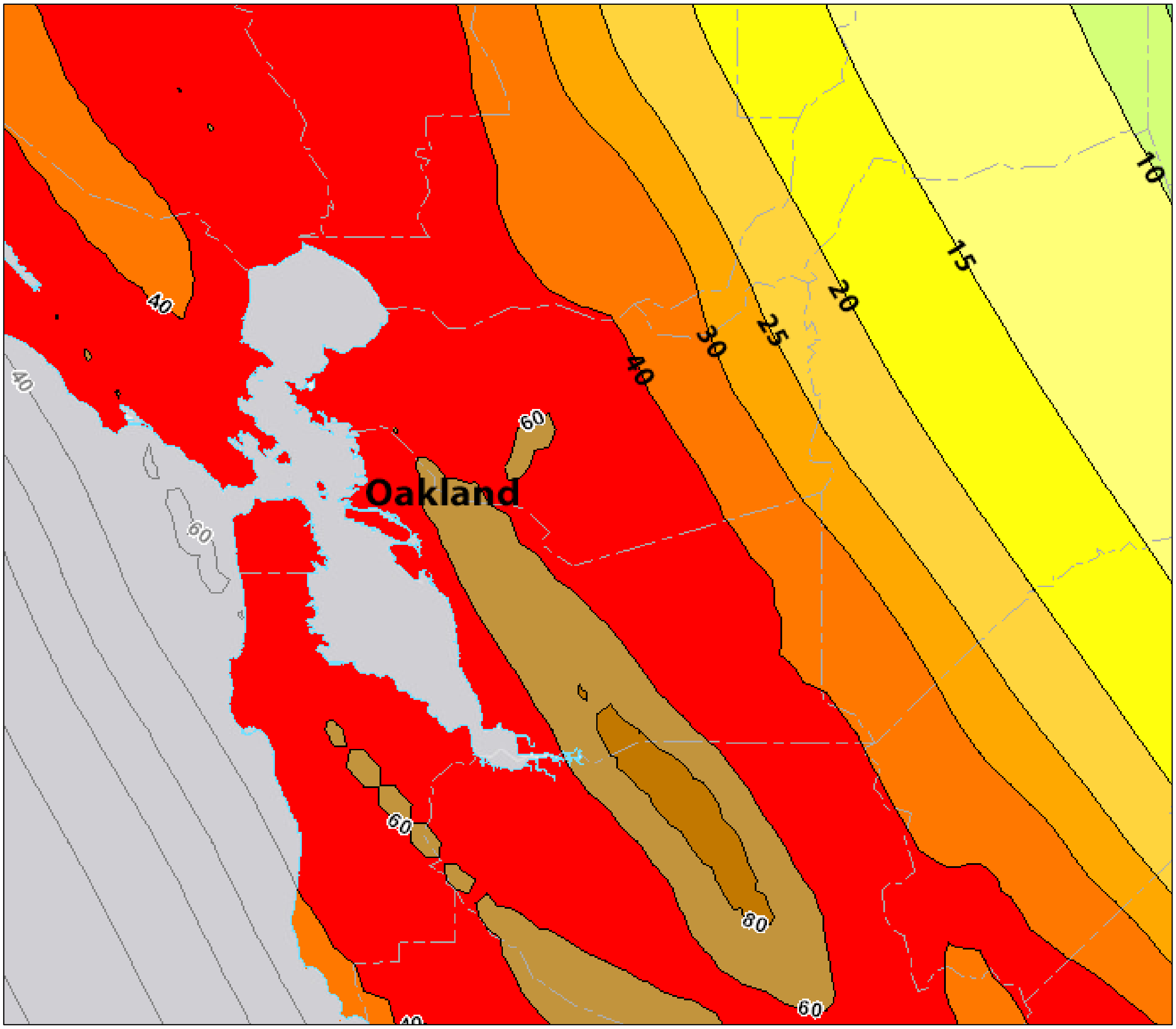


Figure 9-5. PGA (%g) with 10-Percent Probability of Exceedance in 50 Years

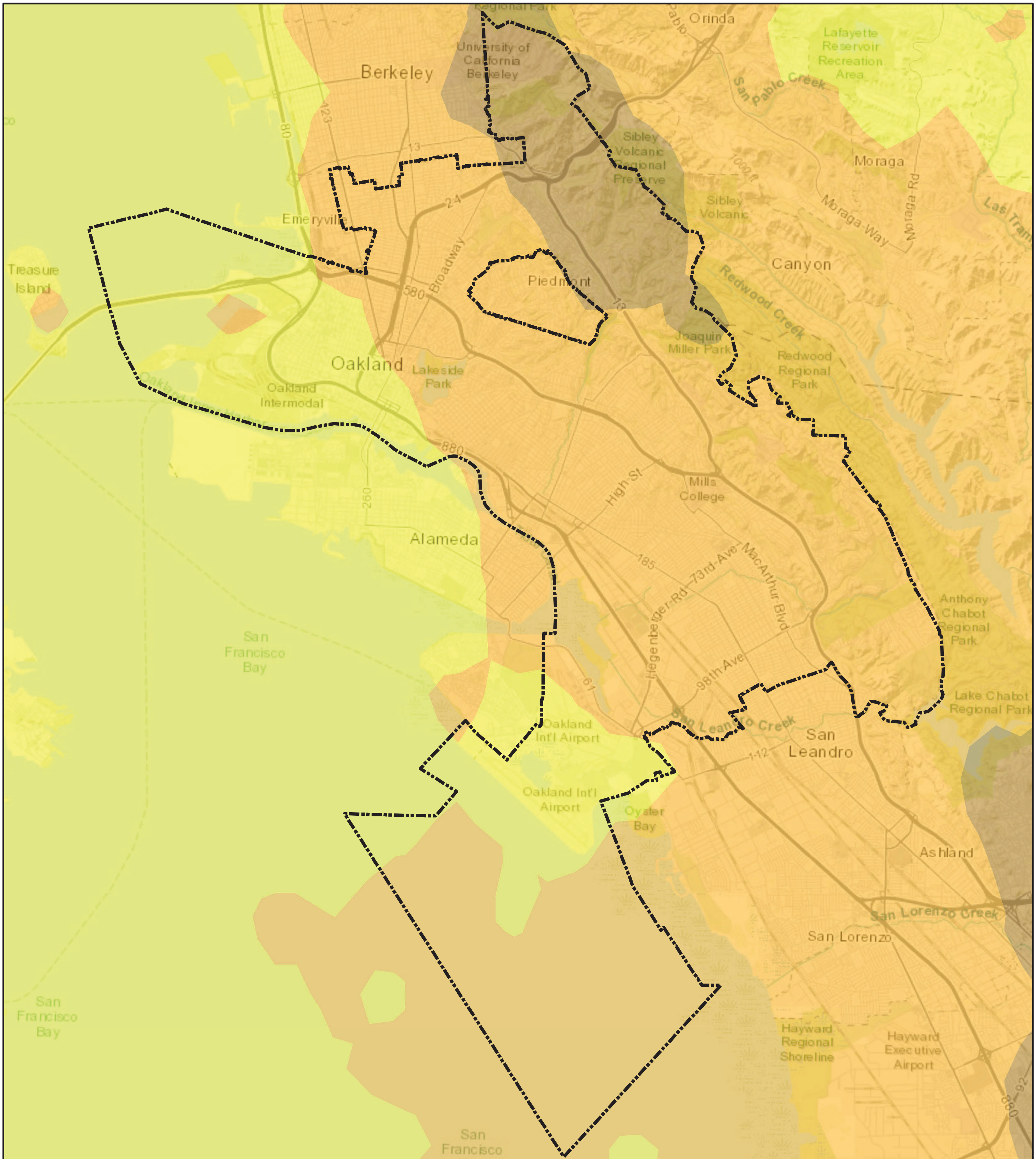


Figure 9-6. Hayward (Hay Wired) M7.05 Scenario

Modified Mercalli Intensity Scale

- **IV (Light/None)**
- **V (Moderate/Very Light)**
- **VI (Strong/Light)**
- **VII (Very Strong/Moderate)**
- **VIII (Severe/Moderate-Heavy)**
- **IX (Violent/Heavy)**

Intensity scale described as: (potential damage / perceived shaking)

City Limits

N

0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland, USGS

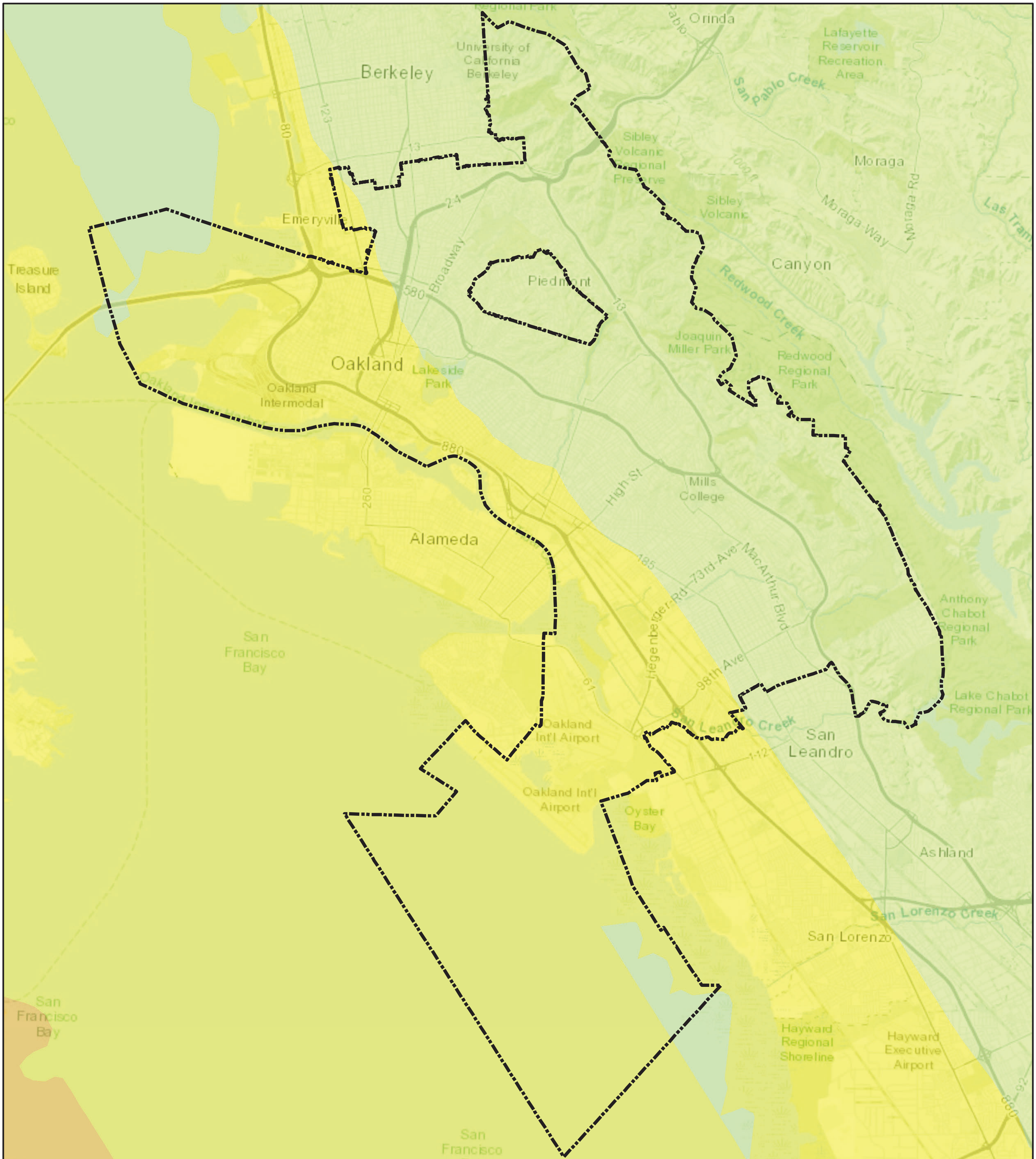


Figure 9-7. San Andreas M7.38 Scenario

Modified Mercalli Intensity Scale

- **IV (Light/None)**
- **V (Moderate/Very Light)**
- **VI (Strong/Light)**
- **VII (Very Strong/Moderate)**
- **VIII (Severe/Moderate-Heavy)**
- **IX (Violent/Heavy)**

Intensity scale described as: (potential damage / perceived shaking)

City Limits

N

0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland, USGS

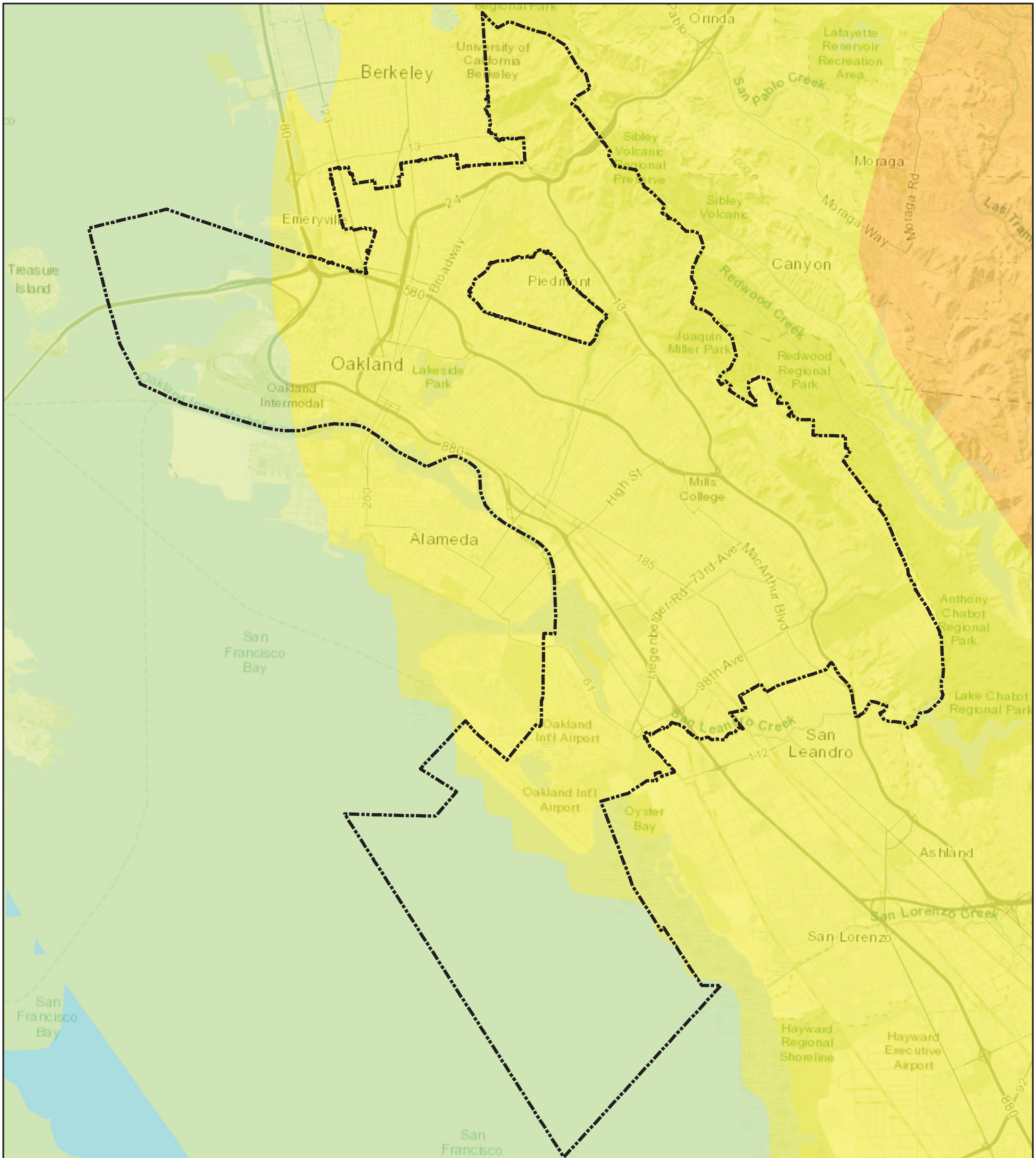


Figure 9-8. Calaveras M6.8 Scenario

Modified Mercalli Intensity Scale

- **IV (Light/None)**
- **V (Moderate/Very Light)**
- **VI (Strong/Light)**
- **VII (Very Strong/Moderate)**
- **VIII (Severe/Moderate-Heavy)**
- **IX (Violent/Heavy)**

Intensity scale described as: (potential damage / perceived shaking)

City Limits

N

0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland, USGS

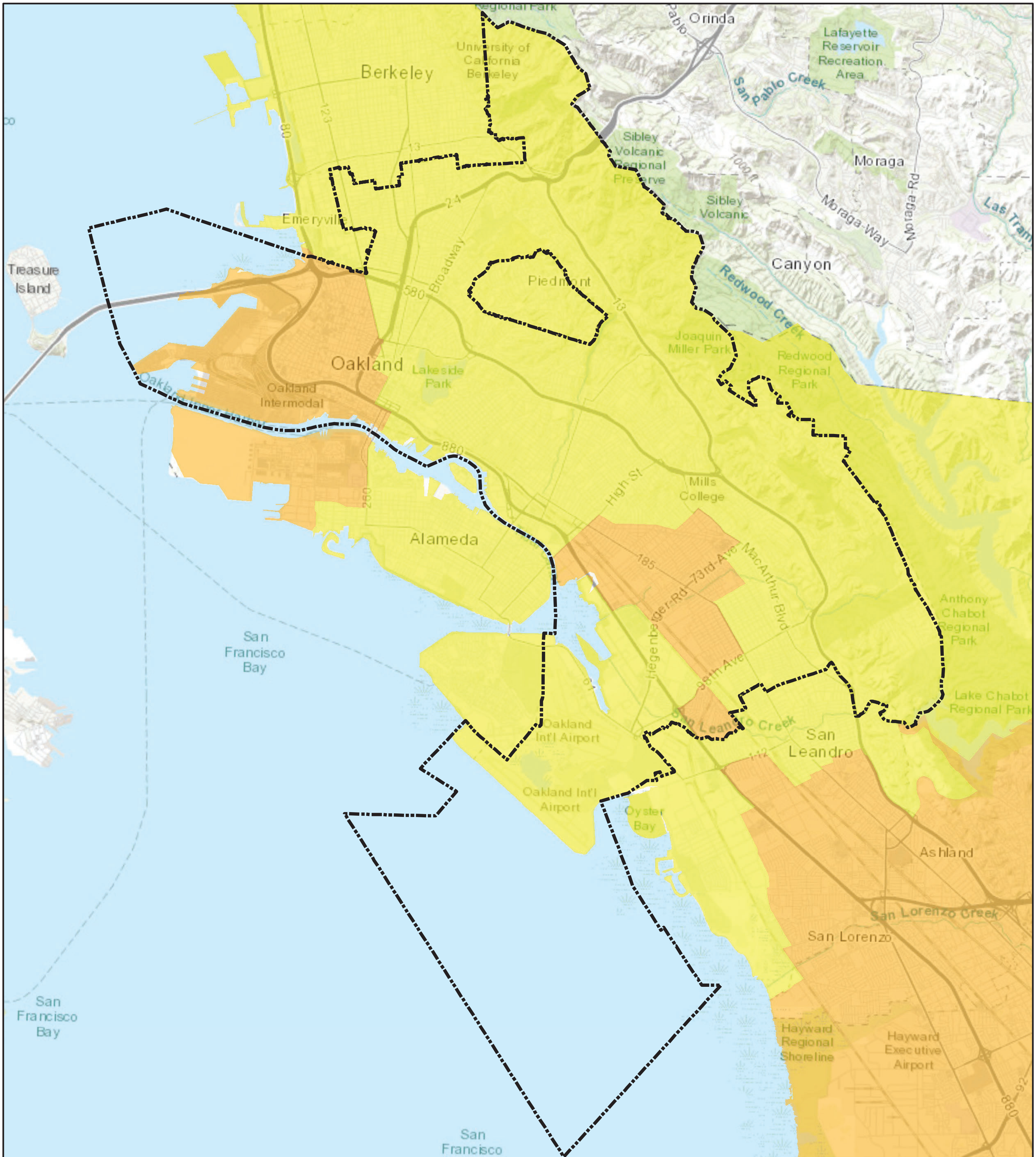


Figure 9-9. 100-Year Probabilistic Scenario

Modified Mercalli Intensity Scale

- **IV (Light/None)**
- **V (Moderate/Very Light)**
- **VI (Strong/Light)**
- **VII (Very Strong/Moderate)**
- **VIII (Severe/Moderate-Heavy)**
- **IX (Violent/Heavy)**

Intensity scale described as: (potential damage / perceived shaking)

City Limits

N

0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland, USGS

9.2.5 Warning Time

There is currently no reliable way to predict the day or month that an earthquake will occur at any given location. Earthquake early warning systems use earthquake science and the technology of monitoring systems to alert devices and people when shaking waves generated by an earthquake are expected to arrive at their location. Strong seismic shaking from an earthquake travels at about two miles per second, so it is possible to detect a large earthquake near its source and broadcast a warning of imminent strong shaking to more distant areas before the shaking arrives. The seconds to minutes of advance warning can allow people and systems to take actions to protect life and property from destructive shaking.

9.3 EXPOSURE

The entire planning area is exposed to the earthquake hazard, so an earthquake has the potential to affect the entire population of 433,697, all 93,365 buildings in the planning area, with a total replacement value of $118 billion, all 2,606 of the planning area's identified critical facilities, and the entire environment of the planning area.

Socially vulnerable populations exposed to the earthquake hazard were estimated based on data for the Census-defined blocks that lie at least partially within the mapped NEHRP D and E soil zones, which are considered to be liquefiable. Because many of those Census blocks extend outside the inundation zone, the estimates are greater than the actual exposed populations, but they provide reasonable relative data for use in mitigation planning. Table 9-5 summarizes the estimated socially vulnerable populations.

Table 9-5. Relative Exposure of Socially Vulnerable Populations in NEHRP D and E Soil Zones

	Number[a]	% of Total in Hazard Area
Exposed Population by Age		
Over 65 Years	27,478	10.4%
Under 16	58,697	22.3%
Exposed Population by Race[b]		
White	53,434	20.3%
Black or African American	79,163	30.1%
American Indian and Alaska Native	875	0.3%
Asian	37,441	14.2%
Native Hawaiian and Other Pacific Islander	1,557	0.6%
Some other race	749	0.3%
Exposed Population by Ethnicity		
Hispanic or Latino (of any race)	81,180	30.8%
Exposed Number of Households by Income		
Households with Income Below $50,000	56,545	56.7%
Totals Used for Calculating Percentages[a]		
Population	263,197	
Households	99,765	

a. Note that the methodology used for this analysis overestimates exposed population and households. Results presented in this table should be used to evaluate relative exposure between groups rather than absolute numbers of exposed persons or households.
b. Race data shown are as-is output from Hazus, suitable for comparing exposure between groups listed. Data are for persons identifying as one race only, and do not add up to the total exposed population.

VULNERABILITY

Earthquake vulnerability data for the risk assessment was generated using a Hazus Level 2 (user-defined) analysis for the earthquakes described in Table 9-4. The results are summarized in the sections below.

9.3.1 Population

Impacts on persons and households in the planning area were estimated for the assessed earthquake scenarios through the Level 2 Hazus analysis. Table 9-6 summarizes the results. See Appendix E for a breakdown by sub-area.

Table 9-6. Estimated Earthquake Impact on Persons and Households

	Hayward Scenario	San Andreas Scenario	Calaveras Scenario	100-Year Probabilistic
Displaced Households	3,640	314	367	2,761
Number of Residents Requiring Short-Term Shelter	2,254	190	225	1,833

Whether impacted directly or indirectly, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could keep people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself.

9.3.2 Property

Building Age

Table 9-7 identifies significant milestones in building and seismic code requirements that directly affect the structural integrity of development. Using these time periods, the planning team used Hazus to identify the number of structures in the planning area by date of construction. The City has a very high percentage—45.7 percent—of structures built before 1933 when there were no building permits or seismic standards. Only about 5.5 percent of the planning area's structures were constructed after the Uniform Building Code was amended in 1994 to include seismic safety provisions.

Table 9-7. Age of Structures in Planning Area

Time Period	Number of Current Structures Built in Period	Significance of Time Frame
Pre-1933	42,701	Before 1933, there were no explicit earthquake requirements in building codes. State law did not require local governments to have building officials or issue building permits.
1933-1940	8,036	In 1940, the first strong motion recording was made.
1941-1960	20,499	In 1960, the Structural Engineers Association of California published guidelines on recommended earthquake provisions.
1961-1975	10,014	In 1975, significant improvements were made to lateral force requirements.
1976-1994	6,976	In 1994, the Uniform Building Code was amended to include provisions for seismic safety.
After 1994	5,139	Seismic code is currently enforced.
Total	**93,365**	

Loss Potential

Property losses were estimated through the Level 2 Hazus analysis for the assessed earthquake scenarios. Table 9-8 shows the estimates for damage to structures and building contents with the percent of total replacement value. See Appendix E for a breakdown by sub-area. The Hazus analysis also estimated the amount of earthquake-caused debris in the planning area for the assessed earthquake scenarios, as summarized in Table 9-9.

Table 9-8. Loss Estimates for the Assessed Earthquake Scenarios

Earthquake Scenario	Estimated Loss Associated with Earthquake			% of Total Replacement Value
	Structure	Contents	Total	
San Andreas	$3,808,936,052	$1,843,787,123	5,652,723,175	4.8%
Hayward	$15,142,112,941	$6,596,117,255	21,738,230,196	18.5%
Calaveras	$5,187,643,061	$2,402,189,075	7,589,832,136	6.5%
100-Year Probabilistic	$9,345,821,513	$4,289,891,798	13,635,713,311	11.6%

Table 9-9. Estimated Earthquake-Caused Debris

Earthquake Scenario	Debris to Be Removed (tons)
San Andreas	465,110
Hayward	3,926,860
Calaveras	712,380
100-Year Probabilistic	2,029,720

9.3.3 Critical Facilities

Level of Damage

Hazus classifies the vulnerability of critical facilities to earthquake as no damage, slight damage, moderate damage, extensive damage, or complete damage. Hazus was used to assign a category to each critical facility in the planning area for the assessed earthquake scenarios. Table 9-10 through Table 9-13 summarize the results.

Table 9-10. Estimated Number of Vulnerable Critical Facilities by Damage Level—Hayward Fault Scenario

	# of Critical Facilities	# of Buildings with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Safety and Security	332	22	292	18	0	0
Food, Water and Sheltering	4	1	3	0	0	0
Health and Medical	12	0	12	0	0	0
Energy	29	0	20	9	0	0
Communications	574	0	25	369	118	34
Transportation	376	122	112	70	57	15
Hazardous Materials	1,279	85	1,136	58	0	0
Total	**2,606**	**230**	**1,600**	**524**	**175**	**49**

Table 9-11. Estimated Number of Vulnerable Critical Facilities by Damage Level—San Andreas Scenario

	# of Critical Facilities	# of Buildings with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Safety and Security	332	327	5	0	0	0
Food, Water and Sheltering	4	4	0	0	0	0
Health and Medical	12	12	0	0	0	0
Energy	29	17	12	0	0	0
Communications	574	120	358	68	0	0
Transportation	376	305	71	0	0	0
Hazardous Materials	1,279	1,278	1	0	0	0
Total	**2,606**	**2,063**	**447**	**68**	**0**	**0**

Table 9-12. Estimated Number of Vulnerable Critical Facilities by Damage Level—Calaveras Fault Scenario

	# of Critical Facilities	# of Buildings with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Safety and Security	332	310	22	0	0	0
Food, Water and Sheltering	4	4	0	0	0	0
Health and Medical	12	12	0	0	0	0
Energy	29	16	13	0	0	0
Communications	574	0	410	136	0	0
Transportation	376	326	50	0	0	0
Hazardous Materials	1279	1,278	1	0	0	0
Total	**2,606**	**1,946**	**496**	**136**	**0**	**0**

Table 9-13. Estimated Number of Vulnerable Critical Facilities by Damage Level—100-Year Probabilistic

	# of Critical Facilities	# of Buildings with 50% or Greater Probability of Achieving Damage Level				
		None	Slight	Moderate	Extensive	Complete
Safety and Security	332	176	154	2	0	0
Food, Water and Sheltering	4	1	3	0	0	0
Health and Medical	12	1	11	0	0	0
Energy	29	0	28	1	0	0
Communications	574	0	113	387	46	0
Transportation	376	239	71	51	15	0
Hazardous Materials	1,279	638	641	0	0	0
Total	**2,606**	**1,055**	**1,021**	**441**	**61**	**0**

Time to Restore Critical Facilities to Functionality

Hazus estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments: 1, 3, 7, 14, 30 and 90 days after the event. For example, Hazus may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95 percent chance of being fully functional at Day 90. The analysis of critical facilities in the planning area was performed for the assessed earthquake scenarios. The results are summarized in Figure 9-10 through Figure 9-13. These figures show the average functionality for all critical facilities in each category.

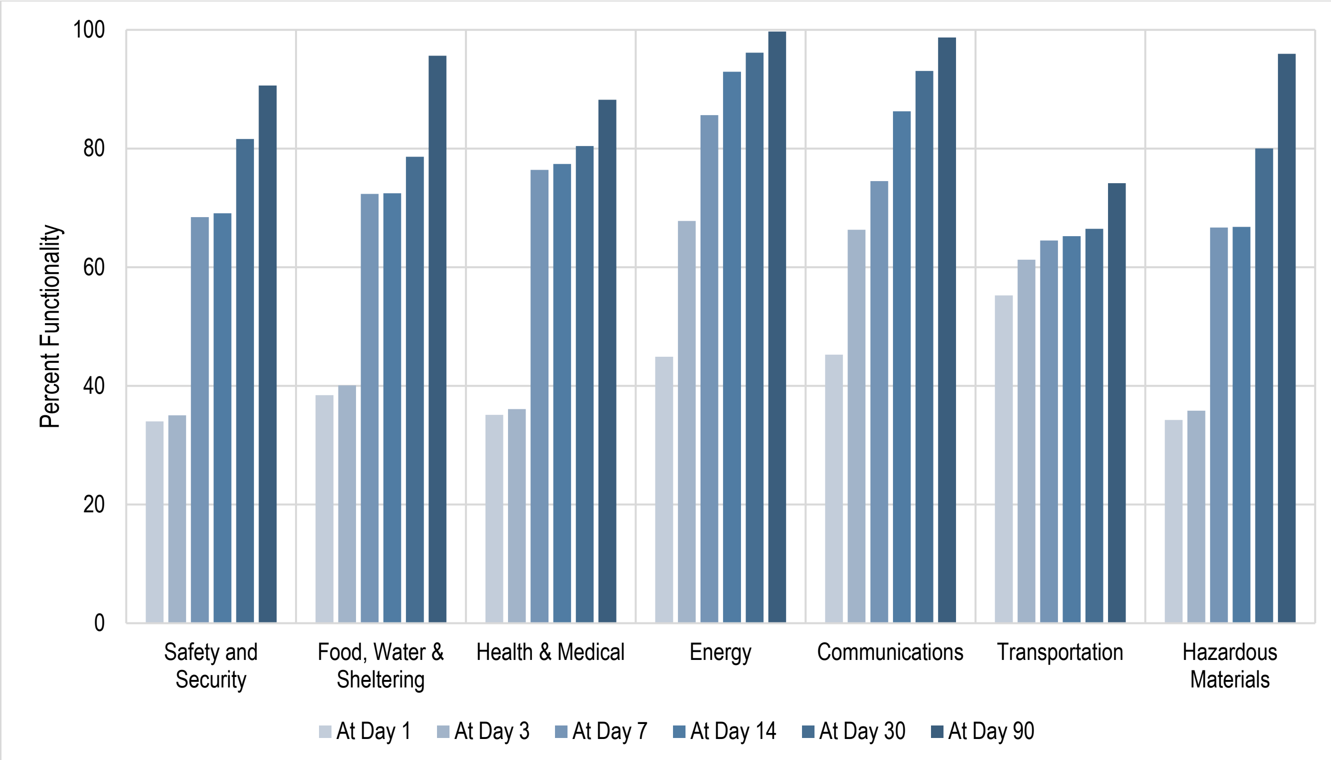


Figure 9-10. Average Critical Facility Functionality by # of Days Post-Event, Hayward Fault Scenario

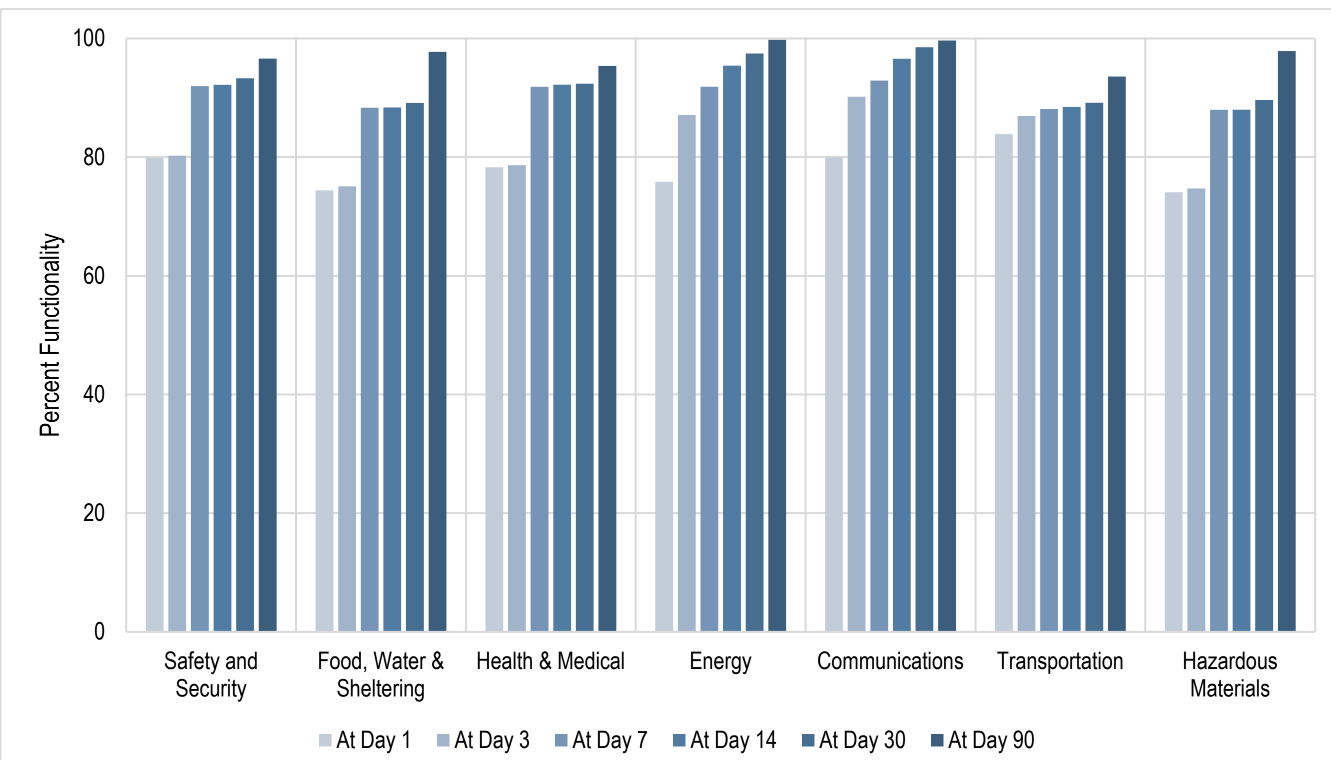


Figure 9-11. Average Critical Facility Functionality by # of Days Post-Event, San Andreas Fault Scenario

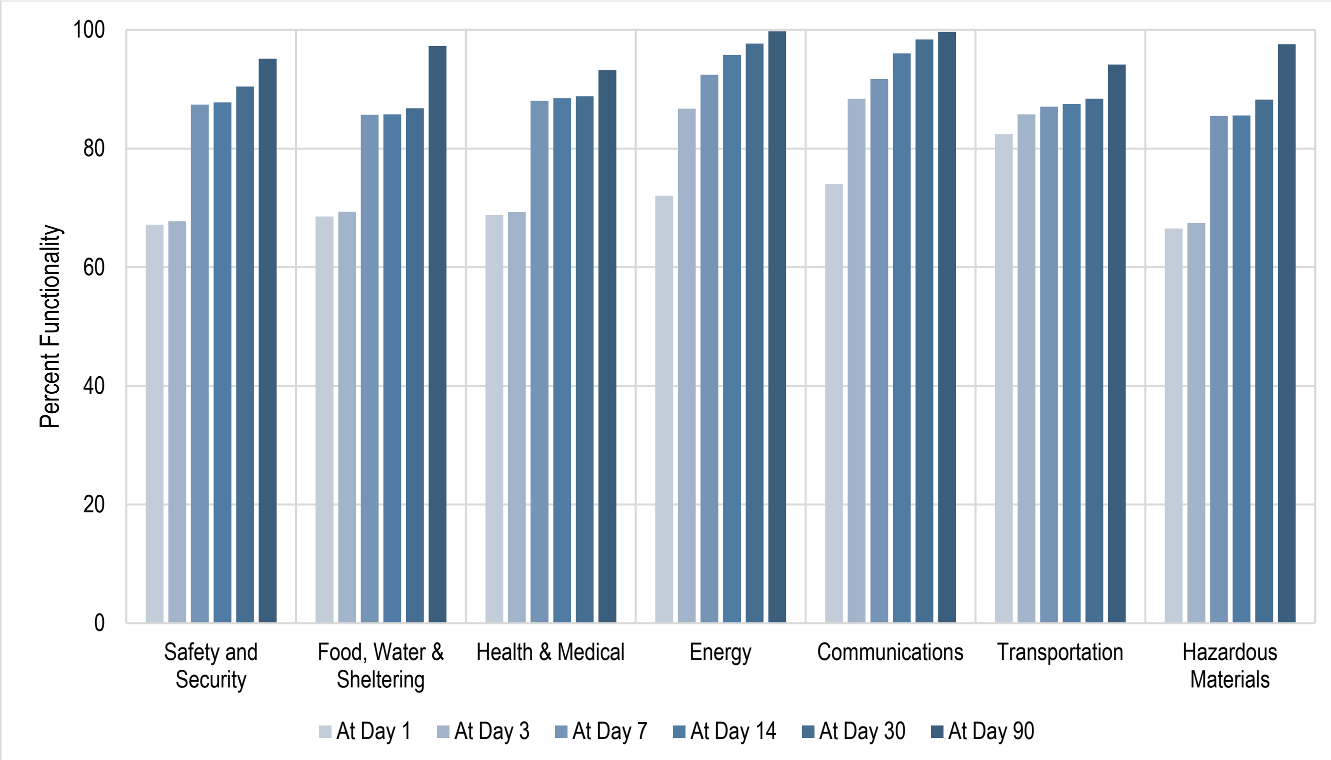


Figure 9-12. Average Critical Facility Functionality by # of Days Post-Event, Calaveras Fault Scenario

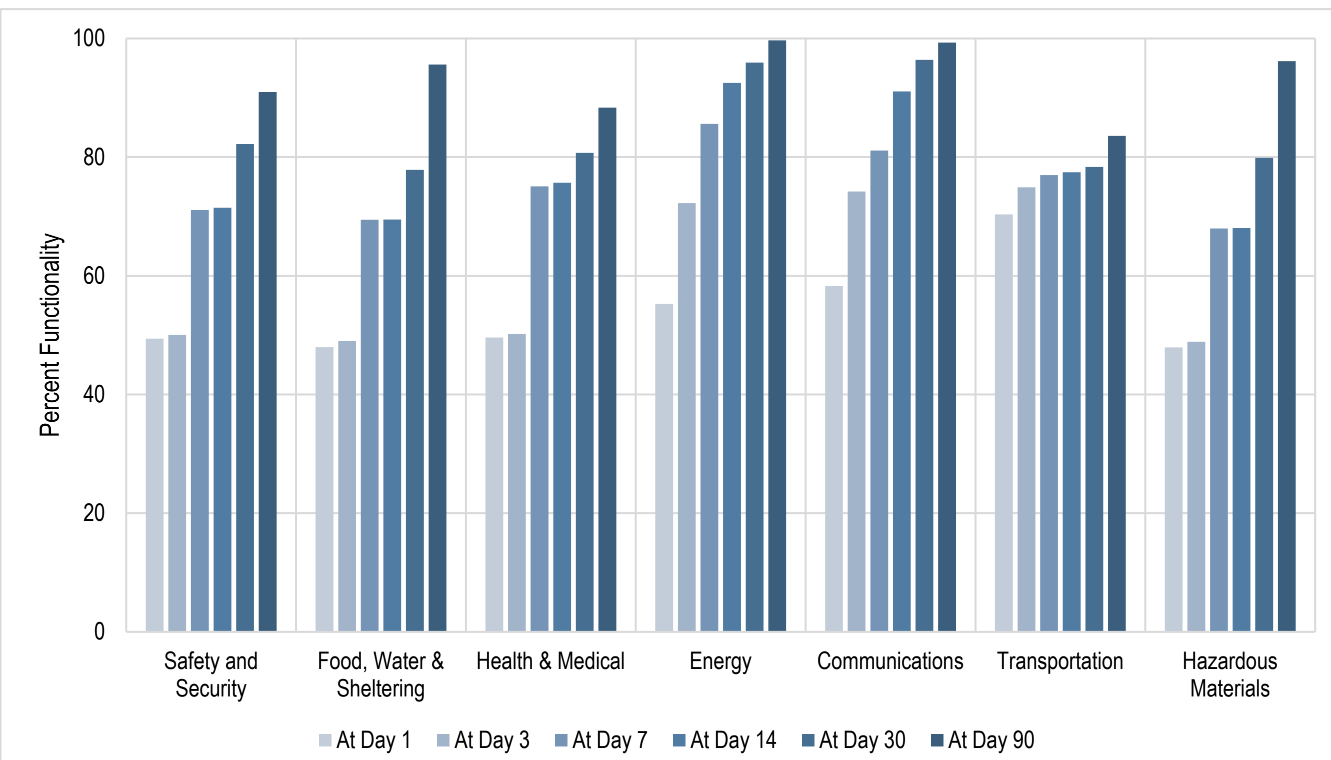


Figure 9-13. Average Critical Facility Functionality by # of Days Post-Event, 100-Year Probabilistic Event

Vulnerability of Hazardous Materials

Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. Hazardous material releases can occur during an earthquake from fixed facilities or transportation-related incidents. During an earthquake, structures storing these materials could rupture and leak into the surrounding area or an adjacent waterway, having a disastrous effect on the environment. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment.

9.3.4 Environment

Earthquake environmental effects are induced by ground shaking and are classified into ground cracks, slope movements, dust clouds, liquefactions, hydrological anomalies, tsunamis, trees shaking and jumping stones. Secondary hazards associated with earthquakes will likely have damaging effects on the environment. Earthquake-induced landslides can significantly impact surrounding habitat. It is also possible for streams to be rerouted after an earthquake. This can change the water quality, possibly damaging habitat and feeding areas. There is a possibility of streams fed by groundwater drying up because of changes in underlying geology.

9.4 FUTURE TRENDS IN DEVELOPMENT

Since all of the planning area is located within earthquake hazard zones, all future development will, to some extent, be exposed to the earthquake hazard. The City of Oakland will strictly enforce all seismic building codes and design standards to prevent loss of life and property from earthquakes. Public education, cooperation with the development community, and individual preparedness are essential.

The City’s General Plan has policies directing land use and dealing with issues of geologic and seismic safety. This plan provides the capability to protect future development from the impacts of earthquakes. Deficiencies identified by development reviews can be identified as mitigation actions to increase the capability to deal with future trends in development.

To further address earthquake hazards, and pursuant to Oakland Municipal Code Chapter 15.20, the City of Oakland applies Standard Conditions of Approval to all projects that involve new structures, major additions, and subdivisions located in an Earthquake Fault Zone per the State Alquist-Priolo Fault Zoning Act (California Department of Conservation, 2010) and in a seismic hazard zone per the State Seismic Hazards Mapping Act. Details are provided in Appendix D.

9.5 SCENARIO

With the abundance of fault exposure in the Bay Area, the potential scenarios for earthquake activity are many. An earthquake does not have to occur within the planning area to have a significant impact on the people, property, and economy of the planning area.

Any seismic activity of 6.0 or greater on faults within the planning area would have significant impacts throughout the planning area. Potential warning systems could give approximately 40 seconds notice that a major earthquake is about to occur. This would not provide adequate time for preparation. Earthquakes of this magnitude or higher would lead to massive structural failure of property on NEHRP C, D, E, and F soils. Levees and revetments built on these poor soils would likely fail, representing a loss of critical infrastructure. These events could cause secondary hazards, including landslides and mudslides that would further damage structures. Soil liquefaction would occur in water-saturated sands, silts, or gravelly soils.

9.6 ISSUES

The planning team has identified the following earthquake-related issues:

- More information is needed on the exposure and performance of soft-story construction within the planning area.
- The City has a very high percentage—45.7 percent—of structures built before 1933 when there were no building permits or seismic standards.
- Based on the modeling of critical facility performance performed for this plan, a high number of facilities in the planning area are expected to have complete or extensive damage from scenario events. These facilities are prime targets for structural retrofits.
- Critical facility owner should be encouraged to create or enhance continuity of operations plans using the information on risk and vulnerability contained in this plan.
- Geotechnical standards should be established that take into account the probable impacts from earthquakes in the design and construction of new or enhanced facilities.
- There are a multiple dams that could affect the planning area. Dam failure warning and evacuation plans and procedures should be reviewed and updated to reflect the dams' risk potential associated with earthquake activity in the region.
- Earthquakes could trigger other natural hazard events such as dam failures and landslides, which could severely impact the planning area.
- A worst-case scenario would be the occurrence of a large seismic event during a flood or high-water event. Levee failures would happen at multiple locations, increasing the impacts of the individual events.

10. FLOOD

10.1 GENERAL BACKGROUND

Flooding is any overflowing of water onto land that is normally dry, whether due to rain, ocean waves, snowmelt, or the failure of a dam or levee. Floods are the most common and widespread of all weather-related natural disasters. They kill more people in the United States each year than tornadoes, hurricanes, or lightning (NOAA, 2020). Areas near rivers or streams are at risk from floods during heavy rain or periods of upstream snowmelt. In urban areas, where buildings, highways, driveways, and parking lots reduce the ground's ability to absorb rainfall, the resulting increase in runoff can overwhelm constructed storm drain systems, resulting in flooding on nearby roads and buildings.

10.1.1 Floodplains

A floodplain is the area adjacent to a river, creek or lake that becomes inundated if flooding occurs. Floodplains may be broad, as when a river crosses an extensive flat landscape, or narrow, as when a river is confined in a canyon. These areas form a complex physical and biological system that not only supports a variety of natural resources but also provides natural flood and erosion control.

Ecosystems and Beneficial Functions

Floodplains can support ecosystems that are rich in plant and animal species. Wetting of the floodplain soil releases an immediate surge of nutrients: those left over from the last flood, and those that result from the rapid decomposition of organic matter that has accumulated since then. Microscopic organisms thrive and larger species enter a rapid breeding cycle. The production of nutrients peaks and falls away quickly, but the surge of new growth endures for some time. This makes floodplains valuable for agriculture. Species growing in floodplains are markedly different from those that grow outside floodplains. For instance, riparian trees (trees that grow in floodplains) tend to be very tolerant of root disturbance and very quick-growing compared to non-riparian trees.

When floodwaters recede after a flood event, they leave behind layers of rock and mud. These gradually build up to create a new floor of the floodplain. Floodplains generally contain accumulations of sand, gravel, loam, silt, and/or clay, often extending below the bed of the stream. These sediments provide a natural filtering system, with water percolating back into the ground and replenishing groundwater. These are often important aquifers, the water drawn from them being filtered compared to the water in the stream. Fertile, flat reclaimed floodplain lands are commonly used for agriculture, commerce, and residential development.

Effects of Human Activities

Because they border water bodies, floodplains have historically been popular sites to establish settlements. Human activities tend to concentrate in floodplains for a number of reasons: water is readily available; land is fertile and suitable for farming; transportation by water is easily accessible; and land is flatter and easier to develop. But human activity in floodplains frequently interferes with the natural function of floodplains. When a river is separated from its floodplain with levees and other flood control facilities, natural, built-in benefits can be lost, altered, or significantly reduced. Structures can affect the distribution and timing of drainage, thereby increasing flood problems. Human development can create local flooding problems by altering or confining drainage channels. This increases flood potential in two ways: it reduces the stream's capacity to contain flows, and it increases flow rates or velocities downstream during all stages of a flood event. Human activities can interface effectively with a floodplain as long as steps are taken to mitigate the activities' adverse impacts on floodplain functions.

10.1.2 FEMA Regulatory Flood Zones and Flood Maps

The frequency and severity of flooding for river systems are based on "discharge probability." The discharge probability is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for different discharge levels. These measurements reflect statistical averages only; it is possible for multiple floods with a low probability of occurrence (such as a 1-percent-annual-chance flood) to occur in a short time period. A single flood event can have flows at different points on a river or stream that correspond to different probabilities of occurrence.

The extent of flooding associated with a 1-percent annual probability of occurrence (the base flood or 100-year flood) is used as a regulatory boundary by many agencies. Also referred to as the special flood hazard area (SFHA), this boundary is a convenient tool for assessing vulnerability and risk in flood-prone communities. Many communities have maps that show the extent and likely depth of flooding for the base flood. Corresponding water-surface elevations describe the elevation of water that will result from a given discharge level, which is one of the most important factors used in estimating flood damage. SFHAs are areas where floodplain management regulations outlined in the National Flood Insurance Program (NFIP) must be enforced, and where mandatory purchase of flood insurance applies. A structure within an SFHA has a 26 percent chance of undergoing flood damage during the term of a 30-year mortgage.

FEMA defines flood hazard areas as areas expected to be inundated by a flood of a given magnitude. These areas are determined via statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Flood hazard areas are delineated on DFIRMs (Digital Flood Insurance Rate Maps), which provide the following information:

- Locations of specific properties in relation to special flood hazard areas
- Base flood elevations (1-percent-annual-chance) at specific sites
- Magnitudes of flood in specific areas
- Undeveloped coastal barriers where flood insurance is not available
- Regulatory floodways and floodplain boundaries (1-percent and 0.2-percent-annual-chance floodplains).

DFIRMs depict the following SFHAs and other areas:

- **Zone A (Also known as Unnumbered A-zones)**—SFHAs where no base flood elevations or depths are shown because detailed hydraulic analyses have not been performed.
- **Zones A1-30 and AE—**SFHAs that are subject to inundation by the base flood, determined using detailed hydraulic analysis. Base flood elevations are shown within these zones.
- **Zone AH—**SFHAs that are subject to shallow flooding, usually in the form of a pond, with an average depth ranging from 1 to 3 feet. Base flood elevations derived from detailed analyses are shown at selected intervals within these zones.
- **Zone AO—**SFHAs subject to inundation by types of shallow flooding where average depths are between 1 and 3 feet. These are normally areas prone to shallow sheet flow flooding on sloping terrain.
- **Zone AR—**Areas with a temporarily increased flood risk due to the building or restoration of flood control system (such as a levee or a dam). Mandatory flood insurance purchase requirements apply, but rates do not exceed the rates for unnumbered A zones if the structure is built or restored in compliance with Zone AR floodplain management regulations.
- **Zone A99—**Areas with a 1 percent annual chance of flooding that will be protected by a federal flood control system where construction has reached specified legal requirements. No depths or base flood elevations are shown within these zones.
- **Zone B and X (shaded)—**Zones where the land elevation has been determined to be above the base flood elevation, but below the 500-year flood elevation. These zones are not SFHAs.
- **Zones C and X (unshaded)—**Zones where the land elevation has been determined to be above both the base flood elevation and the 500-year flood elevation. These zones are not SFHAs.

The FEMA designated floodway is the channel of a water course and portion of the adjacent floodplain that is needed to convey the base flood without increasing flood levels by more than a specified amount (typically, 1 foot). A floodway may be designated within the SFHA where the deepest, highest velocity flow is expected, and any infrastructure will be at risk. Floodways should be kept free of obstructions and development to allow floodwaters to move downstream unobstructed. Any development in a floodway is subject to severe damage and high risks for occupants and emergency responders.

Flood damage may occur outside of SFHAs. FEMA typically does not designate SFHAs for areas subject to flooding from local drainage problems, particularly in urban areas; drainage basins of less than 1 square mile in area; or hillside areas subject to runoff, erosion, and mudflow. FEMA does not map flooding along the length of all streams or in areas that are undeveloped.

10.1.3 Levee Accreditation

Levees are often built along the banks of a river or stream to prevent high water from flooding bordering land. For flood mapping, FEMA only recognizes levee systems that meet minimum design, operation, and maintenance standards. CFR 44 (Section 65.10) describes the information needed for FEMA to determine if a levee system provides protection from the 1 percent annual chance flood. This information must be supplied to FEMA by the community or other party when a flood risk study or restudy is conducted, when Flood Insurance Rate Maps (FIRMs) are revised, or upon FEMA request. FEMA reviews the information for the purpose of establishing the appropriate FIRM flood zone.

FEMA coordinates its programs with the U.S. Army Corps of Engineers, who may inspect, maintain, and repair levee systems. The Corps has authority under Public Law 84-99 to supplement local efforts to repair flood control projects that are damaged by floods. Like FEMA, the Corps provides a program to allow public sponsors or operators to address levee system maintenance deficiencies. Failure to do so within the required timeframe results in the levee system being placed in an inactive status in the Corps' Rehabilitation and Inspection Program. Levee systems in an inactive status are ineligible for rehabilitation assistance under Public Law 84-99.

There are FEMA-accredited levees within the planning area that protect the airport. These levees fall under the jurisdiction of the Alameda County Flood Control District for operations and maintenance.

10.1.4 Secondary Hazards

The most problematic secondary hazard for flooding is bank or coastal erosion. In many cases the threat and effects of erosion are worse than actual flooding. This is especially true on the upper courses of rivers where there are steep gradients. Floodwaters in these reaches may pass quickly and without much damage, but scour the banks, edging properties closer to the floodplain or causing them to fall in. Flooding is also responsible for hazards such as landslides when high flows over-saturate soils on steep slopes, causing them to fail. Hazardous materials spills are also a secondary hazard of flooding if storage tanks rupture and spill into streams, rivers or drainage sewers.

10.2 HAZARD PROFILE

The Safety Element of the Oakland General Plan describes the following risks to Oakland from floods (City of Oakland, 2012):

> *Flooding is the inundation of normally dry land as a result of a rise in the level of surface waters or the rapid accumulation of storm-water runoff; it becomes a hazard when the flow of water has the potential to damage property and threaten human life or health. Flood risks are greatest, and flood hazards most severe, in winter, when water bodies are usually full and soils saturated. Flooding is primarily a natural process and, therefore, difficult to prevent. However, land-use and development decisions have a significant effect on the frequency and severity of floods; in general, urbanization increases the risk of flooding by increasing stormwater runoff and, to a lesser extent, erosion. Flooding can take many forms—river floods, storm-related flash floods and coastal floods, for example—and be caused by many reasons, including heavy rains, melting snow, inadequate drainage systems, hurricanes, and failed dams and levees.*

10.2.1 Federal Flood Programs Participation

National Flood Insurance Program

The City of Oakland has been participating in the NFIP since September 31, 1982 and has adopted and enforced floodplain management regulations that meet or exceed the requirements of the NFIP. Communities participating in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but not less stringent. The City of Oakland Municipal Code requires new construction to be elevated to 1 foot above the base flood elevation.

Full compliance and good standing under the NFIP are application prerequisites for all FEMA grant programs for which participating jurisdictions are eligible under this plan. At the time of the preparation of this plan, the City is in good standing with NFIP requirements (FEMA, 2021). However, the City's last Community Assistance Visit, performed by FEMA on September 26, 2017, did identify potential violations that the City is in the process of responding to. Therefore, the City's full compliance status as of this plan update is not known. The City has identified actions in this plan that commit the City to maintaining its compliance and good standing under the NFIP.

The first FIRMs in the planning area were available in May 1982. The most recent preliminary FIRMs are dated December 21, 2018. These effective FIRMs form the basis of the risk assessment outlined later in this chapter. In NFIP participating communities, structures permitted or built in the planning area before NFIP and related building code regulations went into effect are called "pre-FIRM" structures, and structures built afterwards are called "post-FIRM." The insurance rate is different for the two types of structures.

Table 10-1 lists recent flood insurance statistics for the City of Oakland.

Table 10-1. Flood Insurance Statistics

Date of Entry Initial FIRM Effective Date	09/30/1982
Current Effective FIRM Date	12/21/2018
# of Flood Insurance Policies as of 12/21/2020	559
Insurance In Force	$142,865,700
Premium in Force	$509,290
# of Total Loss Claims filed, as of 12/21/2020	224
Total Payments for Losses	$297,352
Total Adjuster Expense	$70,049

Data as of 10/31/2020

The Community Rating System

The City of Oakland is currently not participating in the Community Rating System.

Repetitive Loss Areas

A repetitive loss property is defined by FEMA as an NFIP-insured property that has experienced any of the following since 1978, regardless of any changes in ownership:

- Four or more paid losses in excess of $1,000
- Two paid losses in excess of $1,000 within any rolling 10-year period
- Three or more paid losses that equal or exceed the current value of the insured property.

The government has instituted programs encouraging communities to identify and mitigate the causes of repetitive losses. Studies have found that many of these properties are outside any mapped 1 percent annual chance (100-year) floodplain. The key identifiers for repetitive loss properties are the existence of flood insurance policies and claims paid by the policies.

FEMA-sponsored programs such as the CRS require participating communities to identify repetitive loss areas. A repetitive loss area is the portion of a floodplain holding structures that FEMA has identified as meeting the definition of repetitive loss. Identifying repetitive loss areas helps to identify structures that are at risk but are not on FEMA's list of repetitive loss structures because no flood insurance policy was in force at the time of loss.

According to FEMA Region IX, the City of Oakland has six identified repetitive loss properties as of March 10, 2021, (see Table 10-2). Three are inside the special flood hazard area, and all are residential.

Table 10-2. Repetitive Loss Data

Repetitive Loss Properties	Total Losses	Total Building Payments	Total Contents Payments	Total Payments
6	12	$37,573.96	$12,966.76	$50,540.72

At the time of this plan update, FEMA had changed its policies regarding the acquisition of information on repetitive loss properties due to implications of the Privacy Act. The "routine use" provision for acquiring this data involves certifications and assurances on how the data will be utilized by entities requesting the data. Due to the expedited timeline for this plan update process, there was not sufficient time to exercise the routine use provisions to acquire repetitive loss data for analysis and assessment. Future updates to this plan will allow for sufficient time to request this data to support the flood hazard risk assessment.

10.2.2 Flood Types and Areas in City of Oakland

In Northern California, most flooding is the result of heavy precipitation over several days. Short streams and steep watersheds emptying onto lowlands in heavily populated areas may produce large volumes of water in short periods, and damage can be severe.

The City of Oakland's watershed consists of 15 main creeks, over 30 tributaries, Lake Merritt and the Oakland Estuary. The following are excerpts from FEMA's December 21, 2018 Flood Insurance Study (FIS) for Alameda County as the principle flood problems for the City of Oakland:

> *In the City of Oakland, many of the storm drain facilities are natural creeks meandering through residential areas. Natural vegetation growth; man-deposited debris; and encroachment of buildings, bridges, and other structures into the floodway contribute to the flood problems.*
>
> *In general, the drainage systems are adequate to carry low frequency storm runoff. However, with larger storms, general flooding occurs.*
>
> *There is little record of past flooding. Principal flood problems are due to inadequate capacity of the open channel or underground conduit, or debris-plugged culverts and bridges. Generally, shallow flooding results, occurring primarily in the lower residential and industrial areas close to the shoreline.*
>
> *Lake Merritt tidal lagoon was a source of flooding in the past. However, since the construction of the 7th Street Pump Station, the 1-percent annual chance flood is contained.*

Flash Flooding

The National Weather Service defines flash flooding as follows (NWS, 2009):

> *… rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within 6 hours of the causative event (e.g., intense rainfall, dam failure). However, the actual time threshold may vary in different parts of the country.*

Flash floods are capable of tearing out trees, undermining buildings and bridges, and scouring new channels. In urban areas, flash flooding is an increasingly serious problem due to the removal of vegetation and replacement of ground cover with impermeable surfaces such as roads, driveways, and parking lots. The greatest risk from flash floods is that they occur with little to no warning. The major factors in predicting potential damage are the intensity and duration of rainfall and watershed and stream steepness.

Stormwater Flooding

Stormwater flooding is a result of local drainage issues and high groundwater levels. Locally, heavy precipitation, especially during high tide events, may produce flooding in areas other than delineated floodplains or along recognizable channels, due to storm system outfalls that are inadequate to provide gravity drainage into an adjacent body of water. If local conditions cannot accommodate intense precipitation through a combination of infiltration and surface runoff, water may accumulate and cause flooding. Flooding of this nature generally occurs in areas with flat gradients and generally increases with urbanization, which increases the accumulation of floodwaters because of impervious areas. Shallow street flooding can occur unless channels have been improved to account for increased flows. Numerous areas in the planning area experience stormwater flooding and contribute to street and structure inundation.

Urban drainage flooding is caused by increased water runoff due to urban development and drainage systems. Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and other urban areas. These systems make use of a closed conveyance system that channels water away from an urban area to surrounding streams and bypasses the natural processes of water filtration through the ground, containment, and evaporation of excess water. Since drainage systems reduce the amount of time the surface water takes to reach surrounding streams, flooding in those streams can occur more quickly and reach greater depths than prior to development in that area.

Non-SFHA Hillside Areas

Hillside areas (slopes of 6 percent or greater) that have not been mapped as SFHAs can still be subject to flood hazards. These include water courses that may appropriately belong among the City's regulated water courses, as well as mud and debris flow areas that have yet to be mapped.

10.2.3 Past Events

Alameda County and the communities within it have experienced 12 flooding events since 1969 for which federal disaster declarations were issued, as summarized in Table 10-3. Many flood events do not trigger federal disaster declaration protocol but have significant impacts on their communities. The NOAA Storm Events Data Base lists the events shown in Table 10-4 as having directly impacted the City of Oakland since 1997.

10.2.4 Location

Area Within the Mapped Floodplain

Flooding in the city has been documented by gage records, high water marks, damage surveys, and personal accounts. This documentation was the basis for the floodplains mapped by FEMA on FIRMs for the City of Oakland (see Figure 10-1). All of the principal flooding sources are incorporated in the currently effective FIRMs. The FIRMs are the most detailed and consistent data source available for determining flood extent. The 2018 Flood Insurance Study is the sole source of data used in this risk assessment to map the flood hazard. Only 6.82 percent of the city (3,398 acres) is within the mapped 1 percent annual chance floodplain.

Table 10-3. History of Federally Declared Flood Incidents Affecting Alameda County

Date	Declaration #	Type of event
February 1 – February 23, 2017	4308	Severe Winter Storms, Flooding, Mudslides
January 18-23, 2017	4305	Severe Winter Storms, Flooding, and Mudslides
March 29 – April 16, 2006	1646	Severe Storms, Flooding, Landslides, and Mudslides
December 17 – January 3, 2006	1628	Severe Storms, Flooding, Mudslides, and Landslides
February 2 – April 30, 1998	1203	Severe Winter Storms and Flooding
December 28, 1996 – April 1, 1997	1155	Severe Storms, Flooding, Mud and Landslides
February 13 – April 19, 1995	1046	Severe Winter Storms, Flooding, Landslides, Mud Flows
January 3 – February 10, 1995	1044	Severe Winter Storms, Flooding, Landslides, Mud Flows
February 12-March 10, 1986	758	Severe Storms & Flooding
January 21 – March 30, 1983	677	Coastal Storms, Floods, Slides & Tornadoes
December 19, 1981 – January 8, 1983	651	Severe Storms, Flood, Mudslides & High Tide
February 16, 1970	283	Severe Storms & Flooding

Source: FEMA, 2020

Table 10-4. Other Flood Events Impacting Planning Area Since 1997

Date	Type	Deaths or Injuries	Property Damage
01/16/2020	Flood/Heavy Rain	0	None Reported
***Description**: A potent cold front swept through the region on January 16, bringing widespread rain, gusty winds, low elevation snow, and thunderstorms. This system brought widespread roadway flooding, downed trees, small hail, and snow as low as 2400 feet in elevation. Numerous flights were delayed or canceled at San Francisco Airport due to the weather. Roadway flooding at I-580 W and Coolidge Ave off ramp. Number 1 lane flooded from Coolidge to Grand.*			
12/13/2002	Flood	0	None Reported
***Description:** There were three primary episodes of precipitation in December. The first was a two-day storm with less than an inch and a half accumulation at any one location; flooding problems were not an issue, but the rainfall helped to saturate the soil. The next and by far most serious storm episode lasted on and off for nine days. A very strong and moist jet stream developed across the Pacific Ocean and brought a series of storms into California. Locally heavy rain pounded the north bay counties for days. Flooding was a serious issue, not just for urban and small stream flooding, but for mainstem flooding as well. 24-hour rain falls recorded at the Oakland airport for 12/13 to 12/16 were 1.17”, 1.88”, 0.2”, and 1.27”*			
1/13/1998	Flash Flood	0	None reported
***Description:** Flooded basement at Whittier Elementary School*			
12/10/1996	Flash Flood	0	None Reported
***Description:** A Pacific storm caused widespread damage. Oakland had 2.02” of rain in the preceding 24 hours. This caused an earthen holding pond to rupture and the ensuing flash flood of mud, water, and debris swept across I-580, a major commute route. It created a 4-foot-deep lake a quarter mile long. Six cars were trapped in the muck, but no injuries were reported.*			
12/25/1997	Flash Flood	0	None Reported
***Description:** Rainstorms brought flooding problems to the Bay Area. San Lorenzo Creek, Alameda Creek and Dry Creek all showed moderate increases in stream flow during the warning period. Castro Valley Creek showed sharp increases in stream flow.*			

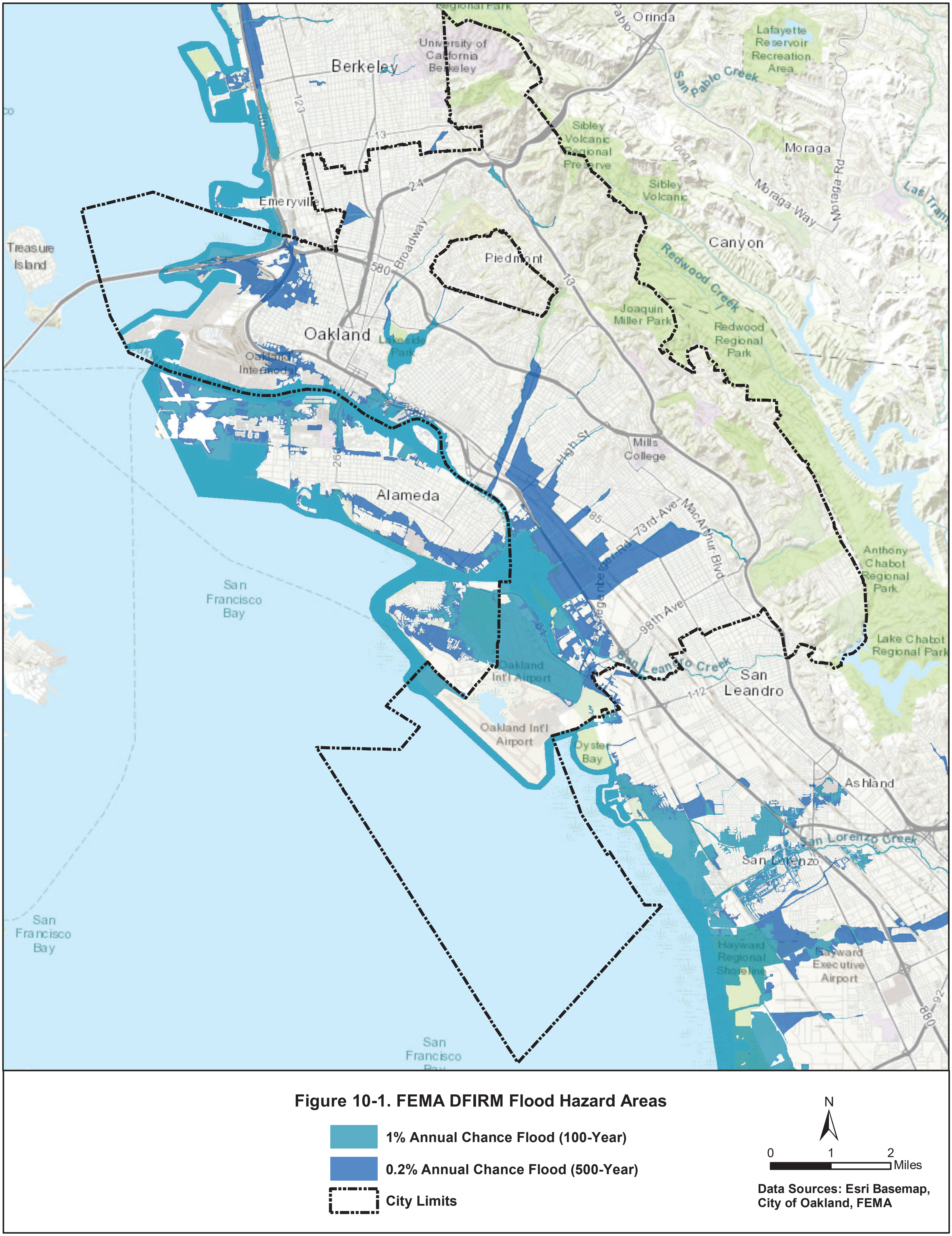


Figure 10-1. FEMA DFIRM Flood Hazard Areas

10.2.5 Frequency

Statistically, a structure within a 1-percent annual chance flood area has a 26-percent chance of suffering flood damage during the term of a 30-year mortgage.

According to the NOAA National Centers for Environmental Information (NCEI), Alameda County has experienced 57 flood events since 1950, most of which have been flash floods. Table 10-5 shows these statistics, as well as the annual average number of events and the percent chance of each flood hazard occurring in Alameda County in future years.

Table 10-5. Probability of Future Occurrences of Flood Events

Hazard Type	Number of Occurrences Between 1950 and 2020	Rate of Occurrence	Recurrence Interval (in years)	% Chance of Occurrence in Any Given Year
Flash Flood	15	0.21	4.76	21
Flood	42	0.60	1.67	59.90
TOTAL	**57**	**0.81**	**1.23**	**81.30**

Source: NOAA-NCEI Storm Database 2021g

Smaller floods may occur on a more frequent basis and be categorized under a different hazard event type, most typically severe weather or severe storms. It is estimated that the planning area will experience the direct and indirect impacts of flooding each year, including urban flooding and smaller floods in identified flood-prone areas.

10.2.6 Severity

Flooding in the City of Oakland has the potential for significant damage, especially as development in the floodplain has increased dramatically. The principal factors affecting flood damage are flood depth and velocity. The deeper and faster flood flows become, the more damage they can cause. Shallow flooding with high velocities can cause as much damage as deep flooding with slow velocity. This is especially true when a channel migrates over a broad floodplain, redirecting high-velocity flows and transporting debris and sediment.

Peak flows used by FEMA to map floodplains within the planning area are listed in Table 10-6.

Table 10-6. Summary of Discharges Within the Planning Area

Standard Value	Drainage Area (Square Miles)	Discharge (cubic feet/second)			
		10-Percent Annual Chance	2-Percent Annual Chance	1-Percent Annual Chance	0.2-Percent Annual Chance
Largest Drainage Area	630	--	--	--	--
Smallest Drainage Area	0.2	--	--	--	--
Highest Discharge Value	--	12,500	25,00	32,000	51,000
Lowest Discharge Value	--	30	870	110	230

Source: FEMA, 2018

10.2.7 Warning Time

The warning time that a community has to take action to protect lives and property from a flooding threat is a function of the time between the first predictions of heavy rainfall, the first rainfall, and the first occurrence of flooding. Each watershed has unique qualities that affect its response to rainfall. Once rainfall starts falling over a watershed, runoff begins, and the stream begins to rise.

Water depth in the stream channel (stage of flow) will continue to rise in response to runoff even after rainfall ends. Eventually, the runoff will reach a peak and the stage of flow will crest. At this peak, the stream stage remains at a constant level until it begins to fall and eventually subside to a level below flooding stage. The length of time that floodwaters remain above flood stage is an important characteristic of the flood hazard.

Due to the sequential pattern of weather conditions needed to cause serious flooding, it is unusual for a flood to occur without warning. Warning times for river and stream floods can be between 24 and 48 hours. Flash flooding can be less predictable, but communities can be warned in advance of the potential for flash flooding to occur.

The Oakland Fire Department’s Emergency Management Services Division (EMSD) works to help Oakland prepare for flood events. The AC Alert system provides critical information in the event of an emergency, including flood. The NWS issues watches and warnings when forecasts indicate rivers may approach bank-full levels. When a watch is issued, the public should prepare for the possibility of a flood. When a warning is issued, the public is advised to stay tuned for further information and be prepared to take quick action if needed. A warning means a flood is imminent, generally within 12 hours, or is occurring. Local media broadcast NWS warnings.

10.3 EXPOSURE

Exposure to the flood hazard was assessed through a spatial analysis. Mapped flood hazard areas as shown on Figure 10-1 were overlaid with planning area general building stock, Census data at the block level, and critical facility locations.

10.3.1 Population

Total Exposed Population

Table 10-7 summarizes the total population living in the mapped flood hazard areas. These estimates were developed by multiplying the total planning area population by the percentage of total residential buildings that are within the mapped flood hazard areas. See Appendix E for a breakdown by sub-area.

Table 10-7. Total Exposed Population in Mapped Flood Hazard Zones

	1% Annual Chance Flood Zone	0.2% Annual Chance Flood Zone
Population Exposed	1,241	23,635
% of Total Planning Area Population	*0.3*	*5.7*

Socially Vulnerable Populations

The socially vulnerable populations exposed to the flood hazard were estimated based on data for the Census-defined blocks that lie at least partially within the mapped flood hazard areas. Because many of those Census blocks extend outside the hazard zone, the estimates are greater than the actual exposed populations, but they provide reasonable relative data for use in mitigation planning. Table 10-8 summarizes the estimated socially vulnerable populations.

Table 10-8. Relative Exposure of Socially Vulnerable Populations in Mapped Flood Hazard Zones

	1% Annual Chance Flood Area		0.2% Annual Chance Flood Area	
	Number[a]	% of Total in Hazard Area	Number[a]	% of Total in Hazard Area
Exposed Population by Age				
Over 65 Years	3,353	10.8%	6,783	10.5%
Under 16	7,478	24.0%	15,720	24.4%
Exposed Population by Race[b]				
White	6,460	20.8%	10,749	16.7%
Black or African American	9,067	29.1%	17,224	26.8%
American Indian and Alaska Native	140	0.4%	273	0.4%
Asian	3,723	12.0%	7,421	11.5%
Native Hawaiian and Other Pacific Islander	219	0.7%	409	0.6%
Some other race	115	0.4%	164	0.3%
Exposed Population by Ethnicity				
Hispanic or Latino (of any race)	10,455	33.6%	26,234	40.8%
Exposed Number of Households by Income				
Households with Income Below $50,000	6,616	55.8%	13,429	58.1%
Totals Used for Calculating Percentages[a]				
Population	31,118		64,324	
Households	11,865		23,128	

a. Note that the methodology used for this analysis overestimates exposed population and households. Results presented in this table should be used to evaluate relative exposure between groups rather than absolute numbers of exposed persons or households.

b. Race data shown are as-is output from Hazus, suitable for comparing exposure between groups listed. Data are for persons identifying as one race only, and do not add up to the total exposed population.

10.3.2 Property

Buildings

Table 10-9 summarizes the Hazus-estimated number and value of properties within the mapped flood hazard zones. See Appendix E for a breakdown by sub-area.

Land Use

Some land uses are more vulnerable to flood risks, such as single-family homes, while others are less vulnerable, such as agricultural land or parks. Hazus defines an occupancy class for buildings in its inventory. These occupancy classes provide an indication of land use within the mapped hazard area. Table 10-10 shows the occupancy class of all buildings in the mapped floodplains. See Appendix E for a breakdown by sub-area.

Table 10-9. Exposed Property in Mapped Flood Hazard Areas

	1% Annual Chance Flood Zone	0.2% Annual Chance Flood Zone
Inundated area (acres)	3,398	6,417
Number of Buildings Exposed	307	5,395
Value of Exposed Structures	$576,742,473	$6,825,317,244
Value of Exposed Contents	$531,765,656	$6,523,593,834
Total Exposed Property Value	**$1,108,508,129**	**$13,348,911,078**
Total Exposed Value as % of Planning Area Total	*0.9*	*11.4*

Table 10-10. Building Occupancy Classes in the Mapped Floodplains

	1% Annual Chance Flood Zone		0.2% Annual Chance Flood Zone	
Building Occupancy Class	Building Count	% of Total Exposed	Building Count	% of Total Exposed
Residential	258	84.04	4,321	80.09
Commercial	28	9.12	713	13.22
Industrial	3	0.98	230	4.26
Agriculture	0	0	0	0
Religion	1	0.33	32	0.59
Government	13	4.24	70	1.30
Education	4	1.29	29	0.54
Total	**307**	**100**	**5,395**	**100**

The assessment of land use based on building occupancy classes does not provide an indication of parks and open space areas, which account for approximately 7 percent of the total area for the City. The amount of the floodplain that contains vacant, developable land is not known. This would be valuable information for gauging the future development potential of the mapped floodplains.

10.3.3 Critical Facilities

Critical facilities exposed to the flood hazard represent 3.6 percent (94 facilities) of the total critical facilities in the planning area for the 1-percent-annual-chance flood hazard and 21.2 percent (554 facilities) for the 0.2-percent-annual-chance flood hazard. The breakdown of exposure by facility type is shown in Figure 10-2.

Critical facilities that are within the 1-percent annual chance flood zone include one City building, a library, a police station, a post office and two education facilities. There are 40 bridges that are in the 1-percent-annual-chance floodplain, including 5 owned by the Port of Oakland and 10 on state highways.

10.3.4 Environment

All environment within the mapped floodplain is exposed to the hazard from a 1 percent annual chance flood.

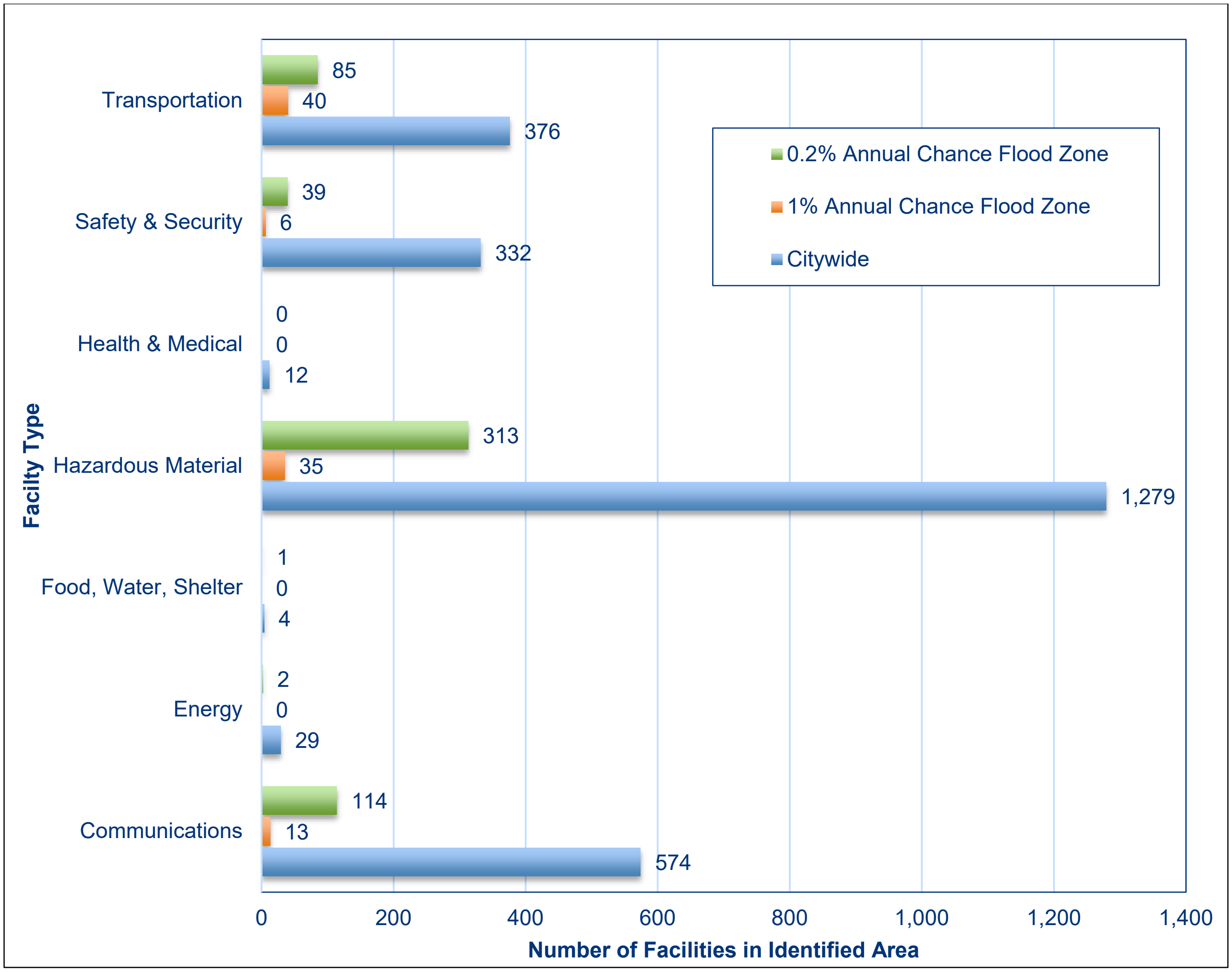


Figure 10-2. Critical Facilities in Mapped Flood Hazard Areas and Citywide

10.4 VULNERABILITY

10.4.1 Population

Table 10-11 summarizes impacts on persons and households for the 1 percent and 0.2 percent annual chance flood events, as estimated through the Level 2 Hazus analysis.

Table 10-11. Estimated Flood Impacts on Households and Residents

	1% Annual Chance Flood Zone	0.2% Annual Chance Flood Zone
Displaced Population	119	11,513
Number of Residents Requiring Short-Term Shelter	5	1,311

10.4.2 Property

Table 10-12 summarizes Hazus estimates of flood damage in the planning area. The debris estimate includes only structural debris and building finishes; it does not include additional debris that may result from a flood event, such as from trees, sediment, building contents, bridges, or utility lines.

Table 10-12. Estimated Impact of a 0.2 Percent Annual Chance Flood Event in the Planning Area

	1% Annual Chance Flood Zone	0.2% Annual Chance Flood Zone
Structure Debris (Tons)	3,818	48,422
Buildings Impacted	94	2,609
Total Value (Structure + Contents) Damaged	$39,173,862	$1.06 billion
Damage as % of Total Value	Less than 1%	0.9%

10.4.3 Critical Facilities

Hazus was used to estimate the level of potential damage to critical facilities exposed to the 1-percent-annual-chance and 0.2-percent-annual-chance floods. The analysis uses depth/damage function curves to estimate the percent of damage to the building and contents of critical facilities. Table 10-13 summarizes the results. The damage estimates shown represent the average percent damage for all affected facilities in each category.

Table 10-13. Estimated Damage to Critical Facilities from Modeled Flood Events

	Number of Facilities Affected	Average % of Total Value Damaged	
		Building	Contents
1% Annual Chance Flood Event			
Safety and Security	4	10.74	57.45
Food, Water and Sheltering	0	N/A	N/A
Health and Medical	0	N/A	N/A
Energy	0	N/A	N/A
Communications	8	14.35	N/A
Transportation	32	5.36	25.76
Hazardous Materials	35	13.14	24.96
Total	**79**	**10.90**	**36.06**
0.2% Annual Chance Flood Event			
Safety and Security	15	10.22	44.58
Food, Water and Sheltering	0	N/A	N/A
Health and Medical	0	N/A	N/A
Energy	2	7.88	13.31
Communications	18	10.44	N/A
Transportation	64	6.88	16.20
Hazardous Materials	249	6.66	11.69
Total	**348**	**8.42**	**21.44**

Specific vulnerabilities of critical facilities to flooding have been identified as follows:

- Roads that are blocked or damaged can isolate residents and prevent access throughout the planning area, including for emergency service providers needing to get to vulnerable populations or to make repairs.
- Bridges washed out or blocked by floods or debris also can cause isolation.
- Underground utilities can be damaged.
- Levees can fail or be overtopped, inundating the land that they protect.
- Floodwaters can back up drainage systems, causing localized urban flooding.
- Culverts can be blocked by debris from flood events, also causing localized urban flooding.
- Floodwaters can get into drinking water supplies, causing contamination.
- Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers, and streams.

10.4.4 Environment

Flooding is a natural event, and floodplains provide many natural and beneficial functions. Nonetheless, flooding can impact the environment in negative ways.

- Fish can wash into roads or over dikes into flooded fields, with no possibility of escape.
- Pollution from roads, such as oil, and hazardous materials can wash into rivers and streams. During floods, these can settle onto normally dry soils, polluting them for agricultural uses.
- Human development such as bridge abutments and levees can increase stream bank erosion, causing rivers and streams to migrate into non-natural courses.
- Flooding may disrupt normal drainage systems in cities and can overwhelm sewer systems, causing raw sewage to spill into the flooded area.
- Severe flooding can destroy buildings that may contain toxic materials (paints, pesticides, gasoline, etc.) releasing these materials into the local environment.

Loss estimation platforms such as Hazus are not currently equipped to measure environmental impacts of flood hazards. The best gauge of vulnerability of the environment would be a review of damage from past flood events. Loss data that segregates damage to the environment was not available at the time of this plan. Capturing this data from future events could be beneficial in measuring the vulnerability of the environment for future updates.

10.5 FUTURE TRENDS IN DEVELOPMENT

According to the California Department of Finance, the population of the greater Alameda County region is expected to increase the most over the next 45 years. The City of Oakland has limited potential for expansion through annexation, as it is surrounded by other incorporated cities. It is anticipated that future growth in the City will be managed through redevelopment, which creates an opportunity to correct past land use decisions, especially with regards to development within floodplains.

The City will be well-equipped to manage growth in floodplains with its flood damage prevention ordinance, its building code, and the Safety Element of its General Plan. Proper application of these tools requires accurate hazard mapping. Flood mapping should be taken into account as future land use decisions are made for areas impacted by flooding.

To further address flooding hazards, the City of Oakland applies Standard Conditions of Approval related to storm drain systems and development in mapped flood zones. Details are provided in Appendix D.

10.6 SCENARIO

The major flooding causes in the City of Oakland are short-duration, high-intensity storms. Water courses in the City can flood in response to a succession of intense winter rainstorms, usually between early November and late March. A series of such weather events can cause severe flooding in the City due to the large percentage of impervious area and the age and capacity of the drainage system.

A worst-case scenario is a series of storms that flood numerous drainage basins in a short time, such as those projected by USGS in the CA ARkStorm Scenario (USGS, 2020). This could overwhelm response and floodplain management capabilities within the city. Major roads could be blocked, preventing critical access for many residents and critical functions. High in-channel flows could cause water courses to scour, possibly washing out roads and creating more isolation problems. In the case of multi-basin flooding, floodplain management resources would not be able to make repairs quickly enough to restore critical facilities. Additionally, as the grounds become saturated, groundwater flooding issues typical for the City would be significantly enhanced.

10.7 ISSUES

The planning team has identified the following flood-related issues relevant to the planning area:

- As of this plan update, the City's compliance and good standing under the NFIP could not be confirmed due to an open Community Assistance Visit that was performed by FEMA Region IX in September 2017.
- The City's regulatory provisions for development within the FEMA mapped SFHA are not clear and well established as stand-alone provisions in the municipal code.
- The City's current administration of its floodplain is not clearly designated. The City should consider aligning this administration with a department better suited to meet the City's floodplain administration requirements under the NFIP.
- Ongoing flood hazard mitigation will require funding from multiple sources.
- A coordinated hazard mitigation effort between jurisdictions affected by flood hazards across the City of Oakland will benefit future mitigation for the flooding hazard.
- Floodplain residents need to continue to be educated about flood preparedness and the resources available during and after floods.
- A lack of concern regarding flood risk by property owners can translate to the lack of political will to make changes.
- The potential impact of climate change on flood conditions needs to be better understood.
- The capability for flood threat recognition and warning needs to be enhanced.
- Flood warning capability should be tied to flood phases.
- There needs to be enhanced modeling to better understand the true flood risk.

- Floodplain restoration/reconnection opportunities should be identified as a means to reduce flood risk.
- Post-flood disaster response and recovery actions need to be solidified.
- Staff capacity is required to maintain the City's existing level of floodplain management.
- Floodplain management actions require interagency coordination.
- With the large percentage of pre-FIRM flood insurance policies in force, the City can expect to see significant increases in the costs of flood insurance within the City. This will create challenges in the promotion of flood insurance.
- Open spaces (infiltration) have decreased substantially, with no plans to reverse this trend. More impervious surface leads to more runoff.

11. LANDSLIDE

11.1 GENERAL BACKGROUND

Ground saturation by water, steepening of slopes by erosion or construction, alternate freezing and thawing, and earthquake shaking are all factors that contribute to landslides. Landslides are typically associated with periods of heavy rainfall or rapid snow melt. Rain-saturated hill slopes and increased groundwater pressure on porous hillsides are triggering agents of slope failure. In areas burned by forest and brushfires, a lower threshold of precipitation may initiate landslides.

11.1.1 Landslide Types

Landslides are commonly categorized by the type of initial ground failure. Common types of slides are shown on Figure 11-1. The most common is the shallow colluvial slide, occurring particularly in response to intense, short-duration storms. The largest and most destructive are deep-seated slides, although they are less com mon than other types.

Debris flows—sometimes referred to as mudslides or mud flows—are rivers of rock, earth, organic matter and other soil materials saturated with water. Debris flows develop in the soil overlying bedrock on sloping surfaces when water rapidly accumulates in the ground, such as during heavy rainfall or rapid snowmelt. Water pressure in the pore spaces of the material increases to the point that the internal strength of the soil is drastically weakened. The soil's reduced resistance can then easily be overcome by gravity, changing the earth into a flowing river of mud. The consistency of debris flows ranges from watery mud to thick sludge that can carry large items such as boulders, trees, and cars. Debris flows from many sources can combine into channels that, with the addition of water, sand, mud, boulders, trees, and other materials, can become greatly more destructive. The debris carried by a debris flow has the potential to spread over a broad area, wreaking havoc in developed communities.

A debris avalanche is a fast-moving debris flow that travels faster than about 10 miles per hour (mph). Speeds in excess of 20 mph are not uncommon, and speeds in excess of 100 mph, although rare, can occur. Debris avalanches can travel many miles from their source, picking up large objects in their path and they can have many times the hydraulic force of water due to the mass of material included in them. They can be among the most destructive events in nature.

Landslides also include the following:

- Rock Falls—Blocks of rock that fall away from a bedrock unit without a rotational component
- Rock Topples—Blocks of rock that fall away from a bedrock unit with a rotational component
- Rotational Slumps—Blocks of fine-grained sediment that rotate and move down slope

Source: Washington Department of Ecology, 2016

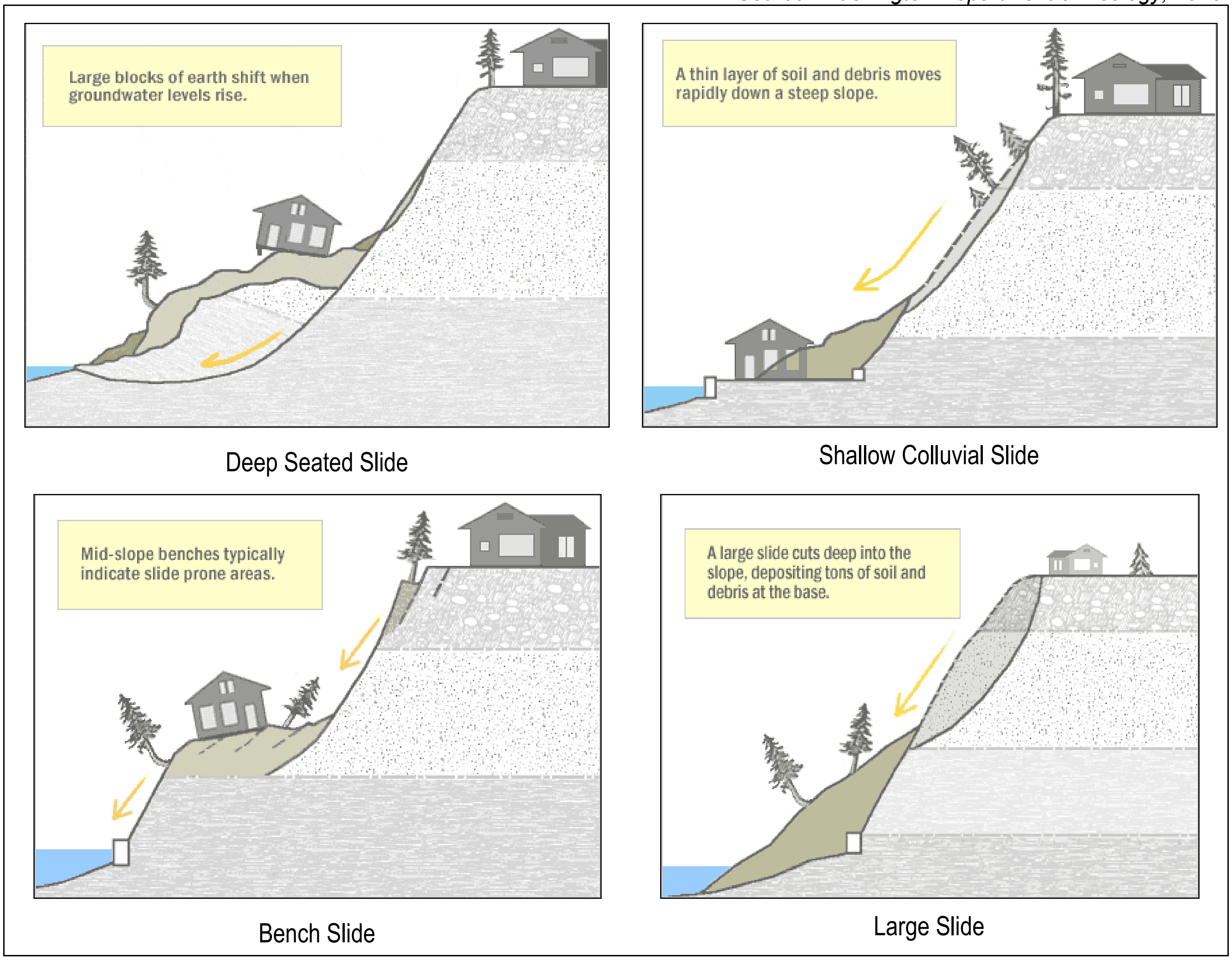


Figure 11-1. Common Landslide Types

- Transitional Slides—Sediments that move along a flat surface without a rotational component
- Earth Flows—Fine-grained sediments that flow downhill and typically form a fan structure
- Creep—A slow-moving landslide often only noticed through crooked trees and disturbed structures
- Block Slides—Blocks of rock that slide along a slip plane as a unit down a slope.

11.1.2 Landslide Modeling

Two characteristics are essential to conducting an accurate risk assessment of the landslide hazard:

- The type of initial ground failure that occurs, as described above
- The post-failure movement of the loosened material ("run-out"), including travel distance and velocity.

All current landslide models—those in practical applications and those more recently developed—use simplified hypothetical descriptions of landslide behavior to simulate the complex behavior of actual flow. The models attempt to reproduce the general features of the moving mass of material through measurable factors, such as base shear, that define a system and determine its behavior. Due to the lack of experimental data and the limited current knowledge about the behavior of the moving flows, landslide models use simplified parameters to account for complex aspects that may not be defined. These simplified parameters are not related to specific physical processes that can be directly measured, and there is a great deal of uncertainty in their definition. Some, but not all, models provide estimates of the level of uncertainty associated with the modeling approach.

Run-out modeling is further complicated because the movement of materials may change over the course of a landslide event, depending on the initial composition, the extent of saturation by water, the ground shape of the path traveled and whether there is additional material incorporated during the event.

11.1.3 Landslide Causes

Landslides are caused by a combination of geological and climate conditions, as well as the encroaching influence of urbanization. In general, landslides are most likely during periods of higher than average rainfall. The ground must be saturated prior to the onset of a major storm for significant landslide to occur. Water is involved in nearly all cases; and human influence has been identified in more than 80 percent of reported slides. The following human-caused factors can contribute to landslide: change in slope of the terrain, increased load on the land, shocks and vibrations, change in water content, groundwater movement, frost action, weathering of rocks, and removing or changing the type of vegetation covering slopes.

Excavation and Grading

Slope excavation is common in the development of home sites or roads on sloping terrain. Grading can result in some slopes that are steeper than the pre-existing natural slopes. Since slope steepness is a major factor in landslides, these steeper slopes can be at an increased risk for landslides. The added weight of fill placed on slopes can also result in an increased landslide hazard. Small landslides can be fairly common along roads, in either the road cut or the road fill. Landslides occurring below new construction sites are indicators of the potential impacts stemming from excavation.

Drainage and Groundwater Alterations

Watershed protection is a primary concern to the City of Oakland. While permeable soils soak up rain and irrigation water, proper grading and drainage systems can collect water to protect slopes from oversaturation and slippage. Water flowing through or above ground is often the trigger for landslides. Any activity that increases the amount of water flowing into landslide-prone slopes can increase landslide hazards. Broken or leaking water or sewer lines can be especially problematic, as can water retention facilities that direct water onto slopes. Even lawn irrigation and minor alterations to small streams in landslide prone locations can result in damaging landslides. Drainage can be affected naturally by the geology and topography of an area. Development that results in an increase in impervious surface impairs the ability of the land to absorb water and may redirect water to other areas. Channels, streams, flooding, and erosion on slopes all indicate potential slope problems. Road and driveway drains, gutters, downspouts, and other constructed drainage facilities can concentrate and accelerate flow. Ground saturation and concentrated velocity flow are major causes of slope problems and may trigger landslides.

Changes in Vegetation

Following major brushfires, federal or state agencies typically seed denuded areas with wild plant seeds. This encourages vegetation growth, thereby stabilizing the barren soil and protecting the watershed from erosion. Areas that have experienced wildfire and land clearing for development may have long periods of increased landslide hazard. The City of Oakland is currently drafting a Vegetation Management Plan that examines how vegetation can be managed to provide more defensible space around structures and assets to protect against wildfire impacts.

11.1.4 Landslide Management

While small landslides are often a result of human activity, the largest landslides are often naturally occurring phenomena with little or no human contribution. The sites of large landslides are typically areas of previous landslide movement that are periodically reactivated by significant precipitation or seismic events. Such naturally occurring landslides can disrupt roadways and other infrastructure lifelines, destroy private property, and cause flooding, stream bank erosion and rapid stream channel migration.

Landslides can create immediate, critical threats to public safety. Engineering solutions to protect structures on or near large active landslides are often expensive. Despite their destructive potential, landslides can serve beneficial functions to the natural environment. They supply sediment and large wood to stream channel networks and can contribute to stream complexity and dynamic channel behavior critical for aquatic and riparian ecological diversity. Effective landslide management should include the following elements:

- Continuing investigation to identify natural landslides, understand their mechanics, assess their risk to public health and welfare, and understand their role in ecological systems
- Regulation of development in or near existing landslides or areas of natural instability through codes and ordinances.
- Preparation for emergency response to landslides to facilitate rapid, coordinated action among local, state, and federal agencies, and to provide emergency assistance to affected or at-risk residents
- Evaluation of options including landslide stabilization or structure relocation where landslides are identified as a threat to critical public structures or infrastructure

11.1.5 Secondary Impacts

Landslides can cause secondary impacts such as blocking roads, which can isolate residents and businesses and delay commercial, public, and private transportation. This could result in economic losses for businesses. Other potential problems resulting from landslides are power and communication failures. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and communication lines. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents. They also can damage rivers or streams, potentially harming water quality, fisheries, and spawning habitat.

11.2 HAZARD PROFILE

The Safety Element of the Oakland General Plan describes the following risks to Oakland from landslides (City of Oakland, 2012):

> *Most sloping land has some landslide potential. The risks tend to be greatest where a number of contributing factors are present, including slopes over 15 percent, weak, unconsolidated or shallow soils,*

water saturation, a history of landslides, active earthquake faults, extensive grading and vegetation removal (from fires or development activity). The slide itself is usually triggered by an earthquake, heavy rain or misdirected runoff. Landslides are a relatively common hazard in the East Bay hills, especially during and soon after heavy rainstorms, when the ground is saturated. Mudslides—fast, shallow movements of water-saturated earth that flow as muddy slurries, typically following water courses—are the most common type of landslides in Oakland; they are also known as debris flows or soil slumps.

More than half of Oakland's area, including most of its vacant land, consists of gently sloping or hilly land. Moreover, approximately one-quarter of the city, including all of the Oakland Hills, contains slopes greater than 15 percent. Slopes of 15-30 percent are considered developable but are likely to require site modification or special grading or foundation design to reduce the potential for slope instability. Slopes of that degree are found in Oakland throughout the southern Oakland Hills, in the roughly triangular area formed by I-580 and State Highways 13 and 24, in the vicinity of Mills College and Eastmont, and on some of the hills around Lake Merritt. Development on slopes exceeding 30 percent is considered difficult and potentially hazardous. Such slopes are concentrated throughout the Oakland Hills (especially in the northern hills) and within two miles south of Highway 13.

The landslide hazard in the Oakland Hills is exacerbated by the fact that the area is crossed by the Hayward fault. During a major earthquake on that fault, landsliding, widespread failure of steep slopes and the collapse of natural stream banks could be expected in the hills in response to strong ground movements anticipated to occur in the area. Landslides could block roads, which would hamper evacuation, firefighting and relief operations within the area. Nevertheless, landslides are not expected to produce a large-scale disaster; rather, they present a persistent risk of damage to buildings and infrastructure in areas of potentially unstable slopes. Landslides would affect only scattered structures located in the direct path, but could result in some loss of life, from the collapse of structures and tumbling earth, rocks and debris.

Although the landslide hazard cannot be completely eliminated, damage can be minimized by following proper development practices or by steering development away from areas of unstable slopes. While efforts have been taken by the city through the development process to minimize landslide potential, most hillside development predates the imposition of grading and related requirements. For this reason, older hillside homes and subdivisions are the most susceptible to damage from landslides.

11.2.1 Past Events

The City of Oakland has had several small-scale debris flow events over the years, as well as major landslide events. Table 11-1 lists known landslide events that occurred in the vicinity of the planning area between 1980 and 2020. Significant events are further described in the sections below.

April 6, 2017

On April 6, 2017, a large section of Aitken Drive collapsed onto Banning Drive, which runs below. Oakland Fire Department and the Oakland Police Department responded to the event, evacuating about six homes in the area. This event left 23 homes in the area without water service for several days. Downed power lines left 401 customers in the dark. By early Friday afternoon, the number of those without power was down to 21 and all were expected to have power restored later Friday. The landslide brought firefighters, city public works, and PG&E and EBMUD workers to the scene.

Table 11-1. Landslide Events in and Near the Planning Area

Event Date	Event Type	FEMA Number	Description
April 6, 2017	Landslide		Aitken Drive in the Oakland Hills severely damaged. Several homes evacuated. At least 2 homes red-tagged.
January 3 – 12, 2017	Severe Winter Storms, Flooding, and Mudslides	4301	Major disaster declaration, primary impact was damage to roads and bridges. Alameda County per capita impact ($6.17)
2012	Landslide		Landslide on Sheridan and CA-13 caused the rock slope protection to spill onto the roadway system.
2012	Landslide		Landslide on Wild Currant Way collapsed the road.
2008	Landslide		Landslide at Tunnel Road and Bay Forest Road blocked one lane of the road
March 29 – April 6, 2006	Severe Storms, Flooding, Landslides, and Mudslides	1646	
2006	Landslide		Landslide on McKillop destroyed several homes
December 17, 2005 – January 3, 2006	Severe Storms, Flooding, Mudslides, and Landslides	1628	Public assistance given to Alameda County. Landslide on Armour Drive permanently closed part of Armour Drive and destroyed several homes
2002	Landslide		Landslide on Wallace Street resulted in several red-tagged homes overlooking 14th Avenue.
1998	Landslide		Destroys two homes on Snake Road
1998	Landslide		Landslide on Rettig Avenue blocked the street.
1998	Landslide		Landslides on Snake Road and Cabot Road destroy four homes
December 28, 1996 – April 1, 1997	Severe Storms, Flooding, Mud and Landslides	1155	
February 13 – April 19, 1995	Severe Winter Storms, Flooding, Landslides, Mud Flows	1046	
January 3 – February 10, 1995	Severe Winter Storms, Flooding, Landslides, Mud Flows	1044	
1982	Landslide		Landslides on Snake Road and Cabot Road destroys four homes

Source: FEMA 2020

January 3 – 12, 2017

Three storm systems hit the Bay Area in January 2017, causing widespread damage and disruption, primarily to roads and bridges. The City of Oakland received 0.93 inches of rain and several flights were canceled at Oakland International Airport due to high winds and reduced visibility. The storm was part of a series of rainstorms starting in October that sent an above normal amount of rainfall to the Bay Area. Oakland recorded 13.54 inches from October 2016 to January 2017, which was 132 percent of the normal total. Alameda County was awarded public assistance funding based on the per capita impact.

December 17 – January 3, 2006

Heavy precipitation resulted in landslides, damaging the embankment and stormwater conveyance features at three City of Oakland sites. Oakland Public Works proposed to fix the stormwater conveyance features damaged by the landslides. FEMA authorized funds to stabilize and restore damage caused by the landslides at each site.

11.2.2 Location

The best predictor of where landslides might occur is the location of past landslides. These can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Landslides recognizable in this fashion range from a few acres to several square miles. Most show no evidence of recent movement and are not currently active. A small portion of them may become active in any given year. Ancient dormant landslide sites can be reactivated by earthquakes or by exceptionally wet weather. Also, because they consist of broken materials and frequently involve disruption of groundwater flow, these dormant sites are vulnerable to construction-triggered sliding. As development has spread into the hillsides, unstable soil and erosion often contributes to landslides.

California's state geologist identifies and maps hazardous landslide areas for use by municipalities. This program focuses on urban areas and growth areas that exhibit significant slope, weak rocks, and heavy rains. Figure 11-2 shows mapped landslide hazard areas in the City of Oakland. The hazard is designated by zone as low, moderate, high or very high susceptibility to deep-seated landslides.

11.2.3 Frequency

Landslides are often triggered by other natural hazards such as earthquakes, heavy rain, floods, or wildfires, so landslide frequency is often related to the frequency of these other hazards. According to FEMA and the NCEI storm events database, the planning area has been impacted by earthquakes, wildfires, or severe storms at least once every other year since 1980, representing an annual probability of 50 percent. Given the preponderance of steep slopes and the frequency of contributory sources to landslides in the planning area, the probability of future occurrence can be considered equal to this 50-percent annual probability. Until better data is generated specifically for landslide hazards, this frequency is appropriate for the purpose of ranking risk.

11.2.4 Severity

Landslides destroy property and infrastructure and can take the lives of people. They can pose a serious hazard to properties on or below hillsides. Landslides directly damage structures in two ways: disruption of structural foundations caused by differential movement/deformation of the ground upon which the structure sits, and the physical impact of debris moving down-slope against structures located in the debris flow's path. As a landslide breaks away from a slope, it deforms the ground into an undulating surface broken up by fissures and scarps. This deformation distresses foundations and structures situated on top of a landslide by settlement, cracking, and tilting. This can occur slowly, over years, or rapidly within days or hours. A water-saturated, fast-moving debris flow can destroy all in its path, collapsing walls and shifting structures off their foundations.

Slope failures in the United States result in an average of 25 to 50 lives lost per year and an estimated $2 billion to $4 billion in damage. Landslides and debris flows cause millions of dollars in cumulative damage to Bay Area homes, businesses, and infrastructure every year.

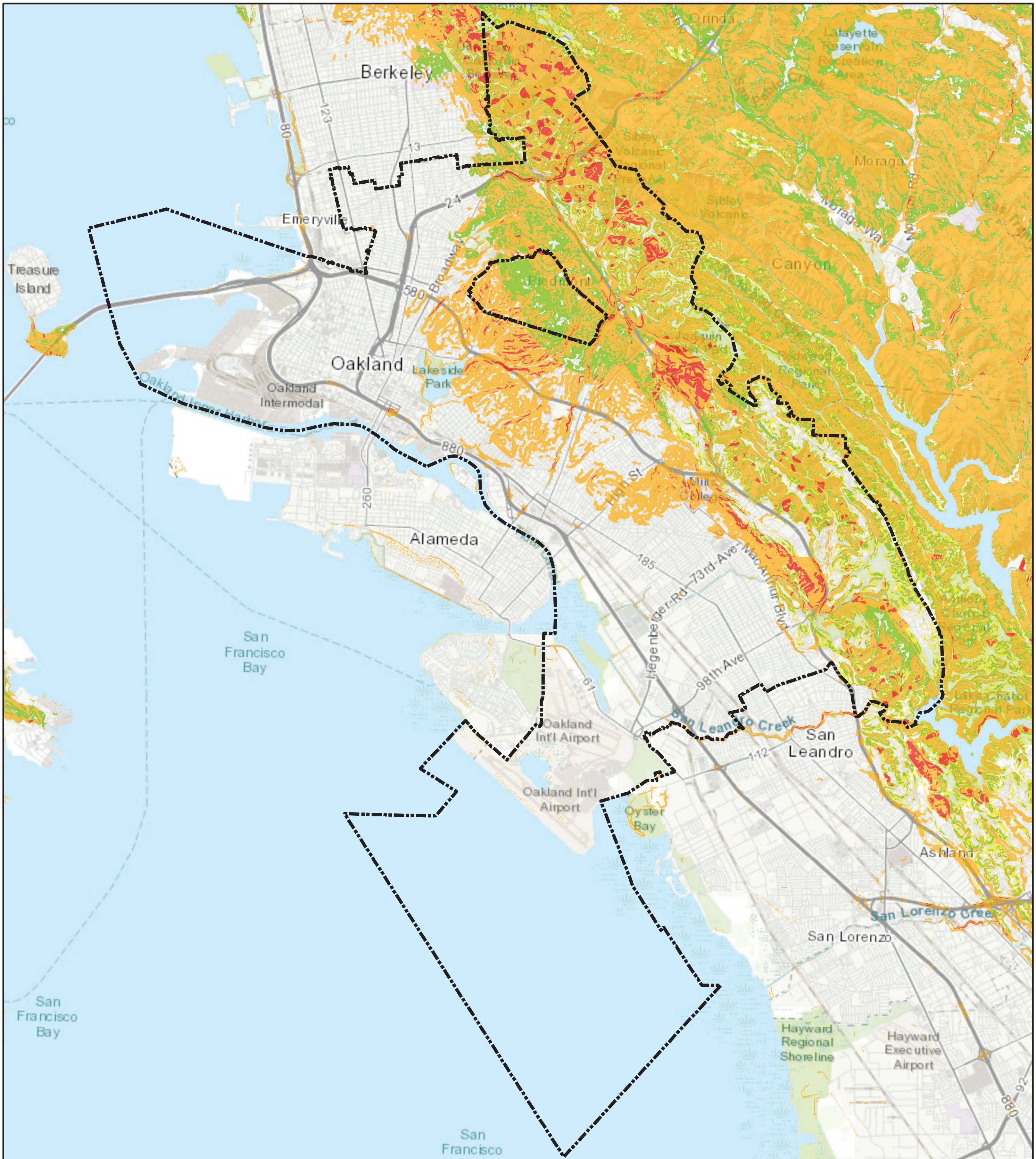


Figure 11-2. Landslide Hazard Zones in the Planning Area

Susceptibility to Deep-Seated Landslides

- **Low**
- **Moderate**
- **High**
- **Very High**
- **City Limits**

N

0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland, CGS

11.2.5 Warning Time

Landslides can occur suddenly or slowly. The velocity of movement may range from a slow creep of inches per year to many feet per second, depending on slope angle, material, and water content. Landslides and debris flows can be initiated by severe storms, earthquakes, wildfires, or human modification of the land. They can move rapidly down slopes or through channels and can strike with little or no warning at avalanche speeds.

Some methods used to monitor landslides can provide an idea of the type of movement and the amount of time prior to failure. It is also possible to determine what areas are at risk during general time periods. Assessing the geology, vegetation and amount of predicted precipitation for an area can help in these predictions. However, there is no practical warning system for individual landslides. The current standard operating procedure is to monitor situations on a case-by-case basis and respond after the event has occurred.

When atmospheric river weather patterns occur, the risk and dangers of landslides and debris flows increase. Improved forecasting of such events could allow advanced warning to better prepare for and respond to potential slope failures and flood events. Generally accepted warning signs for landslide activity include the following:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavements or sidewalks
- Soil moving away from foundations
- Ancillary structures such as decks and patios tilting and/or moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls or fences
- Offset fence lines
- Sunken or down dropped roadbeds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity (soil content)
- Sudden decrease in creek water levels though rain is still falling or just recently stopped
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together.

11.3 EXPOSURE

Exposure to the landslide hazard was assessed through a spatial analysis using Hazus. Mapped landslide hazard areas with the highest degree of susceptibility (moderate, high, or very high susceptibility, as shown on Figure 11-2), were overlaid with planning area general building stock, Census data at the block level, and critical facility locations.

11.3.1 Population

Total Exposed Population

Table 11-2 summarizes the total population living in the highest-susceptibility landslide hazard areas. These estimates were developed by multiplying the total planning area population by the percentage of total residential buildings that are within the mapped landslide hazard areas. See Appendix E for a detailed breakdown of exposure by sub-area.

Table 11-2. Total Exposed Population in Mapped Landslide Hazard Zones

	Moderate Landslide Susceptibility	High Landslide Susceptibility	Very High Landslide Susceptibility
Population Exposed	18,044	107,267	6,081
% of Total Planning Area Population	*4.2*	*24.7*	*1.4*

Socially Vulnerable Populations

The socially vulnerable populations exposed to the high and very-high susceptibility landslide hazard were estimated based on data for the Census-defined blocks that lie at least partially within the mapped susceptibility zones. Because many of those Census blocks extend outside the hazard zone, the estimates are greater than the actual exposed populations, but they provide reasonable relative data for use in mitigation planning. Table 11-3 summarizes the estimated socially vulnerable populations.

11.3.2 Property

Buildings

Table 11-4 summarizes the Hazus-estimated number and value of properties within the highest-susceptibility landslide hazard areas. See Appendix E for a breakdown by sub-area.

Land Use

Table 11-5 shows the occupancy class of all buildings in the landslide susceptibility zones based on building occupancy type for the planning area. See Appendix E for a breakdown by sub-area.

11.3.3 Critical Facilities

The breakdown of exposure of critical facilities by susceptibility class and facility type is shown in Figure 11-3 shows the numbers of critical facilities by type that are within areas with high or very high landslide susceptibility ratings. The 358 total facilities in these areas represent 13.7 percent of the citywide total number of critical facilities.

Table 11-3. Relative Exposure of Socially Vulnerable Populations in Landslide Hazard Zone

	Number[a]	% of Total in High and Very-High Susceptibility Landslide Hazard Area
Exposed Population by Age		
Over 65 Years	24,993	12.5%
Under 16	39,177	19.7%
Exposed Population by Race[b]		
White	70,444	35.4%
Black or African American	44,745	22.5%
American Indian and Alaska Native	619	0.3%
Asian	38,427	19.3%
Native Hawaiian and Other Pacific Islander	872	0.4%
Some other race	731	0.4%
Exposed Population by Ethnicity		
Hispanic or Latino (of any race)	35,186	17.7%
Exposed Households by Income		
Households with Income Below $50,000	34,131	40.8%
Totals Used for Calculating Percentages[a]		
Population	199,265	
Households	83,697	

a. Note that the methodology used for this analysis overestimates exposed population and households. Results presented in this table should be used to evaluate relative exposure between groups rather than absolute numbers of exposed persons or households.
b. Race data shown are as-is output from Hazus, suitable for comparing exposure between groups listed. Data are for persons identifying as one race only, and do not add up to the total exposed population.

Table 11-4. Exposed Property in Mapped Landslide Hazard Zones

	Moderate Landslide Susceptibility	High Landslide Susceptibility	Very High Landslide Susceptibility
Number of Buildings Exposed	5,788	25,620	1,862
Value of Exposed Structures	$2,077,867,402	$11,473,263,568	$715,952,094
Value of Exposed Contents	$1,179,462,851	$7,380,593,109	$416,258,825
Total Exposed Property Value	**$3,257,330,253**	**$18,853,856,677**	**$1,132,210,919**
Total Exposed Value as % of Planning Area Total	*2.8*	*16*	*1.0*

Table 11-5. Building Occupancy Classes in Landslide Susceptibility Zones

Building Occupancy Class	Moderate Landslide Susceptibility		High Landslide Susceptibility		Very High Landslide Susceptibility	
	Building Count	% of Total Exposed	Building Count	% of Total Exposed	Building Count	% of Total Exposed
Residential	5,729	98.98	24,822	96.89	1,840	98.82
Commercial	34	0.59	577	2.25	9	0.48
Industrial	0	0	22	0.09	0	0
Agriculture	0	0	2	0.01	0	0
Religion	11	0.19	76	0.30	4	0.21
Government	6	0.10	54	0.20	7	0.38
Education	8	0.14	67	0.26	2	0.11
Total	**5,788**	**100**	**25,620**	**100**	**1,862**	**100**

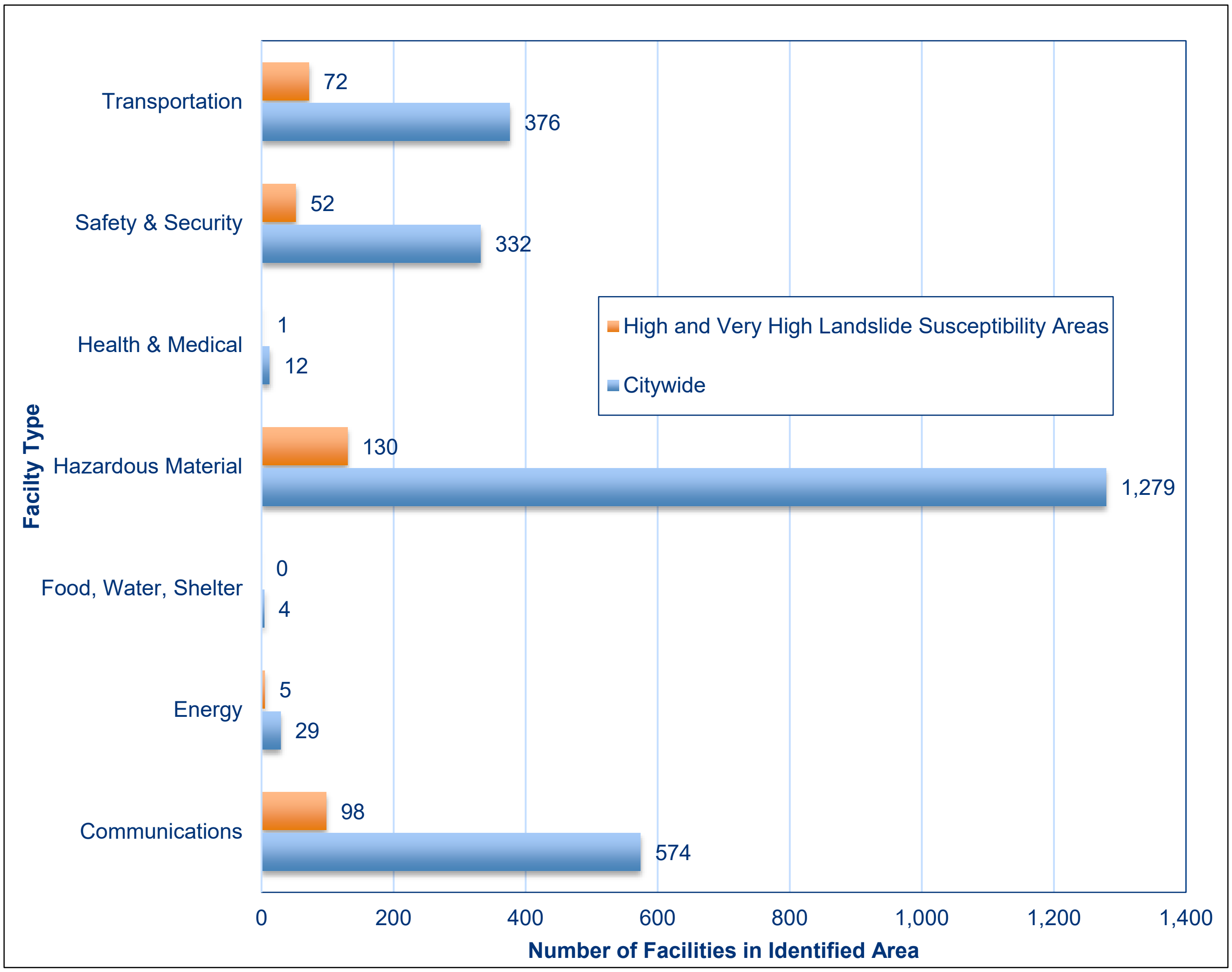


Figure 11-3. Critical Facilities in High and Very High Landslide Susceptibility Areas and Citywide

11.3.4 Environment

All natural areas within the high susceptibility zones for landslide are considered to be exposed to the hazard.

11.4 VULNERABILITY

11.4.1 Population

Due to the nature of census block group data, it is difficult to determine demographics of populations vulnerable to mass movements. In general, all of the estimated 113,000 persons exposed to high-risk or very-high-risk landslide areas are considered to be vulnerable. Increasing population and the fact that many homes are built on view property atop or below bluffs and on steep slopes subject to mass movement, increases the number of lives endangered by this hazard.

11.4.2 Property

Loss estimations for the landslide hazard are not based on modeling utilizing damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 11-6 shows potential losses in the areas with the highest degree of landslide susceptibility.

Table 11-6. Loss Estimation for Landslide

	Exposed Value	Loss Value	Loss as % of Total Planning Area Replacement Value
Moderate Landslide Susceptibility Zone			
Loss = 1% of Exposed Value	$3.26 billion	$32,573,303	0.03%
Loss = 10% of Exposed Value		$325,733,025	0.28%
Loss = 30% of Exposed Value		$977,199,076	0.83%
Loss = 50% of Exposed Value		$1,628,665,126.33	1.39%
High Landslide Susceptibility Zone			
Loss = 1% of Exposed Value	$18.85 billion	$188,538,567	0.16%
Loss = 10% of Exposed Value		$1,885,385,668	1.60%
Loss = 30% of Exposed Value		$5,656,157,003	4.81%
Loss = 50% of Exposed Value		$9,426,928,339	8.02%
Very High Landslide Susceptibility Zone			
Loss = 1% of Exposed Value	$1.13 billion	$11,322,109	0.01%
Loss = 10% of Exposed Value		$113,221,092	0.10%
Loss = 30% of Exposed Value		$339,663,276	0.29%
Loss = 50% of Exposed Value		$566,105,460	0.48%

11.4.3 Critical Facilities

There are 358 critical facilities exposed to the high or very high landslide hazard to some degree. Exposed infrastructure includes transportation, water, sewer, and power infrastructure. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from mass movements should be done to determine if they could withstand impacts of a mass movement. At this time, all infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available.

11.4.4 Environment

Landslides can destroy natural assets that are highly valued by the community:

- Landslides that fall into streams may significantly impact fish and wildlife habitat, as well as affecting water quality.
- Hillsides that provide wildlife habitat can be lost due to landslides.
- Endangered species and their critical habitat in the planning area may be located in landslide hazard areas.

11.5 FUTURE TRENDS IN DEVELOPMENT

Land use controls (such as prohibiting development on unstable soils or steep slopes) are the most cost-effective way to prevent loss of life and property. The City is equipped to handle future growth within landslide hazard areas. The Safety Element of the General Plan addresses landslide risk areas. Linking the General Plan to this hazard mitigation plan will create an opportunity for wise land use decisions as future growth impacts landslide hazard areas.

The California Building Standards Code has adopted the International Building Code (IBC) by reference. The IBC includes provisions for geotechnical analyses in steep slope areas that have soil types considered susceptible to landslide hazards. These provisions assure that new construction is built to standards that reduce the vulnerability to landslide risk. To further address landslide hazards, the City of Oakland applies Standard Conditions of Approval to all proposals for newly constructed land use facilities where a geologic hazard is present. Details are provided in Appendix D.

11.6 SCENARIO

Major landslides in the planning area occur as a result of soil conditions that have been affected by severe storms, groundwater, or human development. Landslides are most likely during late winter when the water table is high. After heavy rains, soils become saturated with water. As water seeps downward through upper soils that may consist of permeable sands and gravels and accumulates on impermeable silt, it will cause weakness and destabilization in the slope. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm with heavy rain and flooding and/or high ocean waves, followed by a damaging earthquake. An earthquake that occurs when water tables are high and soils are saturated has the potential to trigger a significant number of landslides in the planning area.

11.7 ISSUES

Important issues associated with landslides in the planning area include the following:

- An accurate picture of where landslides occurred during previous storms is vital in making intelligent land use planning and mitigation decisions. In the past, many landslide losses may have gone unrecorded because insurance companies do not cover such damage. Transportation network damage has often been repaired under the general category of "maintenance."
- Landslides may result in isolation of vulnerable neighborhoods and communities, due to the fact that large portions of the transportation infrastructure are in areas of high and moderate slope instability. Isolation may result in food shortages, loss of power, and severely reduced economic productivity.
- Critical facilities in areas of unstable slopes that could result in interruption to utility services, particularly water and power. This creates a need for mitigation and for continuity of operations planning to develop procedures for providing services without access to essential facilities.
- Landslides may result in loss of water quality to the environment and for drinking purposes, due to increased sediment delivery into surface waterways.
- The vulnerability of existing homes in landslide hazard areas depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- The impact of climate change on landslides is uncertain. If climate change impacts the timing and intensity of rain event, then the frequency of landslide events may increase.
- The risk associated with the landslide hazard overlaps the risk associated with other hazards such as earthquake, flood, and wildfire. This provides an opportunity to seek mitigation alternatives with multiple objectives that can reduce risk for multiple hazards.
- California's Disclosures in Real Property Transactions law requires disclosure if a property is in a landslide hazard area. Such disclosure is dependent upon knowledge by the seller or the seller's real estate agent or the posting of a landslide hazard map at the offices of the county recorder, county assessor, and local planning agency and a notice identifying the location of the map and any changes to it.
- Future development could lead to more homes in landslide risk areas.
- Mapping and assessment of landslide hazards are constantly evolving. As new data and science become available, assessments of landslide risk should be reevaluated.

12. SEA-LEVEL RISE

12.1 GENERAL BACKGROUND

Sea-level rise is caused primarily by two factors related to global warming: the added water from melting ice sheets and glaciers; and the expansion of seawater as it warms. In the past century, global mean sea level has increased by 7 to 8 inches, with human influence the dominant cause of observed atmospheric and oceanic warming. Given current trends in greenhouse gas emissions and increasing global temperatures, sea-level rise is expected to accelerate in the coming decades. Impacts will generally become more frequent and more severe in the latter half of this century (California Coastal Commission, 2021).

The science of sea-level rise is being continuously revised as climate models are improved and updated with new data and observations. These revisions improve understandings of climate variability and the global oceanic response. Keeping up to date with such scientific advances is vital for developing appropriate adaptation strategies that prove implementable over time (Resilient Oakland, 2017).

12.2 HAZARD PROFILE

As a bayfront city, Oakland has long been vulnerable to flooding. Rising waters in San Francisco Bay already affect Oakland with periodic flooding of low-lying shorelines, loss of valuable saltwater marshes, and saltwater impacts on wastewater treatment systems. When heavy rains are coupled with higher-than-normal tides, the high tides can slow the drainage of runoff into the Bay, increasing the potential for urban stormwater flooding. The Oakland Coliseum and Lake Merritt areas, for example, are near channel restrictions and experience flooding from rainwater that is unable to properly drain when downstream channels reach capacity during high tides. In the Lake Merritt area, several capital projects have been implemented to alleviate upstream flooding, and the City is continuing to further manage lake water levels (Resilient Oakland, 2017).

Rising sea levels represent new challenges to Oakland's future. As bay water levels continue to rise, the extent and frequency of flooding will increase. Areas once considered to be outside of the floodplain will begin to experience periodic coastal and/or urban flooding. Sections of Oakland's shoreline built on bay fill, such as the Port of Oakland and the Oakland International Airport, are increasingly vulnerable, because they are chronically subsiding and are at a higher risk of liquefaction during seismic events.

12.2.1 Data Sources

Oakland Preliminary Sea-Level Rise Road Map

The *Oakland Preliminary Sea-Level Rise Road Map* was developed in 2017 to identify sea-level rise adaptation actions as part of Resilient Oakland, a coordinated effort to align resources in support of a resilient community.

Oakland was selected in 2013 to join 100 Resilient Cities, an initiative pioneered by the Rockefeller Foundation to help cities build resilience for the social, economic, and physical challenges of the 21st century. The working group for The Road Map was made up of City and Port of Oakland staff, county and regional agencies and districts, educational organizations, and community stakeholders, such as the San Francisco Estuary Institute, and the Pacific Institute.

Adapting to Rising Tides Program

The San Francisco Bay Conservation and Development Commission's *Adapting to Rising Tides* (ART) program works with local, state, regional and federal agencies and organizations to gather, develop and analyze the data needed to understand the impacts of a changing climate on Bay Area communities, infrastructure, services, and natural resources. The ART program has defined potential scenarios for sea-level rise over coming decades and prepared maps showing areas that would become inundated under each scenario. Each ART program project has a repository of data, maps and analysis about various assets and sectors.

12.2.2 Past Events

In the last century, San Francisco Bay water levels have risen 8 inches (Resilient Oakland, 2017).

12.2.3 Location

Mapping developed by the ART program was used the identify the location of the sea-level rise hazard for this risk assessment. This risk assessment used inundation mapping for two ART scenarios:

- 48" by 2050 (Figure 12-1)
- 108" by 2100 (Figure 12-2)

In the planning area, the potential for new or prolonged flooding as sea-level rises will not be confined to the shoreline. Sea-level rise will increase the likelihood of major flood events because higher water levels in tidal creeks and flood control channels will reduce capacity to discharge rainfall runoff. While some creeks and coastal infrastructure already flood when rainstorms coincide with high tides, rising sea levels will increasingly cause flooding during smaller, more frequent rainfall events.

12.2.4 Frequency

Sea-level rise is an ongoing phenomenon that progresses over time. Neither its past history nor its projected future is based on discrete, countable events. However, scientists do measure long-term values of historical rise and use those data, combined with climate projections, to predict ongoing sea level rise over defined time periods. The probability of additional sea-level rise inundation in Oakland by 2100 is high, though specific levels are uncertain. Table 12-1 shows a range of sea-level rise projections from the Road Map and the ART program.

Table 12-1. Range of Estimates for Bay Area Sea-Level Rise

Year	Oakland Sea-Level Rise Road Map		ART Scenarios	
	Total Rise	Annual Average	Total Rise	Annual Average
2050	11 – 24 inches	0.37 – 0.8 inches per year	48 inches	1.6 inches per year
2100	36 – 66 inches	0.45 – 0.825 inches per year	108 inches	1.35 inches per year

Sources: Resilient Oakland, 2017; ART, 2017

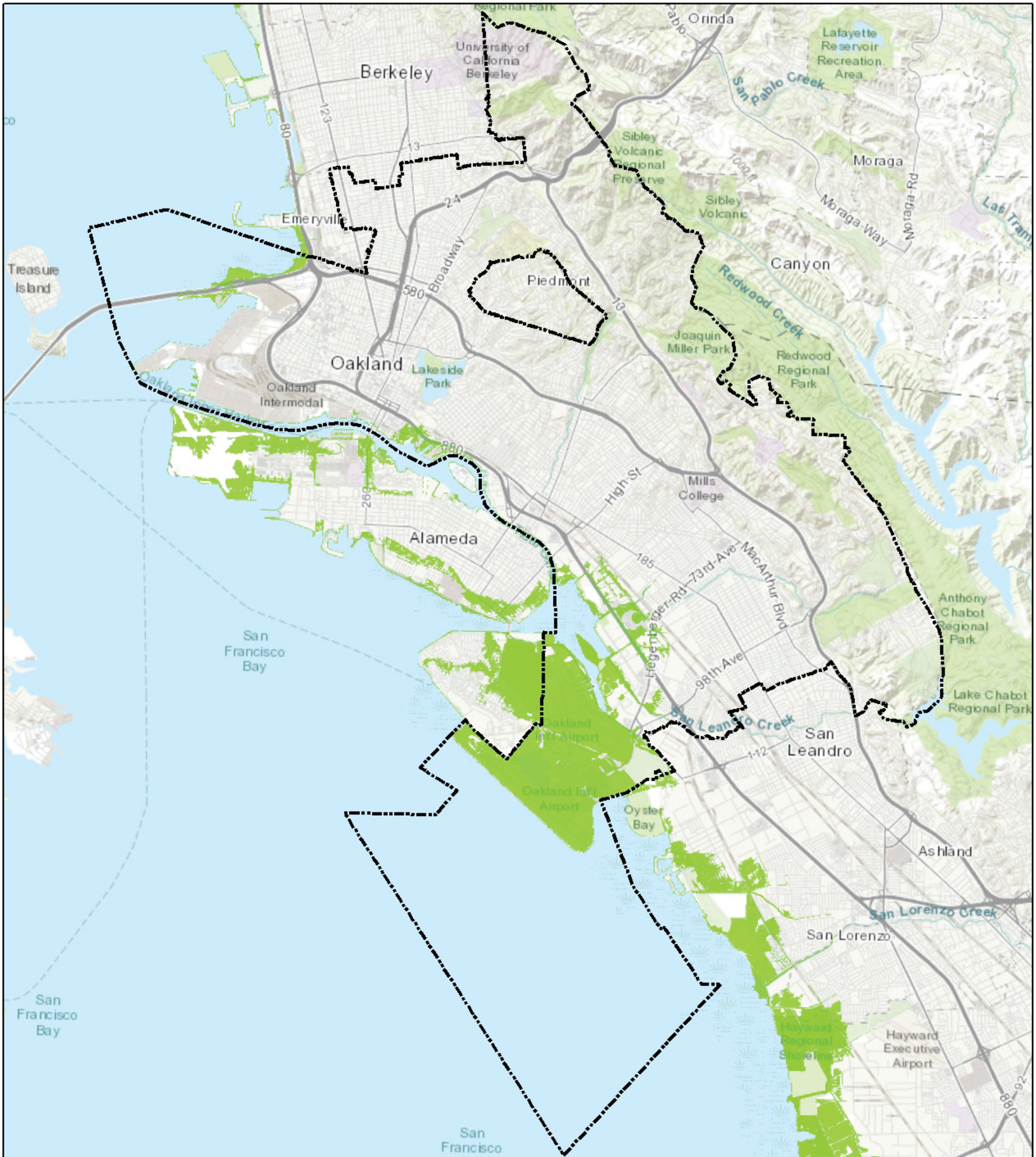


Figure 12-1. 48" Sea-Level Rise Projections

Inundation Area (in Alameda County)

City Limits

N

0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland, BCDC

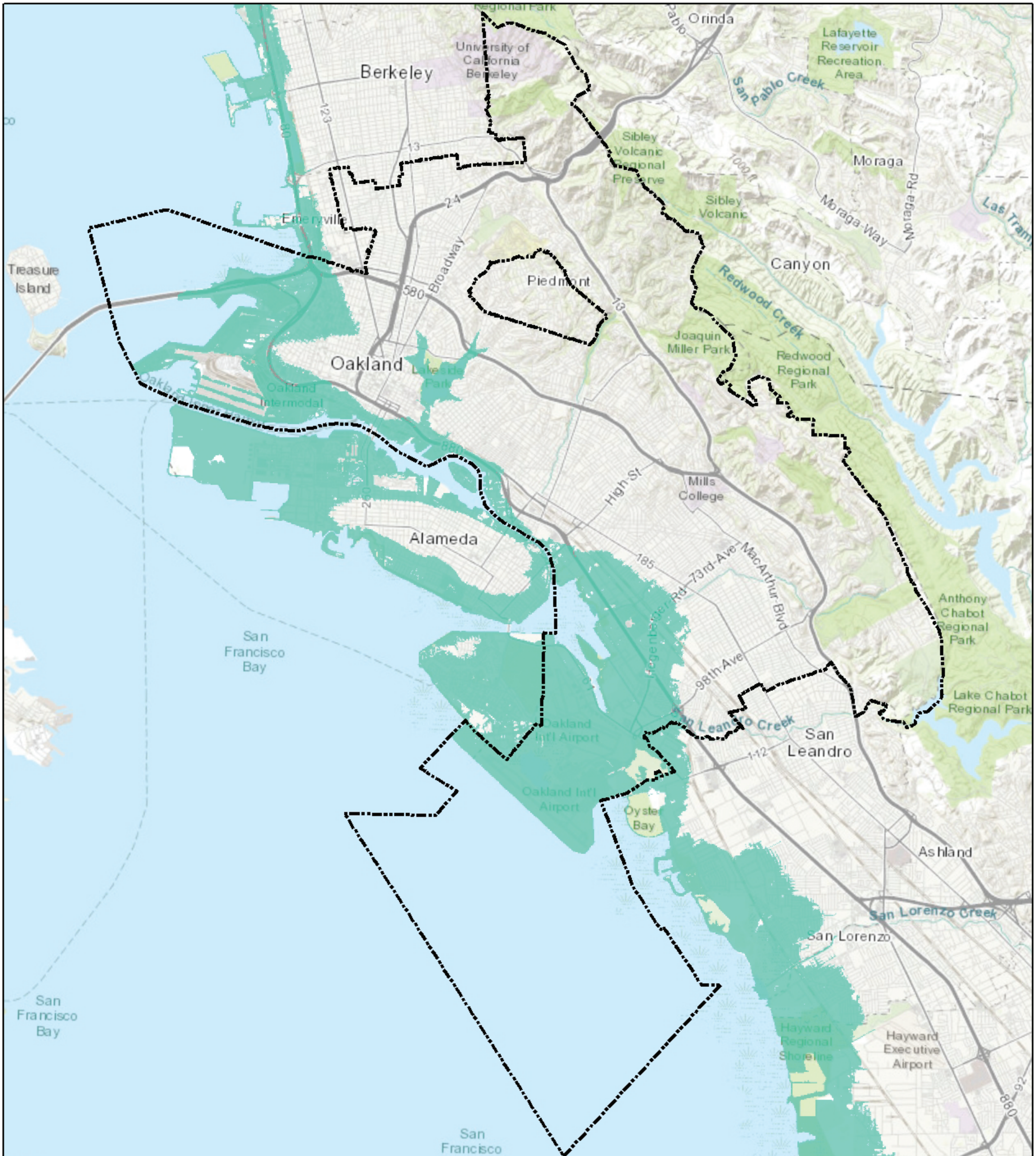


Figure 12-2. 108" Sea-Level Rise Projections

Inundation Area (in Alameda County)

City Limits

N

0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland, BCDC

12.2.5 Severity

The severity of sea-level rise to the City of Oakland is projected to evolve from chronic to more severe over the next 30 to 80 years. The specific level of severity could be exacerbated by the following conditions:

- **Daily tidal inundation**—As sea-level rises, the amount of land and infrastructure subjected to daily inundation by high tides – also known as increases in mean higher high water – will increase. This would result in increased permanent future inundation of low-lying areas.
- **Annual high tide inundation (King Tides)**—King Tides are abnormally high, predictable astronomical tides that occur approximately twice per year. King Tides are the highest tides that occur each year during the winter and summer when the Earth, moon and sun are aligned. In the winter (December, January, and February), King Tides may be amplified by winter weather, making these events more dramatic. King Tides result in temporary inundation, particularly associated with nuisance flooding, such as inundation of low-lying roads, boardwalks, and waterfront promenades.
- **Extreme high tide inundation (storm surge)**—When Pacific Ocean storms coincide with high tides, storm surge due to meteorological effects can elevate Pacific Ocean and San Francisco Bay water levels and produce extreme high tides, resulting in temporary inundation. Such storm surge events occurred on January 27, 1983, December 3, 1983, February 6, 1998, January 8, 2005, and December 31, 2006. Extreme high tides can cause severe inundation of low-lying roads, boardwalks, and promenades; can exacerbate coastal and riverine flooding and cause upstream flooding; and can interfere with stormwater outfalls.
- **El Niño winter storms—**During El Niño winters, atmospheric and oceanographic conditions in the Pacific Ocean produce severe winter storms that impact the San Francisco shorelines. Pacific Ocean storms follow a more southerly route and bring intense rainfall and storm conditions to the Bay Area. Tides are often elevated 0.5 to 1.0 feet above normal along the coast, and wind setup can elevate water levels even further. El Niño winter conditions prevailed in 1977–1978, 1982– 1983, 1997–1998, 2009–2010, and 2015–2016. Typical impacts include severe inundation of low-lying roads, boardwalks, and waterfront promenades; storm drain backup; wave damage to coastal structures; and erosion of natural shorelines.
- **Ocean swell and wind-wave events (storm waves)—**Pacific Ocean storms and strong thermal gradients can produce strong winds that blow across the ocean and the Bay. When the wind blows over long reaches of open water, large waves can be generated that impact the shoreline and cause damage. Typical impacts include wave damage along the shoreline, particularly to coastal structures such as levees, docks and piers, wharves, and revetments; backshore inundation due to wave overtopping of structures; and erosion of natural shorelines.

12.2.6 Warning Time

Sea-level rise is not a hazard that requires near-term advance wanting to support response and recovery operations. Programs such as the ART program and NOAA’s sea-level rise programs are keeping an active watch on the sea-level rise phenomena to keep communities like Oakland informed of the progression. This stream of information will feed City programs such as the Sea-Level Rise Roadmap to help the City to be prepared for and mitigate the long-term impacts from sea-level rise.

12.3 EXPOSURE

Exposure to the sea-level-rise hazard was assessed through a spatial analysis. Mapped inundation areas as shown on Figure 12-1 and Figure 12-2 were overlaid with planning area general building stock, Census data at the block level, and critical facility locations.

12.3.1 Population

Total Exposed Population

Table 12-2 summarizes the total population living in the mapped sea-level-rise inundations areas. These estimates were developed by multiplying the total planning area population by the percentage of total residential buildings that are within the mapped inundations areas. See Appendix E for a breakdown by sub-area.

Table 12-2. Total Exposed Population in Mapped Sea-Level-Rise Inundation Zones

	ART 48" (2050) Scenario	ART 108" (2100) Scenario
Population Exposed	429	10,778
% of Total Planning Area Population	*Less than 1%*	*2.58%*

Socially Vulnerable Populations

The socially vulnerable populations exposed to the sea-level-rise hazard were estimated based on data for the Census-defined blocks that lie at least partially within the mapped inundation zones. Because many of those Census blocks extend outside the hazard zone, the estimates are greater than the actual exposed populations, but they provide reasonable relative data for use in mitigation planning. Table 12-3 summarizes the estimated socially vulnerable populations.

Table 12-3. Relative Exposure of Socially Vulnerable Populations in Mapped Sea-Level-Rise Inundation Zones

	ART 48" (2050) Scenario		ART 108" (2100) Scenario	
	Number[a]	% of Total in Hazard Area	Number[a]	% of Total in Hazard Area
Exposed Population by Age				
Over 65 Years	268	7.0%	3,367	11.0%
Under 16	1,088	28.3%	6,221	20.4%
Exposed Population by Race[b]				
White	612	15.9%	6,885	22.6%
Black or African American	1,673	43.5%	9,477	31.1%
American Indian and Alaska Native	13	0.3%	110	0.4%
Asian	326	8.5%	4,199	13.8%
Native Hawaiian and Other Pacific Islander	25	0.6%	106	0.3%
Some other race	3	0.1%	88	0.3%
Exposed Population by Ethnicity				
Hispanic or Latino (of any race)	1,069	27.8%	8,469	27.8%
Exposed Number of Households by Income				
Households with Income Below $50,000	788	55.6%	7,356	56.2%

	ART 48" (2050) Scenario		ART 108" (2100) Scenario	
	Number[a]	% of Total in Hazard Area	Number[a]	% of Total in Hazard Area
Totals Used for Calculating Percentages[a]				
Population	3,848		30,471	
Households	1,417		13,096	

a. Note that the methodology used for this analysis overestimates exposed population and households. Results presented in this table should be used to evaluate relative exposure between groups rather than absolute numbers of exposed persons or households.
b. Race data shown are as-is output from Hazus, suitable for comparing exposure between groups listed. Data are for persons identifying as one race only, and do not add up to the total exposed population.

12.3.2 Property

Buildings

Table 12-4 summarizes the Hazus-estimated number and value of properties within the mapped sea-level-rise inundation zones. See Appendix E for a breakdown by sub-area.

Table 12-4. Exposed Property in Mapped Sea-Level-Rise Inundation Zones

	ART 48" (2050) Scenario	ART 108" (2100) Scenario
Number of Buildings Exposed	157	3,199
Value of Exposed Structures	$810,897,619	$8,867,152,465
Value of Exposed Contents	$811,163,426	$8,772,430,300
Total Exposed Property Value	**$1,622,061,045**	**$17,639,582,766**
Total Exposed Value as % of Planning Area Total	1.38	15

Land Use

Table 12-5 shows the occupancy class of all buildings in the sea-level rise inundation areas. See Appendix E for a breakdown by sub-area.

Table 12-5. Building Occupancy Classes in Mapped Sea-level rise Inundation Zones

	ART 48" (2050) Scenario		ART 108" (2100) Scenario	
Building Occupancy Class	**Building Count**	**% of Total Exposed**	**Building Count**	**% of Total Exposed**
Residential	84	53.50	1,905	59.55
Commercial	43	27.39	761	23.79
Industrial	12	7.64	379	11.85
Agriculture	0	0	0	0
Religion	1	0.64	23	0.72
Government	17	10.83	123	3.84
Education	0	0	8	0.25
Total	**157**	**100**	**3,199**	**100**

12.3.3 Critical Facilities

The breakdown of exposure by sea-level rise inundation zone and facility type is shown in Figure 12-3. Exposed infrastructure includes transportation, water, sewer, and power infrastructure. Highly susceptible areas include coastal roads and transportation infrastructure.

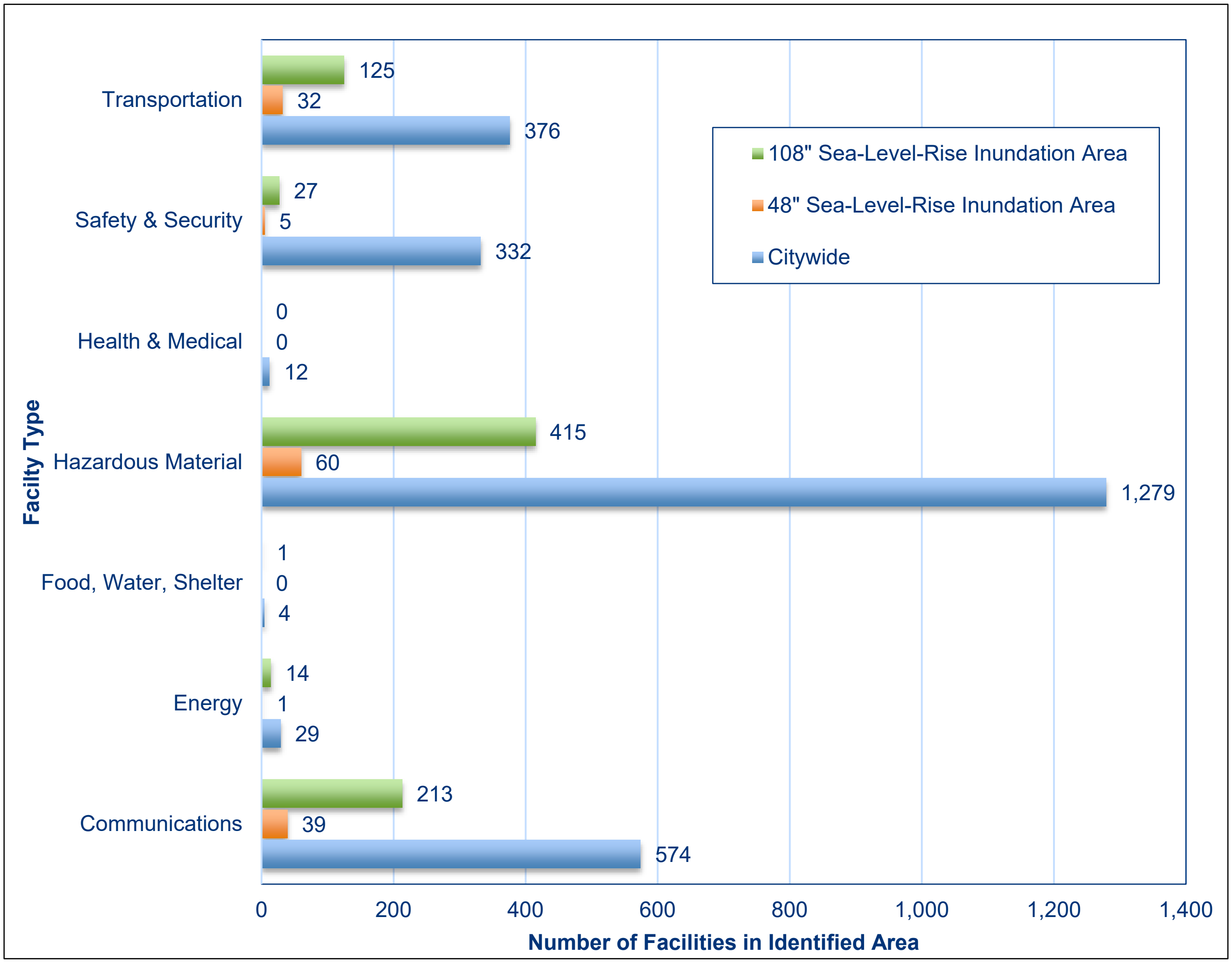


Figure 12-3. Critical Facilities in Mapped Sea-Level-Rise Inundation Areas and Citywide

12.3.4 Environment

All natural areas within the projected sea-level rise inundation areas are exposed and vulnerable to impacts. Important coastal habitat may be lost as sea-level rise permanently inundates areas, or it may be damaged due to extreme tide and storm surge events. Saltwater intrusion into freshwater resources may occur, further altering habitat and ecosystems. Protective ecosystem services may be lost as land area and wetlands are permanently inundated.

12.4 VULNERABILITY

Vulnerability estimates for the tsunami hazard are described qualitatively. No loss estimation of these facilities was performed because damage functions have not been established for the sea-level rise hazard.

12.4.1 Population

Due to the nature of census block group data, it is difficult to determine demographics of populations vulnerable to mass movements. In general, all of the estimated 10,778 persons exposed to sea-level rise areas are considered to be vulnerable. The degree of that vulnerability cannot be quantified at this time due to no established modeling programs for sea-level rise vulnerability.

12.4.2 Property

Loss estimations for the sea-level rise hazard are not based on modeling utilizing damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 12-6 shows potential losses in the mapped sea-level rise inundation zones.

Table 12-6. Loss Estimation for Sea-Level Rise

	Exposed Value	Loss Value	Loss as % of Total Planning Area Replacement Value
ART 48" (2050) Scenario			
Loss = 1% of Exposed Value	$1.62 billion	$16,220,610	0.01%
Loss = 10% of Exposed Value		$162,206,105	0.14%
Loss = 30% of Exposed Value		$486,618,314	0.41%
Loss = 50% of Exposed Value		$811,030,523	0.69%
ART 108" (2100) Scenario			
Loss = 1% of Exposed Value	$17.64 billion	$176,395,828	0.15%
Loss = 10% of Exposed Value		$1,763,958,277	1.50%
Loss = 30% of Exposed Value		$5,291,874,830	4.50%
Loss = 50% of Exposed Value		$8,819,791,383	7.50%

12.4.3 Critical Facilities

There are 137 critical facilities exposed to some degree to the projected 48" sea-level rise and 795 exposed to the 108" sea-level rise. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from inundation should be done to determine if they could withstand impacts of a mass movement. At this time all infrastructure and transportation corridors identified as exposed to the sea-level rise hazard are considered vulnerable until more information becomes available.

12.4.4 Environment

When sea levels rise as rapidly as they have been, even a small increase can have devastating effects on coastal habitats farther inland, it can cause destructive erosion, wetland flooding, aquifer and agricultural soil contamination with salt, and lost habitat for fish, birds, and plants.

12.5 FUTURE TRENDS IN DEVELOPMENT

As the City of Oakland is predominantly built out, any future development in areas projected to be impacted by sea-level rise within the City will be primarily redevelopment. While the Safety Element of the City's General Plan does not address sea-level rise risk as a stand-alone hazard, sea-level rise is addressed as a "flood" hazard. Because of this and the fact that there is significant overlap between the sea-level rise inundation area and the City's regulated floodplain, the City's development standards for floodplain development would provide some level of protection against the probable impacts from sea-level rise. The City should consider looking at higher regulatory standards for redevelopment in areas projected to be impacted by sea-level rise that mitigate those projected impacts. The City currently has the regulatory capabilities to ask about those impacts but lacks the capability to regulate impacts on that development from sea-level rise.

12.6 SCENARIO

Sea levels within the San Francisco Bay will rise over the next 80 years, and the City of Oakland will be adversely impacted by that rise. The impacts are already happening and will progress over time. The City is already preparing for these impacts using programs such as the ART program and the Sea-Level Rise Road Map. Mitigating the impacts from sea-level rise will take resources and some tough land use decisions over the next 80 years.

12.7 ISSUES

The planning team has identified the following sea-level-rise-related issues:

- The City should consider the adoption of higher regulatory standards to mitigate impacts of sea-level rise on redevelopment.
- The data and science that measure sea-level rise impacts progress rapidly. The City should commit to staying in line with the best available data and science on sea-level rise as it evolves.
- The costs to mitigate impacts from sea-level rise will be extensive and likely beyond the City's means.
- There needs to be a determination of where people can go when the only option to mitigate the impacts from sea-level rise is to retreat.
- The City will need to find ways to equitably mitigate impacts from sea-level rise.
- Sea-level rise impacts on the operations of the Port need to be assessed.
- As with all hazards assessed by this plan, risk communication will be crucial to the successful mitigation of this hazard.

13. SEVERE WEATHER

13.1 GENERAL BACKGROUND

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. The most significant severe weather events to impact the planning area are high winds and extreme heat. For this risk assessment, the term "severe weather" refers to these event types in aggregate. They are assessed as a single hazard for the following reasons:

- Records indicate that each of these weather event types has impacted the planning area to some degree, and all have similar frequencies of occurrence.
- None of these weather event types have a clearly defined extent or location. Therefore, no quantitative, geospatial analysis is available to support exposure or vulnerability analysis; the analyses for this hazard are qualitative.

13.1.1 High Wind

Damaging winds are classified as those exceeding 60 mph. Damage from such winds accounts for half of all severe weather reports in the lower 48 states and is more common than damage from tornadoes. Wind speeds can reach up to 100 mph and can produce a damage path extending for hundreds of miles. There are seven types of damaging winds:

- Straight-line winds—Any thunderstorm wind that is not associated with rotation; this term is used mainly to differentiate from tornado winds. Most thunderstorms produce some straight-line winds as a result of outflow generated by the thunderstorm downdraft.
- Downdrafts—A small-scale column of air that rapidly sinks toward the ground.
- Downbursts—A strong downdraft with horizontal dimensions larger than 2.5 miles resulting in an outward burst or damaging winds on or near the ground. Downburst winds may begin as a microburst and spread out over a wider area, sometimes producing damage similar to a strong tornado. Although usually associated with thunderstorms, downbursts can occur with showers too weak to produce thunder.
- Microbursts—A small concentrated downburst that produces an outward burst of damaging winds at the surface. Microbursts are generally less than 2.5 miles across and short-lived, lasting only 5 to 10 minutes, with maximum wind speeds up to 168 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.
- Gust front—A gust front is the leading edge of rain-cooled air that clashes with warmer thunderstorm inflow. Gust fronts are characterized by a wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Sometimes the winds push up air above them, forming a shelf cloud or detached roll cloud.

- Derecho—A derecho is a widespread thunderstorm wind caused when new thunderstorms form along the leading edge of an outflow boundary (the boundary formed by horizontal spreading of thunderstorm-cooled air). The word “derecho” is of Spanish origin and means “straight ahead.” Thunderstorms feed on the boundary and continue to reproduce. Derechos typically occur in summer when complexes of thunderstorms form over plains, producing heavy rain and severe wind. The damaging winds can last a long time and cover a large area.
- Bow Echo—A bow echo is a linear wind front bent outward in a bow shape. Damaging straight-line winds often occur near the center of a bow echo. Bow echoes can be 200 miles long, last for several hours, and produce extensive wind damage at the ground.

Windstorms are generally short-duration events involving straight-line winds or gusts of over 50 mph, strong enough to cause property damage. Windstorms are especially dangerous in areas with significant tree stands and areas with exposed property, poorly constructed buildings, mobile homes (manufactured housing units), major infrastructure, and above-ground utility lines. A windstorm can topple trees and power lines, cause damage to residential, commercial, and critical facilities, and leave tons of debris in its wake.

13.1.2 Extreme Heat

Extreme heat is defined as temperatures that hover 10 ºF or more above the average high temperatures for a region for several days or weeks. Extreme heat events can lead to an increase in heat-related illnesses and deaths, cause drought, and impact water supplies. Such events do not typically impact buildings; however, losses may be associated with the urban heat island effect and overheating of heating, ventilation, and air conditioning systems..

Extreme heat is the primary weather-related cause of death in the United States. In a 10-year record of weather fatalities across the nation (2006 – 2015), excessive heat claimed more lives each year than floods, lightning, tornadoes, and hurricanes. According to the *California Climate Adaptation Strategy*, heat waves have claimed more lives in California than all other declared disaster events combined. Despite this history, not a single heat emergency was proclaimed in California at the state or federal level between 1960 and 2016. Heat waves do not strike victims immediately, but their cumulative effects slowly cause harm to vulnerable populations. Older adults, children, and sick or overweight individuals are at greater risk from extreme heat.

13.1.3 Secondary Hazards

A secondary impact of extreme heat is poor air quality, which can occur during summer, when stagnant atmospheric conditions trap humid air and pollutants near the ground and closer to residents. Ozone, a major component of smog, is created in the presence of sunlight via reactions between chemicals in gasoline vapors and industrial smokestacks. Hot weather can increase ozone levels. High ozone levels often cause or worsen respiratory problems.

Public Safety Power Shutoff events (PSPSs) also are secondary hazards associated with severe weather. Under certain severe weather conditions, utility service providers shut off power to help prevent wildfire and keep communities safe. A combination of dry vegetation and high winds can uproot trees, blow branches onto power lines or create sparks if power lines contact one another. These conditions call for a PSPS. These outages occur across the state to prevent wildfires and keep communities safe. Table 13-1 shows the weather conditions that are monitored by utility service providers that trigger PSPS events. PSPS events can impact areas beyond where severe weather conditions are being observed due to the grid nature of electrical power distribution systems. Sustained periods of downtime could lead to significant economic impacts.

Table 13-1. Triggers for Public Safety Power Shutoff Events

Monitor Factor	Metrics
Red Flag Warning	A warning declared by the National Weather Service that weather conditions could lead to fire and rapid spread.
Low Humidity	20% or lower humidity. Low humidity creates dry vegetation, which fuel fire.
High Winds	Sustained wind speeds above 25 MPH and wind gusts above 45 MPH can cause fire to spread.
Utility Observations	On-the-ground findings from Utility crews.

13.2 HAZARD PROFILE

13.2.1 Past Events

Table 13-2 summarizes some past severe heat and wind events in the planning area.

Table 13-2. Sample of Past Extreme Heat Events in the Planning Area -1970 to 2020

Dates	Event Type	Losses/Impacts
09/07/2020	Excessive Heat	Numerous high temperature records were broken. Temperatures breached 110 degrees across the interior with 90s along the coast. Offshore winds increased flaring up some of the wildfires that had been ignited during August's lightning storm. These winds also enabled smoke from various wildfires across the state to blanket much of the Bay Area.
08/14/2020	Excessive Heat	A prolonged heat wave swept the Central Coast and Bay Area for almost a week with widespread record-breaking temperatures. Multiple days of triple digit afternoon highs were recorded inland with some coastal locations reaching the mid-90s.
06/10/2019	Excessive Heat	Multiple daily records were broken and multiple power outages were reported due to the heat. More than 50,000 people across the region lost power. One man died as a direct result of heat related illness and two others drowned while attempting to cool down. Hot temperatures and dry grass resulted in a vegetation fire that spread to a residence.
10/24/2016	High Winds	Moderately strong winds occurred across the region and caused an 80-foot tree to topple over in a neighboring county.
10/27/2013	High Winds	Strong and gusty northwest winds up to 45 mph impacted the Bay Area resulting in downed trees, downed power lines, toppled scaffolding, and blown over tractor trailers.
5/1/2013	High Winds	Strong northeast winds which gusted up to 62 mph led to critical fire weather conditions.
4/8/2013	High Winds	Strong and gusty northwest winds impacted the Bay Area, resulting in downed trees, downed power lines, and broken windows. The wind gusts were in excess of 35 mph with a few locations over 60 mph.
2/15/2011	High Winds	High winds hit the Bay Area with winds gusting to 60 mph and caused an estimated $150,000 in damage.
1/19/2010	High Winds	High winds hit the Bay Area with winds gusting to 62 mph that caused power outages.
2/17/2004	High Winds	Strong winter storm produced a 74 mph wind gust on Kregor Peak in the East Bay Hills.
12/14/2003	High Winds	High winds hit the Bay Area with winds gusting to 62 mph at Las Trampas in the East Bay Hills, causing thousands of power outages.

Dates	Event Type	Losses/Impacts
11/7/2002	High Winds	For a three-day period starting on November 7, rainfall totaling 2 to 5 inches fell across the North Bay counties. Many trees and branches were down, blocking roads and interrupting power. Winds also blew down power poles and lines. As many as 1 million homes were without power at one time. A number of trees fell on homes and automobiles. Total damage to the area was estimated at $2.5 million.
1/25/2001	High Winds	A severe thunderstorm watch was issued for only the second time in 25 years for the San Francisco Bay Area. No severe thunderstorms were reported, but rotation was noted near Richmond. There was damage from mainly strong gradient winds and lightning strikes. A number of trees were downed causing power outages to the Bay Area.
12/18/2000	High Winds	A gust of 71 mph was reported at the Oakland north Remote Automated Weather Station in Contra Costa County. Power to over 2500 customers was lost due to trees blowing into power lines. Three cars were crushed by two trees falling into the road in the Broadway terrace neighborhood. Trees blown down across Highway 13 and the entry ramp to I-580 snarled traffic.
6/14/2000	Excessive Heat	This unusual early summer record breaking heat wave was responsible for 10 deaths in the Bay Area and a large number of heat-related injuries. Temperature of 103 degrees in San Francisco tied the record high temperature. High temperature caused overloading of power resources and rolling blackouts were implemented to keep the power system from exceeding capacity, so many people lost power for a period during the heat.

13.2.2 Location

High wind and extreme heat have the potential to happen anywhere in the planning area. No location-specific mapping is available. Extreme heat events may be exacerbated in the City where reduced air flow, reduced vegetation, and increased generation of waste heat can contribute to temperatures that are several degrees higher than in surrounding less urbanized areas.

13.2.3 Frequency

NOAA's National Centers for Environmental Information (NCEI) Storm Events Database lists 41 days with reported high wind or thunderstorm wind events over the 21-year period from 2000 through 2020 (NCEI, 2021e)—an average of about two events per year.

In that same 21-year period, the database lists only three days with excessive heat in Alameda County (NCEI, 2021f). However, all three of those days were in the last two years (2019 and 2020), and the expected temperature impacts of climate changes are likely to increase the frequency of such events in the future. The City of Oakland is experiencing more heat waves and more extreme heat days. Heat waves have increased by more than three per century and extreme heat days have increased by 23 per century. The average annual maximum temperature in Oakland has warmed by 5.0 °F, and the average annual minimum temperature has warmed by 4.2 °F. The greatest rate of change was during the summer for both maximum and minimum temperature, with late fall and early winter having the least rates of change. There was also an increase in heat wave duration.

13.2.4 Severity

High Wind

The high wind and thunderstorm wind events listed in the NCEI Storm Events Database for 2000 through 2021 includes a high-wind event on January 7, 2017 that resulted in one death and another on January 20, 2010 that resulted in one injury. The highest wind recorded among these events was a wind of 96 knots (110 mpg) on January 4, 2008.

Extreme Heat

In extreme heat, evaporation is slowed and the body must work extra hard to maintain a normal temperature, which can lead to death by overworking the human body. Extreme heat can cause heat exhaustion, in which the body becomes dehydrated, resulting in an imbalance of electrolytes. Without intervention, heat exhaustion can lead to collapse and heatstroke, which occurs when perspiration cannot occur and the body overheats. Without intervention, heatstroke can lead to confusion, coma, and death.

Because of its expansive urban size, the City of Oakland can experience urban heat island effects, in which materials such as asphalt, concrete and other materials absorb the heat. Radiation from the sun is absorbed by these surfaces during the day and re-radiated at night, raising ambient temperatures. Urban heat islands have high nighttime minimum temperatures compared to neighboring areas. Waste heat from air conditioners, vehicles, and other equipment contributes to the urban heat island effect. When temperatures rise above 80 ºF, it could be 5 ºF hotter in the city's industrial flatlands than in the Oakland Hills due to the urban heat island effect.

13.2.5 Warning Time

High Wind

Severe wind watches, warnings or advisories are broadcast by NOAA Weather Radio and other weather stations to warn residents of upcoming storms so they may prepare and plan accordingly (NSSL, 2021).

Extreme Heat

To better address heat risk and allow people to prepare for upcoming heat events, the NWS has developed the Heat Risk forecast (see Figure 13-1), which provides a quick view of heat risk potential over the upcoming seven days. The heat risk is portrayed in a numeric (0-4) and color (green/yellow/orange/red/magenta) scale, which is similar in approach to the Air Quality Index or the UV Index. It provides one value each day that indicates the approximate level of heat risk concern for any location, along with identifying the groups who are most at risk.

Category	Level	Meaning
Green	0	No Elevated Risk
Yellow	1	Low Risk for those extremely sensitive to heat, especially those without effective cooling and/or adequate hydration
Orange	2	Moderate Risk for those who are sensitive to heat, especially those without effective cooling and/or adequate hydration
Red	3	High Risk for much of the population, especially those who are heat sensitive and those without effective cooling and/or adequate hydration
Magenta	4	Very High Risk for entire population due to long duration heat, with little to no relief overnight

Figure 13-1. NWS Heat Risk Forecasting System

The NWS continues to issue excessive heat watches, excessive heat warnings and heat advisories to warn of an extreme heat event (a "heat wave") within the next 36 hours. If NWS forecasters predict an excessive heat event beyond 36 hours, then the NWS will issue messaging in the form of a special weather statement, emails and social media in the three- to seven-day timeframe. The NWS uses the Heat Risk Forecasting System to determine if an excessive heat watch/warning or heat advisory is warranted. The NWS issues the following types of heat-related advisories:

- **Heat Advisory**—Tied to events where Heat Risk output is on the orange/red (Level 2-3) thresholds (orange will not be an automatic heat advisory).
- **Excessive Heat Watch/Warning**— Tied to events where Heat Risk output is on the red/magenta (Level 3-4) thresholds.

The NWS will issue an excessive heat watch generally two to three days in advance. An excessive heat watch is a way to give the public and emergency officials a warning that extreme temperatures are expected. If significantly hot temperatures remain in the forecast for 24 to 28 hours, the excessive heat watch will be upgraded to an excessive heat warning, indicating that extreme heat has either arrived or is expected soon.

In Alameda County, although the summers are hot, the combination of high temperature and high humidity that is the requirement for the National Weather Service to declare a heat emergency is relatively rare.

13.3 EXPOSURE

All people and property and the entire environment of the planning area is exposed to some degree to the severe weather hazard.

13.4 VULNERABILITY

13.4.1 Population

Vulnerable populations are the elderly, low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. Power outages can be life threatening to those dependent on electricity for life support. Isolation of these populations is a significant concern. These populations face isolation and exposure during severe weather events and could suffer more secondary effects of the hazard. Population vulnerabilities to specific types of severe weather event are as follows:

- **Extreme Heat**—Individuals with physical or mobility constraints, cognitive impairments, economic constraints, or social isolation are typically at greater risk from the adverse effects of excessive heat events. The average summertime mortality for excessive heat events is dependent upon the methodology used to derive such estimates. Certain medical conditions, such as heat stroke, can be directly attributable to excessive heat, while others may be exacerbated by excessive heat, resulting in medical emergencies. Individuals who lack shelter and heating are particularly vulnerable to extreme cold and wind chill.
- **Damaging Winds**—Debris carried by extreme winds and trees felled by gusty conditions can contribute directly to loss of life and indirectly to the failure of protective building envelopes. Utility lines brought down by thunderstorms have also been known to cause fires, which start in dry roadside vegetation. Electric power lines falling down to the pavement create the possibility of lethal electric shock.

13.4.2 Property

All property is vulnerable to extreme weather, but structures in poor condition or in vulnerable locations may risk the most damage. Homes near mature trees or overhead power lines may be more susceptible to wind damage and blackouts. The frequency and degree of damage will depend on specific locations. Typically, the only impact extreme heat has on general building stock is increased demand on air conditioning equipment, which may cause strain on electrical systems.

Loss estimations for the severe weather hazard are not based on damage functions, because no such damage functions have been generated. Instead, loss estimates were developed representing 10 percent, 30 percent, and 50 percent of the replacement value of exposed structures. This allows emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure. Table 13-3 lists these loss potential estimates for severe weather in the planning area.

Table 13-3. Loss Potential for Severe Weather in the Planning Area

Total Building Value (Structure and Contents)	$115 billion
10% of Total Building Value	$11.5 billion
30% of Total Building Value	$34.5 billion
50% of Total Building Value	$57.5 billion

13.4.3 Critical Facilities

All critical facilities are vulnerable during severe weather events, especially those that lack backup power generation capabilities. When facilities supplying power to planning area land line telephone systems are frequently disrupted, significant issues arise with communication in the planning area. In addition, some facilities are particularly vulnerable to specific types of severe weather events:

- **Extreme heat**—Heat poses a risk to ground transportation infrastructure. For instance, high temperatures can cause railroad tracks and wires, and pavement and joints on roads and bridges to crack, buckle, or sag, resulting in service disruptions, potentially hazardous travel conditions, and the need for costly repairs. Power outages or roaming blackouts may occur as a result of extreme heat events that strain and overheat circuits. During a blackout, all critical facilities that are reliant upon electricity for power will be severely impacted unless they are connected to a backup power source. Additional facilities on higher ground may also be exposed to wind damage or damage from falling trees.
- **High Winds**—Critical facilities in the direct path of high winds would be particularly vulnerable. Facilities located near trees or power lines that are likely to fall are also vulnerable. High winds can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, and disrupting ingress and egress.

13.4.4 Environment

The environment is highly vulnerable to severe weather events. Prolonged extreme heat can degrade landscape quality, lakes, and vegetation. High winds can cause trees to topple.

13.5 FUTURE TRENDS IN DEVELOPMENT

All future development will be affected by severe weather. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The City of Oakland has adopted the International Building Code in response to California mandates. This code is equipped to deal with the impacts of extreme weather events. Land use policies identified in the City's General Plan also address secondary impacts of the severe weather hazard. With these tools, the City is well equipped to deal with future growth and the associated impacts of extreme weather.

To further address severe weather hazards, the City of Oakland applies a Standard Conditions of Approval to all construction projects related to the undergrounding of utilities. Details are provided in Appendix D.

13.6 SCENARIO

Heat waves are expected to increase in frequency in California, including the Bay Area. Increased temperatures will affect human health, public health systems, and the energy grid. The number of extreme heat days in San Francisco (days that exceed the 90th percentile of average temperature) may increase from the 20th century average of 12 per year to 20 per year by 2035, 46 by 2050, and 94 by 2100. This will increase the likelihood of heat-related illness and death, especially among the poor, the elderly and the very young.

13.7 ISSUES

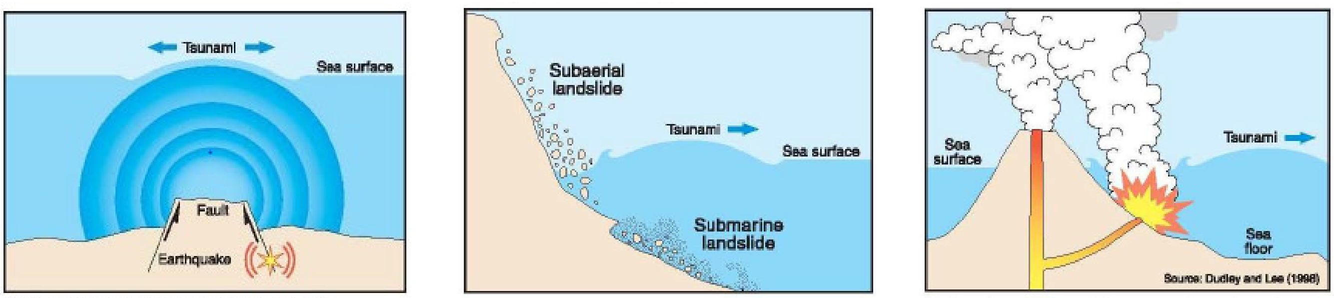
Important issues associated with severe weather in the planning area include the following:

- Dead or dying trees as a result of drought conditions are more susceptible to falling during high wind events.
- Extreme heat events are likely to increase because of climate change impacts.
- Older building stock in the planning area is built to low code standards or none at all. These structures could be highly vulnerable to high wind events.
- Redundancy of power supply and communications equipment must be evaluated.
- The City may need to open cooling stations during extreme temperature events.

14. TSUNAMI/SEICHE

14.1 GENERAL BACKGROUND

A tsunami is a series of high-energy waves that radiate outward like pond ripples from an area where a generating event occurs, arriving at shorelines over an extended period. Tsunamis can be induced by earthquakes, landslides and submarine volcanic explosions (see Figure 14-1).



Faulting of the ocean floor may produce a tsunami.

Subaerial or submarine landslides may produce a tsunami.

A submarine volcanic explosion may produce a tsunami.

Figure 14-1. Common Sources of Tsunamis

Tsunamis are typically classified as local or distant, depending on the location of their source in comparison to where waves occur:

- The waves nearest to the generating source represent a local tsunami. Such events have minimal warning time, leaving few options except to run to high ground after a strong, prolonged local earthquake. Damage from the tsunami adds to damage from the triggering earthquake due to ground shaking, surface faulting, liquefaction, and landslides.
- The waves far from the generating source represent a distant tsunami. Distant tsunamis may travel for hours before striking a coastline, giving a community a chance to implement evacuation plans if a warning is received.

In the open ocean, a tsunami may be only a few inches or feet high, but it can travel with speeds approaching 600 miles per hour. As a tsunami enters the shoaling waters near a coastline, its speed diminishes, its wavelength decreases, and its height increases greatly. At the shoreline, tsunamis may take the form of a fast-rising tide, a cresting wave, or a bore (a large, turbulent wall-like wave). The bore phenomenon resembles a step-like change in the water level that advances rapidly (from 10 to 60 miles per hour). The first wave is usually followed by several larger and more destructive waves.

The configuration of the coastline, the shape of the ocean floor, and the characteristics of advancing waves play important roles in the destructiveness of the waves. Bays, sounds, inlets, rivers, streams, offshore canyons, islands, and flood control channels may cause various effects that alter the level of damage. Offshore canyons can focus tsunami wave energy, and islands can filter the energy. It has been estimated that a tsunami wave entering a flood control channel could reach a mile or more inland, especially if it enters at high tide. The orientation of the coastline determines whether the waves strike head-on or are refracted from other parts of the coastline. A wave may be small at one point on a coast and much larger at other points. The inundation area for a tsunami event is often described as runup as illustrated in Figure 14-2.

Source: UNESCO, 2006

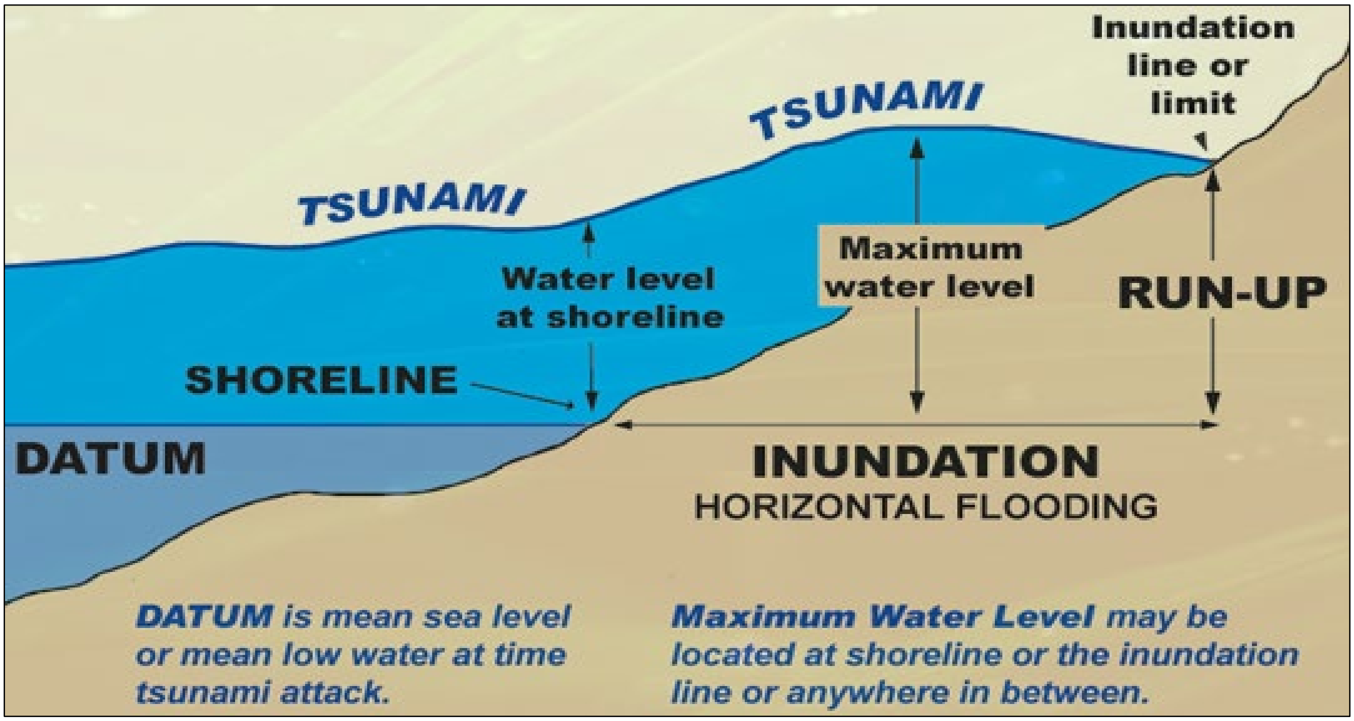


Figure 14-2. Runup Distance and Height in Relation to the Datum and Shoreline

14.1.1 Seiche

A seiche is a resonant, side-to-side movement of water in a closed or mostly closed body of water such as the San Francisco Bay. It can be caused by a number of factors, but all feature resonance where the acting force is more or less in time with the natural sloshing frequency of the body of water. The USGS defines a seiche as the sloshing of a closed body of water from earthquake shaking. Unlike tsunamis, which are created by the sudden uplift of the sea floor, seismic seiches are standing waves set up on rivers, reservoirs, ponds, and lakes when seismic waves from an earthquake pass through the area.

14.2 HAZARD PROFILE

The Safety Element of the Oakland General Plan describes the following risks to Oakland from tsunamis (City of Oakland, 2012):

> *Tsunamis are not an uncommon occurrence on the California coast . . . . In the 100 years between 1868 and 1968, 19 tsunamis were recorded at the Golden Gate tide gauge, with a maximum wave height of 7.4*

> *feet. Most often, tsunamis are generated by large offshore earthquakes in the Pacific Ocean, producing waves that reach the California coast many hours after the earthquake. Tsunamis can also be generated by local earthquakes, in which case the first waves could reach shore mere minutes after the ground stops shaking, giving authorities no time to issue a warning. . . . For most tsunamis approaching the coast, several hours are available to evacuate residents and undertake other emergency preparations.*
>
> *The scarcity of data makes it difficult to estimate the tsunami hazard in Oakland. However, past tsunamis have resulted in little damage around San Francisco Bay. The hazard in the bay is much smaller than along the Pacific Coast, as the bay is an enclosed body of water. . . . Also, locally generated tsunamis, for which there would be little warning time, are much less likely than distant-source tsunamis: there are no geologic structures offshore of central California capable of producing tsunamis; also, large tsunamis appear to be the result of vertical displacement of the sea floor, whereas faulting movements in the Bay Area are mainly in a horizontal direction. (Records at the time of the San Francisco earthquake of 1906 showed the height of the wave measured at Fort Point as no more than six inches.)*
>
> *Flooding from tsunamis would affect low-lying areas along San Francisco Bay and the Oakland Estuary, especially filled areas that are only a few feet above sea level . . . . Areas that could be flooded with several feet of water include the Bay Bridge landing, the outer and middle harbor of the Port of Oakland's seaport, the San Leandro Bay shoreline (including Martin Luther King, Jr. Regional Shoreline) and the Oakland International Airport's shoreline. Areas along the inner harbor, Brooklyn Basin and the tidal channel would be sheltered by the island of Alameda. The likelihood of large-scale devastation in Oakland resulting from tsunamis appears to be small, especially as there would usually be ample time to evacuate residents at risk.*

The Safety Element of the City of Oakland General Plan addresses the seiche hazard as follows (City of Oakland, 2012):

> *There is no data on the local occurrence or impact of seiches, as none has ever been recorded in the Bay Area…. Damage from a seiche would depend primarily on the size, depth, elevation, proximity to development and, if human-made, structural condition of the body of water in which the seiche occurs. Outside the Bay Area, earthquake-generated seiches have on occasion damaged dams and water-storage tanks. In addition, isolated damage to adjacent and down-slope structures has been observed from seiches occurring in swimming pools and in small, shallow lakes and ponds.*
>
> *In Oakland, the only threat of large-scale damage from seiches appears to come from downstream flooding that would be caused by large volumes of water overtopping a dam or reservoir…. (Lake Merritt, with depths greater than two or three feet only near its center, is likely too shallow to be able to generate devastating seiches). The likelihood of large-scale devastation in Oakland resulting from seiches appears to be minuscule.*

Based on this assessment, the seiche hazard is considered to be very low risk and is not fully assessed in plan.

14.2.1 Past Events

California is at risk from both local and distant tsunamis. Eighty-two possible or confirmed tsunamis in California have been observed or recorded. Most recently, the March 11, 2011 tsunami caused by an earthquake near Japan resulted in nearly $100 million in damage to the California maritime community. The February 27, 2010 earthquake near Chile also resulted in minor recorded tsunami inundation in California.

According to the 2016 *Alameda County Local Hazard Mitigation Plan*, tsunamis have not been a major problem in Alameda County or most of the Bay Area. From 1812 to 2000, NOAA recorded 22 tsunamis in the Bay Area.

Of these, 15 originated in Alaska and were caused by an earthquake, landslide, or volcano; the remainder had a source location of Northern California, Japan, or Chile. Table 14-1 lists historical tsunami run-ups that have affected Alameda County.

Table 14-1. Historical Tsunamis that have Impacted Alameda County

Date	Description Source/Source Location	Tsunami Location	Remarks
11/13/1851	Earthquake – California: Northern	San Francisco Bay	“unusual movement of water” was felt
10/21/1868	Earthquake – California: Northern	San Francisco Bay	14.76-foot run-up
3/31/1898	Earthquake – Oakland	Oakland, CA	1.0-foot run-up
4/1/1946	Earthquake – Alaska (Unimak Island)	Alameda, CA	0 .66-foot run-up
3/9/1957	Earthquake – Alaska (Andreanof Islands)	Alameda, CA	0.59-foot run-up
5/22/1960	Earthquake – Southern Chile	Alameda, CA	1.0-foot run-up
3/28/1964	Earthquake – Alaska (Prince William Sound)	Alameda, CA – Alviso Sough	0.59–foot run-up
		Alameda, CA – Naval Air Station	2.62-foot run-up
		Oakland, CA	4.0-foot run-up
5/16/1968	Earthquake – Japan (off east coast of Honshu Island)	Alameda, CA	0.33–foot run-up
4/25/1992	Earthquake – Cape Mendocino	Alameda, CA	0.13-foot run-up
10/4/1994	Earthquake – Russia (S. Kuril Islands)	Alameda, CA	0.13-foot run-up
5/3/2006	Earthquake – Tonga	Alameda, CA	0.13-foot run-up
2/27/2010	Earthquake – Central Chile	Alameda, CA	0.39-foot run-up
3/11/2011	Earthquake – Japan (Honshu Island)	Alameda, CA	1.67-foot run-up
		Berkeley Marina, CA	1.67-foot run-up
10/28/2012	Earthquake – British Columbia	Alameda, CA	0.36-foot run-up
9/16/2015	Earthquake – Central Chile	Alameda, CA	0.20-foot run-up

a. Source: National Center for Environmental Information, Global Historical Tsunami Database, 2020

In 1859, a tsunami generated by an earthquake in Northern California generated 15-foot wave heights near Half Moon Bay. The 1868 earthquake on the Hayward Fault is reported to have created a local tsunami in the San Francisco Bay. In 1960, Pacifica experienced high water resulting from a Magnitude-9.5 earthquake off the coast of Chile. The tsunami generated by the 1964 Alaskan earthquake caused wave heights of 10 to 23 feet off the Coast of Northern California, Oregon, and Washington. Eleven people were killed in Crescent City as a result of this tsunami. Along the coast of San Francisco, Marin, and Sonoma Counties, maximum wave heights of about 4 feet were recorded, and no significant damage was experienced.

14.2.2 Location

Most of the Alameda County coastline is in the tsunami inundation area, including the City of Oakland. Figure 14-3 shows the extent and the location of the tsunami inundation areas based on mapping that was prepared by California Department of Conservation in cooperation with the University of Southern California, California Geological Survey, and California Emergency Management Agency. This map does not represent risk from a single event but shows a composite area of risk that combines the inundation areas from a number of local and distant potential sources, including the Cascadia subduction zone, the Central Aleutians Island subduction zone, historical earthquake events, and other sources (California Department of Conservation, 2020).

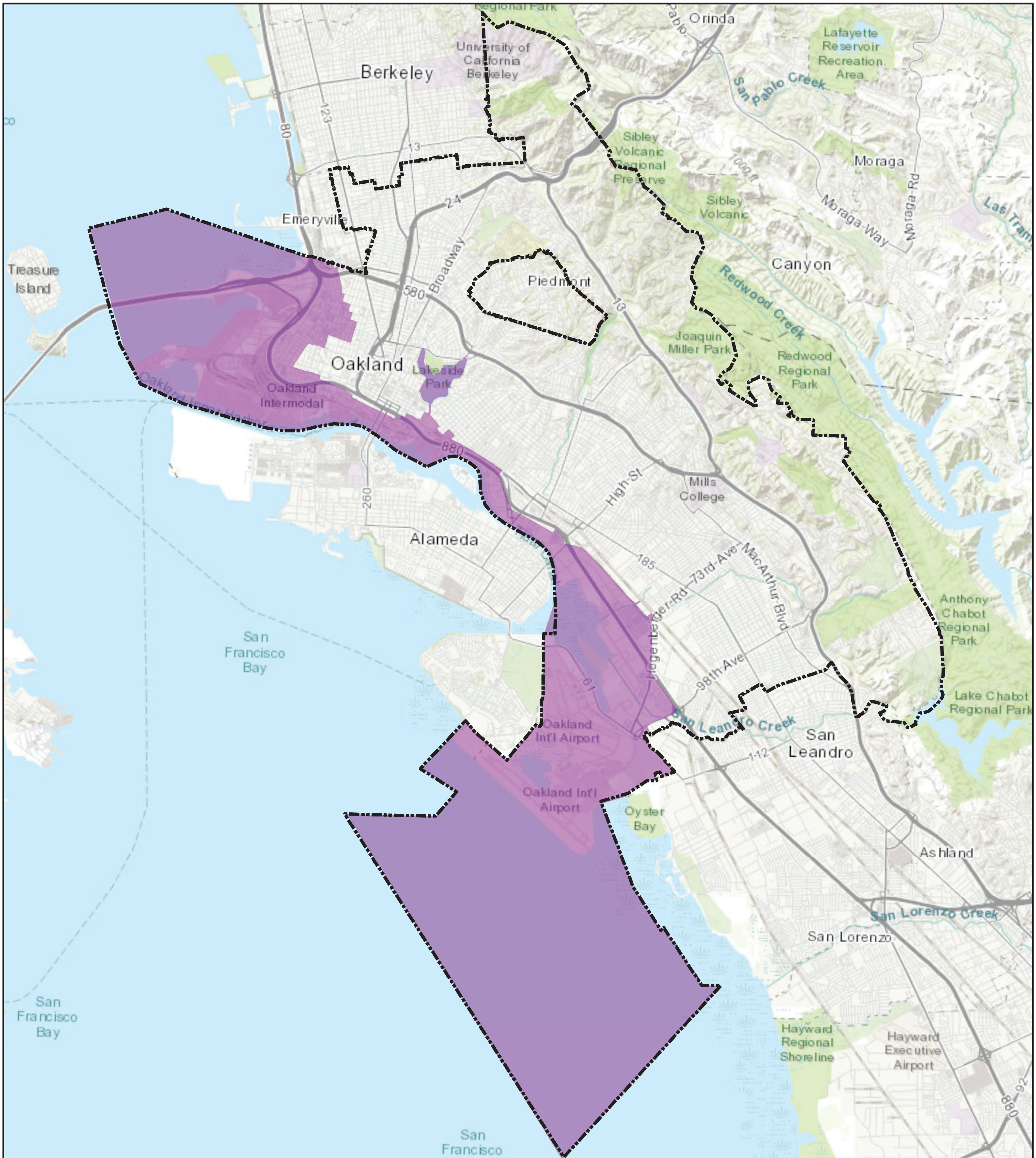


Figure 14-3. Tsunami Inundation Zones

Tsunami Hazard Area

City Limits

N

0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland, CGS

The inundation areas represent the maximum considered tsunami runup from a number of extreme, yet realistic, tsunami sources. The tsunami hazard zone is mostly influenced by a local source Cascadia event; however, distant sources can result in notable wave run ups. Additional tsunami mapping information is available from the California Department of Conservation (California Department of Conservation, 2020 and 2020a) and the Redwood Coast Tsunami Work Group.

14.2.3 Frequency

The 22 tsunami events known to impact Alameda County and the City of Oakland over 170 years amount to a tsunami event every 7.8 years on average. Most of these events were minor (3 feet or less of runup). The National Tsunami Hazard Mitigation Program rates the risk to the U.S. west coast from the tsunami hazard as high to very high (Dunbar and Weaver, 2015). The hazard mapping used for this tsunami risk assessment is based on a 975-year average return period modeled tsunami hazard data for Alameda County.

14.2.4 Severity

Tsunamis are a threat to life and property to anyone living near the ocean. From 1950 to 2007, 478 tsunamis were recorded globally. Fifty-one of these events caused fatalities, to a total of over 308,000 coastal residents. The overwhelming majority of these events occurred in the Pacific basin. Recent tsunamis have struck Nicaragua, Indonesia, and Japan, each killing thousands of people. Property damage due to these waves was nearly $1 billion. Historically, tsunamis originating in the northern Pacific and along the west coast of South America have caused more damage on the west coast of the United States than tsunamis originating in Japan and the Southwest Pacific. A tsunami’s size and speed, as well as the coastal area’s form and depth, affect the impact of the tsunami.

At some locations, the advancing wave front will be the most destructive part of the tsunami wave. In other situations, the greatest damage will be caused by the outflow of water back to the sea between crests, sweeping away items on the surface and undermining roads, buildings, bulkheads, and other structures. This outflow action can carry enormous amounts of highly damaging debris, resulting in further destruction. Ships and boats, unless moved away from shore, may be forced against breakwaters, wharves, and other craft, or be washed ashore and left grounded after the withdrawal of the seawater (National Tsunami Hazard Mitigation Program, 2001).

14.2.5 Warning Time

Visible Indications

Tsunamis are difficult to detect in the open ocean; with waves generally less than 3 feet high. The first visible indication of an approaching tsunami may be either a rise or drop in water surface levels (National Tsunami Hazard Mitigation Program, 2001):

- A drop in water level (draw down) can be caused by the trough preceding the advancing, large inbound wave crest. Rapid draw down can create strong currents in harbor inlets and channels that can severely damage coastal structures due to erosive scour around piers and pilings. As the water’s surface drops, piers can be damaged by boats or ships straining at or breaking their mooring lines. The vessels can overturn or sink due to strong currents, collisions with other objects, or impact with the harbor bottom.
- The advancing tsunami may initially arrive as a strong surge increasing the sea level. This can be similar to the rising tide, but the tsunami surge rises faster and does not stop at the shoreline. Even if the wave height appears to be small, 3 to 6 feet for example, the strength of the accompanying surge can be deadly.

Waist-high surges can cause strong currents that float cars, small structures, other debris, and hazardous materials. Boats and debris are often carried inland by the surge and left stranded when the water recedes.

Warning System

The tsunami warning system for the Pacific Ocean evolved from a program initiated in 1946. It is a cooperative effort involving 26 countries along with numerous seismic stations, water level stations and information distribution centers. The National Weather Service operates two regional information distribution centers: The Pacific Tsunami Warning Center in Ewa Beach, Hawaii; and the National Tsunami Warning Center covering the California coast in Palmer, Alaska. The warning centers issue tsunami watches, warnings, and advisories. A watch is issued when a large earthquake has occurred far away from the region and the threat is still being determined. A warning is issued when damaging tsunami waves inundating dry land are expected. An advisory is issued when tsunami waves less than 1 meter high and dangerous strong currents will occur in harbors. The warning system is activated when a Pacific basin earthquake of magnitude 6.5 occurs or an earthquake is widely felt along the North American coast. When this occurs, the following sequence of actions occurs:

- Data is interpolated to determine epicenter and magnitude of the event.
- If the earthquake is of the right type, depth, magnitude, and is far away from California coast, a TSUNAMI WATCH is typically issued for the California coastline.
- A TSUNAMI WATCH is upgraded to a TSUNAMI WARNING if tsunami wave heights are forecast to be 1 meter or larger. A TSUNAMI ADVISORY is issued if tsunami wave heights are forecast to be 0.3 meters to less than 1 meter.
- Tsunami travel times are calculated, and the warning is transmitted to disseminating agencies who relay it to the public.
- The National Tsunami Warning Center will cancel/expire watches, warnings, or advisories if tide gauges and buoys indicate no significant tsunami was generated or if tsunami waves no longer meet the criteria for at least 3 hours.

This system is not considered to be effective for communities close to the tsunami source, because the first wave would arrive before the data can be processed and analyzed, and communications systems may be impacted by the precipitating event. In this case, strong ground shaking would provide the first warning of a potential tsunami and evacuations should begin immediately.

Estimated Travel Times

The NOAA National Center for Environmental Information website provides maps that show estimated travel times to coastal locations for various tsunami-generating events. Figure 14-4 shows one example of the travel time for a tsunami generated in Aburatsu, Japan to reach the planning area—approximately 11 hours.

14.2.6 Secondary Hazards

Wherever water transport is a vital means of supply, disruption of coastal systems caused by tsunamis can have far-reaching economic effects.

Source: National Centers for Environmental Information, 2018

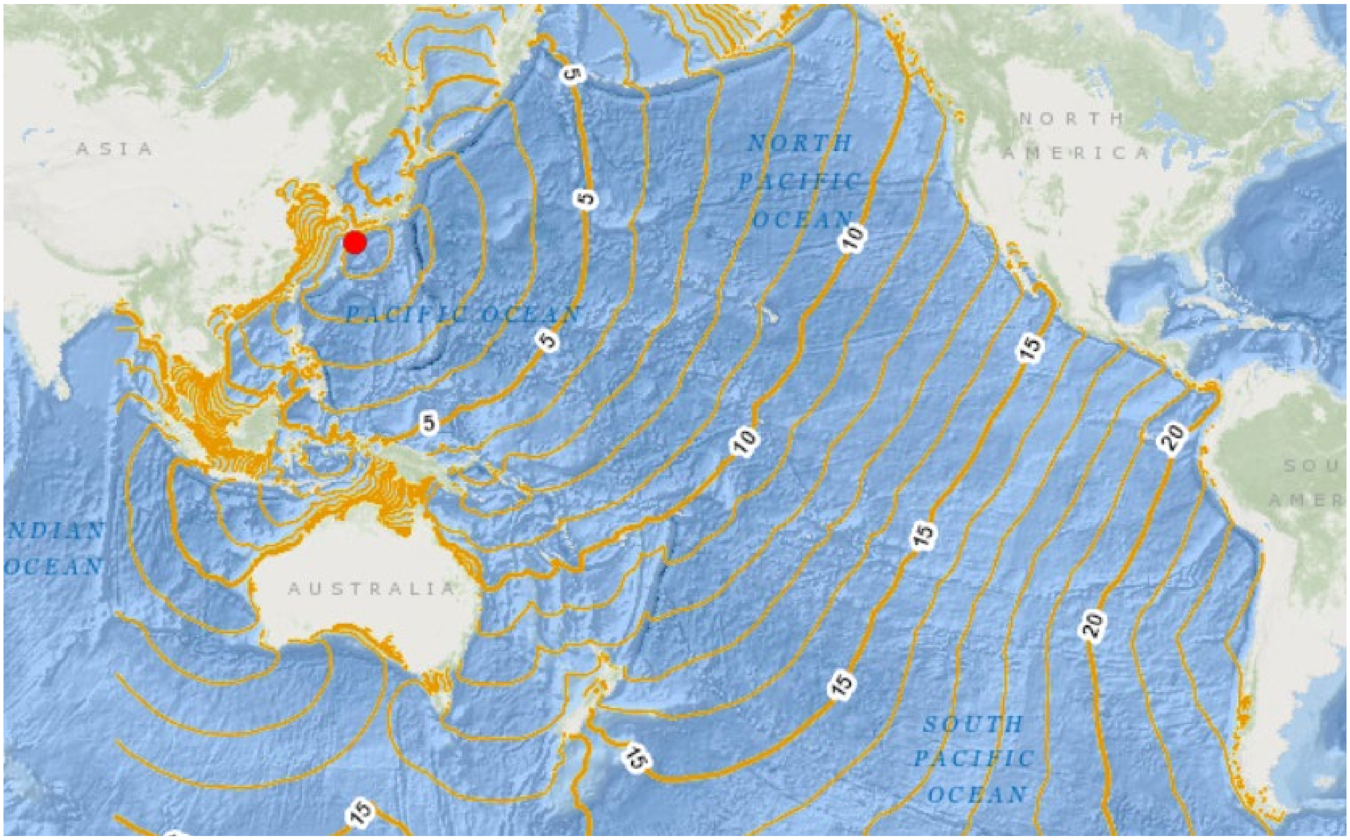


Figure 14-4. Potential Tsunami Travel Times in the Pacific Ocean, in Hours

14.3 EXPOSURE

Exposure to the tsunami hazard was assessed through a spatial analysis. The mapped tsunami inundation area (Figure 14-3) was overlaid with planning area general building stock, Census data at the block level, and critical facility locations.

14.3.1 Population

Total Exposed Population

The estimated total population living in the mapped tsunami inundation zone is 12,054 (2.9 percent of the total City population). This estimate was developed by multiplying the total planning area population by the percentage of residential buildings that are within the mapped inundation zone. See Appendix E for a breakdown by sub-area.

Socially Vulnerable Populations

The socially vulnerable populations exposed to the tsunami hazard were estimated based on data for the Census blocks that lie at least partially within the inundation zone. Because many of those Census blocks extend outside the inundation zone, the estimates are greater than the actual exposed populations, but they provide reasonable relative data for use in mitigation planning. Table 14-2 summarizes the estimated socially vulnerable populations.

Table 14-2. Relative Exposure of Socially Vulnerable Populations in Tsunami Inundation Zone

	Number[a]	% of Total in Hazard Area
Exposed Population by Age		
Over 65 Years	1,053	6.9%
Under 16	2,940	19.4%
Exposed Population by Race[b]		
White	3,790	25.0%
Black or African American	5,014	33.0%
American Indian and Alaska Native	54	0.4%
Asian	2,398	15.8%
Native Hawaiian and Other Pacific Islander	43	0.3%
Some other race	34	0.2%
Exposed Population by Ethnicity		
Hispanic or Latino (of any race)	3,242	21.4%
Exposed Households by Income		
Households with Income Below $50,000	3,362	53.0%
Totals Used for Calculating Percentages[a]		
Population	15,171	
Households	6,343	

a. Note that the methodology used for this analysis overestimates exposed population and households. Results presented in this table should be used to evaluate relative exposure between groups rather than absolute numbers of exposed persons or households.
b. Race data shown are as-is output from Hazus, suitable for comparing exposure between groups listed. Data are for persons identifying as one race only, and do not add up to the total exposed population.

14.3.2 Property

Buildings

Table 14-3 summarizes the Hazus-estimated number and value of properties within the mapped tsunami inundation zone. See Appendix E for a breakdown by sub-area.

Table 14-3. Exposure and Value of Structures in the Tsunami Inundation Zone

Acres of Inundation Area	11,134
% of Total Area	22.3%
Number of Buildings Exposed	3,018
Value of Exposed Structures	$8,119,243,355
Value of Exposed Contents	$8,043,320,086
Total Exposed Property Value	**$16,162,563,441**
Total Exposed Value as % of Planning Area Total	13.7

Land Use

Table 14-4 shows the occupancy class of all buildings in the tsunami inundation area. See Appendix E for a breakdown by sub-area.

Table 14-4. Building Occupancy Classes in Tsunami Inundation Areas

Building Occupancy Class	Tsunami Inundation Area	
	Building Count	% of Total Exposed
Residential	1,795	59.48
Commercial	727	24.09
Industrial	330	10.93
Agriculture	0	0
Religion	25	0.83
Government	124	4.11
Education	17	0.56
Total	**3,018**	**100**

14.3.3 Critical Facilities

Critical facilities exposed to the tsunami hazard represent 26 percent (676 facilities) of the total critical facilities in the planning area. Linear infrastructure is also exposed, including utility lines and roads. The breakdown of exposure by facility type is shown in Figure 14-5.

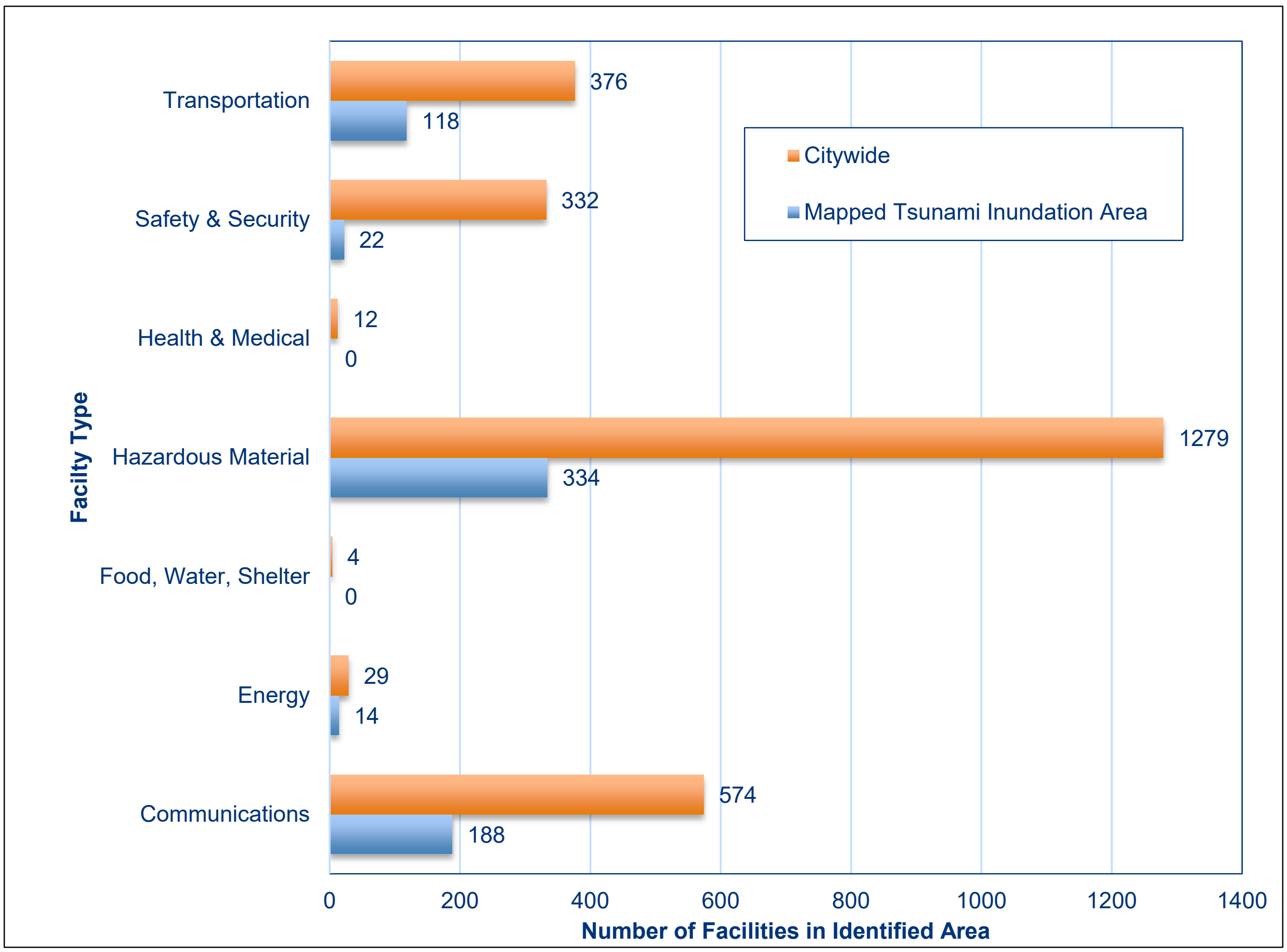


Figure 14-5. Critical Facilities in Mapped Tsunami Inundation Zone and Citywide

14.3.4 Environment

All waterways and beaches would be exposed to the effects of a tsunami; inundation of water and introduction of foreign debris could be hazardous to the environment. All wildlife inhabiting the area also is exposed.

14.4 VULNERABILITY

14.4.1 Population

The populations most vulnerable to the tsunami hazard are the elderly, disabled and very young who reside near beaches, low-lying coastal areas, tidal flats and river deltas that empty into ocean going waters. In the event of a local tsunami generated in or near the planning area, there would be little warning time, so more of the population would be vulnerable.

14.4.2 Property

Property Impacted

The impact of tsunami waves and the scouring associated with debris that may be carried in the water could be damaging to all structures along beaches, low-lying coastal areas, tidal flats and river deltas. The most vulnerable are those in the front line of tsunami impact and those that are structurally unsound. The Hazus analysis indicated that 28.8 percent of the exposed structures (870 structures) would be impacted by the modeled scenario event.

Damage Estimates

Table 14-5 summarizes Hazus estimates of tsunami damage in the planning area. See Appendix E for a breakdown by sub-area. The estimated damage value is associated with the tsunami wave only; it does not include additional damage that may occur as a result of debris battering structures as the tsunami wave rushes in and out of the inundation area or fires caused by an earthquake and tsunami event. The debris estimate includes only structural debris and building finishes; it does not include additional debris that may result from a tsunami event, such as from boats, trees, sediment, building contents, bridges, or utility lines.

Table 14-5. Estimated Impact of a Tsunami Event in the Planning Area

Buildings Impacted	870
Total Structure Damages	$3,961,238,544
Total Contents Damages	$4,677,308,133
Total Value (Structure + Contents) Damaged	$8,638,546,677
Damage as % of Total Value	7.3%

14.4.3 Critical Facilities

There are 676 critical facilities exposed to some degree to the mapped tsunami hazard. A more in-depth analysis of the mitigation measures taken by these facilities to prevent damage from inundation should be done to determine if they could withstand impacts of a mass movement. Critical facilities vulnerable to tsunami damage includes the following infrastructure:

- **Water Proximate Infrastructure**—Breakwaters and piers collapse, sometimes because of scouring actions that sweep away their foundation material and sometimes because of the sheer impact of the tsunami waves.
- **Flood Control Systems**—Floodwaters can back up drainage systems, causing localized flooding. Culverts can be blocked by debris from tsunami events, also causing localized urban flooding.
- **Utility Systems—**Floodwaters can get into drinking water supplies, causing contamination. Sewer systems can be backed up, causing waste to spill into homes, neighborhoods, rivers, and streams. Tsunami waves can knock down power lines and radio/cellular communication towers. Power generation facilities can be severely impacted by wave action and by inundation from floodwater.

14.4.4 Environment

Environmental impacts on local waterways and wildlife would be most significant in areas closest to the point of impact. Areas near gas stations, industrial areas and facilities storing hazardous materials are vulnerable. The vulnerability of aquatic habit and associated ecosystems in low-lying areas close to the coastline is high. Tsunami waves can carry destructive debris and pollutants that can have devastating impacts on all facets of the environment. Millions of dollars spent on habitat restoration and conservation in the planning area could be wiped out by one significant tsunami.

14.5 FUTURE TRENDS IN DEVELOPMENT

As the City of Oakland is predominantly built out, future development in tsunami inundation areas within the City will be primarily redevelopment. The Safety Element of the City’s General Plan does address tsunami risk. Because of this and the fact that there is significant overlap between the tsunami inundation area and the City’s regulated floodplain, the City’s development standards for floodplain development would provide some level of protection against the probable impacts from tsunami.

14.6 SCENARIO

The worst-case scenario for the planning area is a local tsunami or seiche event originating in the San Francisco Bay triggered by a seismic event. This can occur anytime and the series of floodwater waves can carry damaging debris and cause environmental impacts.

14.7 ISSUES

Important issues associated with a tsunami in the planning area include the following:

- As tsunami warning technologies evolve, the tsunami warning capability within the planning area will need to be enhanced to provide the highest degree of warning.
- With the possibility of climate change, the issue of sea-level rise may become an important consideration as probable tsunami inundation areas are identified through future studies.
- Special attention will need to be focused on the vulnerable communities in the tsunami zone and on hazard mitigation through public education and outreach.
- Policies will include considerations of the impact of projected sea-level rise on tsunami hazards.

15. WILDFIRE

15.1 GENERAL BACKGROUND

A wildfire is any uncontrolled fire on undeveloped land that requires fire suppression. Wildfires can occur naturally and are important to many ecosystem processes, but most are started by people. Wildfire is a normal part of most forest and range ecosystems in temperate regions of the world. Fires historically burn on a fairly regular cycle, recycling carbon and nutrients stored in the ecosystem and strongly affecting the species within the ecosystem.

15.1.1 Fire Hazard Severity Zones

The California Department of Forestry and Fire Protection (CAL FIRE) has modeled and mapped wildfire hazard zones using a computer model that designates moderate, high, or very high fire hazard severity zones (FHSZ). FHSZ ratings are derived from a combination of fire frequency (how often an area burns) and expected fire behavior under severe weather conditions. CAL FIRE's model derives fire frequency from 50 years of fire history data. Fire behavior is based on factors such as the following (CAL FIRE, 2013):

- **Fuel**—Fuel may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies. Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Trees killed or defoliated by forest insects and diseases are more susceptible to wildfire.
- **Weather**—Relevant weather conditions include temperature, relative humidity, wind speed and direction, cloud cover, precipitation amount and duration, and the stability of the atmosphere. When the temperature is high, relative humidity is low, wind speed is increasing and coming from the east (offshore flow), and there has been little or no precipitation, so vegetation is dry, conditions are very favorable for extensive and severe wildfires. These conditions occur more frequently inland where temperatures are higher, and fog is less prevalent.
- **Terrain**—Topography includes slope and elevation. The topography of a region influences the amount and moisture of fuel; the impact of weather conditions such as temperature and wind; potential barriers to fire spread, such as highways and lakes; and elevation and slope of land forms (fire spreads more easily uphill than downhill).

The model also is based on frequency of fire weather, ignition patterns, and expected rate-of spread. It accounts for flying ember production, which is the principal driver of the wildfire hazard in densely developed areas. A related concern in built-out areas is the relative density of vegetative fuels that can serve as sites for new spot fires within the urban core and spread to adjacent structures. The model refines the zones to characterize fire exposure mechanisms that cause ignitions to structures. Significant land-use changes need to be accounted for through periodic model updates.

15.1.2 Local Conditions Related to Wildfire

Because natural vegetation and dry-farmed grain areas are extremely flammable during late summer and fall, wildfire is a serious hazard in undeveloped areas and on large lot home sites with extensive areas of un-irrigated vegetation. Grassland fires are easily ignited, particularly in dry seasons. These fires are relatively easily controlled if they can be reached by fire equipment; the burned slopes, however, are highly subject to erosion and gullying.

While brush-lands are naturally adapted to frequent light fires, fire protection in recent decades has resulted in heavy fuel accumulation on the ground. Brush fires, particularly near the end of the dry season, tend to burn fast and very hot, threatening homes and leading to serious destruction of vegetative cover. A brush fire that spreads to a woodland can generate a destructive hot crown fire. No suitable management technique of moderate cost has been devised to reduce the risk of brush fires. Early research is exploring the impact that soil amendments to open space and high-fire risk areas has on reducing the risk of fires.

Peat fires represent a special hazard in that, once ignited, they are extremely difficult to extinguish. In some instances, islands have been flooded to extinguish peat fires. Any area lying landward of the mean high-water line may be peaty because of the marshy origin of the soil.

Structure Fires

Structure fires are not typically considered to be community emergencies unless the fire can spread to adjoining structures. Older structures are often more vulnerable to fire because they do not conform to modern building and fire codes and do not contain fire detection devices. These structures are also prone to faulty electrical, heating, and other utility systems because of their age. Older structures that were constructed close together enable fire to spread rapidly from one to another.

Often, defensive measures such as fire-resistant vegetation and defensible space are not in place, increasing the probability that structural fires in older buildings will spread to local vegetation and surrounding wildlands. These vulnerabilities can facilitate the spread of a wildfire to structures, or vice versa.

Newer residential structures are not as vulnerable to fire as are older structures. These structures include fire-resistant features that conform to modern fire and building codes, as well as fire detection or extinguishing systems. The likelihood that a major structural fire will expand into a wildfire before it can be brought under control is therefore significantly reduced.

The storage and use of hazardous materials by commercial and industrial occupancies increase the risk of fire and pose a threat to firefighters and the community if they should become involved in a fire. Certain materials have been designated by the National Fire Protection Association as flammable and combustible, such as propane or petroleum; if a wildfire ignites a building or container with these materials, it exacerbates the severity and damage associated with the fire.

Toxic chemicals can present public health hazards if a wildfire reaches an industrial sector or building, releasing toxic fumes as clouds of smoke. Hazardous materials-associated fires also can introduce toxins that damage the local environment, destroying or altering important habitats.

15.1.3 Wildland-Urban Interface

Wildland-urban interface (WUI) areas are places where combustible vegetation meets combustible structures. The hazard in such areas is bi-directional: wildfires can burn homes, and home fires can burn into wildlands. In non-urban communities, such areas are often characterized by sub-standard water supplies and a distant location from fire stations. In urban areas, although the WUI area is generally outside the most densely developed core areas, it often is still adequately served by fire protection agencies; the increased fire risk is due to the development's location adjacent to or intermixed with undeveloped areas that have vegetation that can serve as wildfire fuel.

WUI fires require firefighters trained to fight both wildfires and structure fires. Firefighters responding to such fires may need to make choices between protecting homes and structures, protecting wildland resources, or working to slow the overall fire itself. Owners of structures within the WUI can take preventive measures to reduce the risk of a wildfire igniting a structural fire. CAL FIRE recommends protective measures such as using fire-resistant plants, maintaining 100 feet of defensible space, and providing property hardening.

15.1.4 Wildfire Protection Responsibility in California

Hundreds of agencies have fire protection responsibility for wildland and WUI fires in California, and primary legal (and financial) responsibility for wildfire protection is divided by local, state, tribal, and federal organizations. In many instances, two fire organizations have dual primary responsibility on the same parcel of land—one for wildfire protection, and the other for structural or "improvement" fire protection. According to the *2013 California Multi-Hazard Mitigation Plan*, this layering of responsibility and resulting dual policies, rules, practices, and legal ordinances can cause conflict or confusion. To address wildfire jurisdictional responsibilities, the California state legislature in 1981 adopted Public Resource Code Section 4291.5 and Health and Safety Code Section 13108.5 establishing the following responsibility areas:

- **Federal Responsibility Areas (FRAs)—**FRAs are fire-prone wildland areas that are owned or managed by a federal agency such as the U.S. Forest Service, National Park Service, Bureau of Land Management, U.S. Fish and Wildlife Service, or U.S. Department of Defense. Primary financial and rule-making jurisdictional authority rests with the federal land agency. In many instances, FRAs are interspersed with private land ownership or leases. Fire protection for developed private property is usually not the responsibility of the federal land management agency; structural protection responsibility is that of a local government agency.
- **State Responsibility Areas (SRAs)**—SRAs are lands in California where CAL FIRE has legal and financial responsibility for wildfire protection and where CAL FIRE administers fire hazard classifications and building standard regulations. SRAs are defined as lands that meet the following criteria:
  - Are county unincorporated areas
  - Are not federally owned
  - Have wildland vegetation cover rather than agricultural or ornamental plants
  - Have watershed or range/forage value
  - Have housing densities not exceeding three units per acre.

  Where SRAs contain built environment or development, the responsibility for fire protection of those improvements (non-wildland) is that of a local government agency.
- **Local Responsibility Areas (LRAs)—**LRAs include land in cities, cultivated agriculture lands, non-flammable areas in unincorporated areas, and lands that do not meet the criteria for SRA or FRA. LRA fire protection is typically provided by city fire departments, fire protection districts, and counties, or by CAL FIRE under contract to local governments. The City of Oakland is located in incorporated LRAs. LRAs may include flammable vegetation and WUI areas where the financial and jurisdictional responsibility for improvement and wildfire protection is that of a local government agency.

SRAs were originally mapped in 1985, and LRAs were originally mapped in 1996. At that time, many local governments made similar designations under their own authority. CAL FIRE recognized the need to remap both SRAs and LRAs with more recent data and technology to create more accurate zone designations. Updated SRA maps were released in May 2011 and again in August 2012. SRA and LRA maps released in 2007 and 2008 are available at the county level for Alameda County on CAL FIRE's Fire and Resource Assessment Program (FRAP) website (CAL FIRE, 2013).

FRAP not only contains maps showing high hazard fire zones in SRAs and LRAs, it also offers a multitude of fire management prevention and planning tools. Other maps and GIS data include bioregions, fire management environments, fire perimeters, fire threat, fuel rank, surface fuels, land cover, watersheds, historical and anticipated development, and more. FRAP also conducts a periodic assessment on state forests and rangelands to determine the amount and extent of these resources, analyze their conditions, and identify alternative management and policy guidelines. The assessment enhances inter-agency collaboration between state and federal agencies on forest and rangeland resources.

California's SB 1241 (adopted in 2012) requires local governments to update the safety elements in their general plans to recognize wildfire risks in SRAs and "Very High Fire Hazard Severity Zones" (based on consistent statewide criteria and the severity of fire hazard that is expected to prevail in those areas). SB 1241 correlates with AB 2140, which requires local jurisdictions to adopt a federally approved hazard mitigation plan through reference in the safety elements of their general plans. This bill also notes the requirement for the safety element to include information and policies on unreasonable risk from potential hazards, including fire. These bills are both designed to encourage integration within and between jurisdictions to enhance mitigation and prevention efforts. Information from a local general plan safety element should be considered with the development of a hazard mitigation plan, response procedures, evacuation planning, and long-term development.

15.2 HAZARD PROFILE

The Safety Element of the Oakland General Plan describes the following risks to Oakland from wildfires (City of Oakland, 2012):

> *General factors that affect an area's risk from fire hazards include its location, land uses, distance from fire stations, ease of accessibility by firefighting equipment, and adequacy of water supply. More specifically, the extent, severity and damage of fires are determined by several key factors affecting vulnerability. For… [wildfire], these vulnerabilities include:*
>
>> *… Steep and rugged topography, dense and unmanaged vegetation (especially woods and brush), accessibility to human activities, exposure to wind and sun, drought conditions, and the presence of above-ground utility lines. The wildland urban interface is an especially hazardous area because it combines a resident population with large areas of combustible material (including structures), and is often characterized by sub-standard water supplies and a distant location from fire stations. The time of the year of high wildfire danger is from May to October, when temperatures are higher and humidity is lower. The closer to the end of this "fire season," the more critical the danger is, as vegetation becomes increasingly dry.*

15.2.1 Wildfire Factors for the Planning Area

Topography

Oakland lies on the eastern side of the San Francisco Bay and is divided into flatlands and hills:

- Much of the flatland area is just above sea level and includes residential neighborhoods, industry, businesses, urban areas, and transportation routes. The Bayside area is relatively flat with varying minor changes in elevation.
- Oakland Hills forms the eastern border of the city, along the East Bay Regional Park District. The highest point in the City is near Grizzly Peak Boulevard and is just over 1,760 feet above sea level. The northern neighborhoods of the Hills was devastated by the 1991 Oakland Firestorm. That fire burned more than

1,520 acres and included forested, WUI, and suburban areas. Offshore winds and dry conditions greatly contributed to the fire's devastation. The eastern edge of the city is designated as a very high FHSZ.

Weather

Oakland's primary wildfire season typically starts in late summer and ends in November. In the fall, the fog recedes earlier in the day and vegetation begins to dry out from regular offshore winds, leading to a higher chance of fire. The Diablo winds are primarily the cause of fires in Oakland. They are warm, dry winds that flow from warmer and drier inland areas, which flow over the Oakland Hills and down to the Bay. The fire season ends once winter rains, cooler temperatures, and higher relative humidity come to the city. Fires are less common between December and August, but with the effects of climate change expected to extend fire seasons around the state, fire may become a year-round occurrence in the city.

Vegetation and Fuels

Fuel may include living and dead vegetation on the ground, along the surface as brush and small trees, and above the ground in tree canopies. Lighter fuels such as grasses, leaves and needles quickly expel moisture and burn rapidly, while heavier fuels such as tree branches, logs and trunks take longer to warm and ignite. Trees killed or defoliated by forest insects and diseases are more susceptible to wildfire.

15.2.2 Past Events

According to the 2016 Alameda County Local Hazard Mitigation Plan, wildfires are common in the Bay Area, with large historic wildfires recorded in 1961, 1962, 1964, 1965, 1970, 1981, 1985, 1988, and 1991. Between 1954 and 2020, FEMA issued major disaster (DR), emergency (EM) and fire management assistance declarations for 262 fire hazard-related events in California. Alameda County was included in two of these, as listed in Table 15-1; impacts on the planning area were not identified in the available sources reviewed.

Table 15-1. FEMA Declarations for Wildfire Events in Alameda County

FEMA Declaration (Name)	Event Date	Event Type	Location	Damage
DR-295 (Buckingham/ Norfolk Fire)	September 29, 1970	Forest & Brush Fires	Six counties including Alameda County	37 homes destroyed, 21 homes damaged, 204 acres burned
DR-919 (Oakland Hills Fire)	October 20-29, 1991	Oakland Hills Fire	Alameda County	$1.7 billion in losses. Burned 1,520 acres, destroyed 3,354 homes and 456 apartments, injured 150 people and took the lives of 25 people

Source: FEMA, 2020

CAL FIRE maintains statistics on historical wildfire activity through its annual reports (Redbooks). Details include state and county information, cause and size, acres burned, and dollar damage. Table 15-2 shows the identified causes of wildfires in Alameda County between 2010 and 2019, the most recent annual report available. CAL FIRE has Redbooks available for every year since 1942. Based on this data, Alameda County experienced approximately 39 fires per year from 2010 to 2019.

Table 15-2. CAL FIRE Wildfire Activity Statistics for Alameda County

Year	Arson	Campfire	Debris Burning	Electric Power	Equipment Use	Lightning	Miscellaneous	Powerline	Playing With Fire	Railroad	Smoking	Undetermined	Vehicle	Total
2019	7	2	0	3	4	0	4	0	0	0	0	9	11	**40**
2018	3	0	0	0	5	0	11	0	0	0	0	19	3	**41**
2017	3	0	0	4	2	1	7	0	0	0	0	16	2	**35**
2016	0	0	0	8	4	0	4	0	0	0	0	16	7	**39**
2015	0	1	2	6	5	2	4	0	0	0	0	21	9	**50**
2014	0	1	0	6	5	0	1	0	0	0	1	13	6	**33**
2013	1	0	1	7	8	0	1	0	0	0	1	15	12	**46**
2012	0	0	0	0	0	0	3	5	0	0	0	7	0	**15**
2011	1	0	0	0	9	0	16	5	0	0	0	14	4	**49**
2010	0	0	1	0	8	0	12	0	1	0	0	21	2	**45**
Average	**1.5**	**0.4**	**0.4**	**3.4**	**5**	**0.3**	**6.3**	**1**	**0.1**	**0**	**0.2**	**15.1**	**5.6**	**39.3**

Note: Wildfire causes tracked by CAL FIRE include natural, human, and technological. More detailed information is available in each applicable Redbook. For instance, power line-caused fires may be a result of animals or vegetation disrupting or connecting with a power line, sparking a fire. They may also be the result of a technological issue or line down (causes not listed but could include storm events).

Source: CAL FIRE, 2020

The most significant wildfire in recent history was the 1991 Tunnel Fire (aka Oakland Hills Fire and East Bay Hills Fire; see Figure 15-1). The fire started October 19 and was brought under control on October 23. It burned 1,520 acres, destroyed more than 3,200 structures, and had 25 confirmed deaths. Northeasterly winds, known as Diablo Winds, that periodically occur in the fall contributed to the growth of the grass fire eventually generating its own wind, now known as a firestorm.

Figure 15-1. Scenes from the 1991 Oakland Hills Fire (Tunnel Fire)

On December 2, 2016, the fire known as the Ghost Ship Fire started in a former warehouse in the Fruitvale neighborhood that had been converted into artist studios. At the time of the fire, the studio was being used for entertainment purposes for a music concert. Of the 100 people attending the concert, 36 were killed, making it the deadliest fire in Oakland history.

15.2.3 Location

In Alameda County, wildfire risk is primarily in the WUI areas with moderate, high, or very high fire threat risk. These are high-density areas in the mountainous and hillside areas of eastern Oakland and Berkeley, central Union City, and some portions of the southeastern corner of Alameda County (CAL FIRE, 2021). CAL FIRE's FRAP website includes maps of the communities most at risk for wildfire that are within 1.5 miles of a high or very high wildfire threat on federal or non-federal lands. The threat is based on the FRAP fuels and hazard data. Figure 15-2 shows the fire hazard severity zone (FHSZ) map for Alameda County.

In Oakland, built-up urban areas with little or no exposure to vegetative fuel areas are located primarily to the west of the City's very high FHSZ. Within the very high FHSZ, WUI areas consist of two general conditions (Dudek, 2019):

- Urban-level development abutting undeveloped areas with vegetative fuels, such as parklands and open space
- Areas where the size and density of housing units and structures is lower and the space between structures consists of vegetative fuels (sometimes called wildland urban intermix areas)

The Oakland Hills present a complex wildfire environment that presents a significant risk to public and firefighter safety and the built and natural environment. This area is one of the highest risk areas in the country for devastating WUI fires, and is the location of one of the state's most destructive historical wildfires, the 1991 Tunnel Fire (Dudek, 2019).

The wildfire risk assessment for this plan uses the best available data and maps on the extent and location of the wildfire hazard. This data represents only the wildfire risks that can be modeled. Some risk factors, such as floating embers driven by very strong wind events, can lead to dangerous wildfire conditions in areas not identified as high risk in the available mapping.

15.2.4 Frequency

Wildfires will continue to present a risk to Alameda County and the planning area. It is difficult to estimate the number of wildfires that will occur in the planning area because of the number of factors that impact the potential for a fire and because some conditions exert increasing pressure on the WUI zone (e.g., ongoing development). An analysis of the frequency of past occurrences can give a rough guide as to how many events may occur each year if current trends continue.

The Association of Bay Area Governments has evaluated wildfire frequency in the Bay Area using the California Fire Alliance map of past wildfires and the FHSZ maps. Table 15-3 shows the record of fires over the past 130 years (1878 to 2008). In that time, only 0.24 percent of areas mapped in an extreme FHSZ have burned, 22.8 percent of those mapped as very high, and 18.5 percent of those mapped as high. In addition, 4.5 percent of the WUI areas have burned.

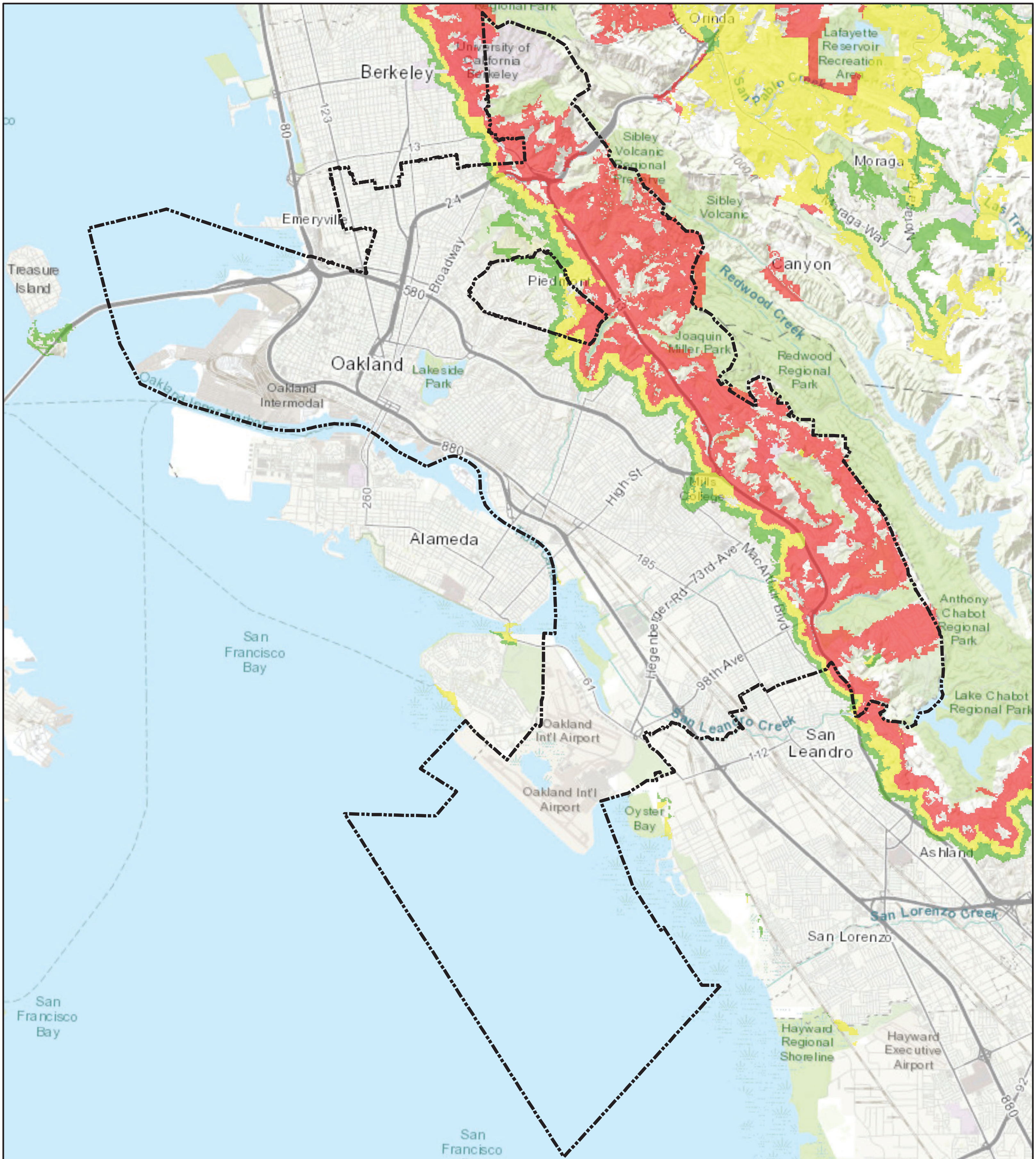


Figure 15-2. Fire Hazard Severity Zones

Fire Hazard Severity Zones within WUI

Moderate

High

Very High

City Limits

N

0 1 2 Miles

Data Sources: Esri Basemap, City of Oakland, CAL FIRE

Table 15-3. Record of Wildfire Affecting Planning Area

FHSZ Category	Total Area in Zone (acres)	Area Burned, 1878 – 2008 Acres	Area Burned, 1878 – 2008 Percent of Total
Moderate	1,300,662	41,651	3.2%
High	1,183,899	218,947	18.49%
Very High	1,344,664	306,264	22.78%
Extreme	2,272	5	0.24%

Source: Association of Bay Area Governments, 2020

15.2.5 Severity

Wildfires

Potential losses from wildfire include human life, structures and other improvements, and natural resources. Given the immediate response times to reported fires and the proximity to firefighting resources, the likelihood of injuries and casualties is minimal. However, under the right conditions, fire can move quickly and overwhelm an initial response. Wildfire may also threaten the health and safety of those fighting the fires. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. In addition, wildfire can lead to ancillary impacts such as landslides in steep ravine areas and flooding due to the impacts of silt in local watersheds.

Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility. Smoke and air pollution from wildfires can be a health hazard, especially for sensitive populations including children, the elderly and those with respiratory and cardiovascular diseases. Smoke generated by wildfire consists of visible and invisible emissions that contain particulate matter (soot, tar, water vapor, and minerals), gases (carbon monoxide, carbon dioxide, nitrogen oxides) and toxics (formaldehyde, benzene). Emissions from wildfires depend on the type of fuel, the moisture content of the fuel, the efficiency (or temperature) of combustion, and the weather.

Wildfire hazards present a considerable risk to vegetation and wildlife habitats. Short-term loss caused by a wildfire can include the destruction of timber, wildlife habitat, scenic vistas, and watersheds. Long-term effects include smaller timber harvests, reduced access to affected recreational areas, and destruction of cultural and economic resources and community infrastructure.

Economic impacts due to wildfires include costs and losses due to burned agricultural crops, damaged public infrastructure and private property, interrupted transportation corridors, and disrupted communication lines. They also include diminished real property values and thus tax revenues, loss of retail sales, and relocation expenses of temporarily or permanently displaced residents.

Urban Fires

Any large fire in a high occupancy, urban building is serious. The disruption to people's lives may be long term and the building owner will incur economic losses from the fire.

15.2.6 Warning Time

Wildfires are mostly caused by humans, intentionally or accidentally. There is no way to predict when one might break out. Since fireworks often cause brush fires, extra diligence is warranted around the Fourth of July when the use of fireworks is highest.

Dry seasons and droughts are factors that greatly increase fire likelihood. Dry lightning may trigger wildfires. Severe weather can be predicted, so special attention can be paid during weather events that may include lightning. Reliable National Weather Service lightning warnings are available on average 24 to 48 hours prior to a significant electrical storm.

If a fire does break out and spread rapidly, residents may need to evacuate within days or hours. A fire’s peak burning period generally is between 1 p.m. and 6 p.m. Once a fire has started, fire alerting is reasonably rapid in most cases. The rapid spread of cellular and two-way radio communications in recent years has further contributed to a significant improvement in warning time.

The fire and life safety systems installed in high-occupancy urban buildings are designed to provide an early warning in the event of a fire. Automatic fire sprinkler protection in modern buildings is designed to control a fire and therefore lessen the need to evacuate all occupants.

15.2.7 Firefighting Resources

Oakland Fire Department is a full-time agency that provides fire and emergency services to the City. Twenty-five stations cover the city’s 78 square miles including Oakland International Airport. Additionally, Oakland Fire is host to one of FEMA’s 28 national Urban Search and Rescue teams, Task Force 4. Oakland Fire participates in mutual-aid county fire response and is part of the California Master Mutual Aid Agreement.

15.2.8 Secondary Hazards

Wildfires can generate a range of secondary effects, which in some cases may cause more widespread and prolonged damage than the fire itself. Fires can cause direct economic losses in the reduction of harvestable timber and indirect economic losses in reduced tourism. Wildfires cause the contamination of reservoirs, destroy transmission lines, and contribute to flooding. They strip slopes of vegetation, exposing them to greater amounts of runoff. This in turn can weaken soils and cause failures on slopes. Mass movement or major landslides can occur several years after a wildfire. Most wildfires burn hot and for long durations that can bake soils, especially those high in clay content, thus increasing the imperviousness of the ground. This condition is sometimes referred to as scorched earth. This devastation increases the runoff generated by storm events, thus increasing the chance of flooding and soil erosion. These secondary impacts of wildfire can also affect the quantity and quality of water, which can pose a significant challenge to drinking water utilities.

The secondary impact of a high-occupancy building fire is the disruption to the population and area in the city. High occupancy / urban buildings can be in almost all parts of the City but are concentrated in the commercial planning zones.

15.3 EXPOSURE

Structural or industrial fires are unlikely to cause widespread damage, so the risk analysis and mitigation measures for this hazard mitigation plan focus on wildfire. Exposure to the wildfire hazard was assessed through a spatial analysis using Hazus. Mapped wildfire hazard areas with the highest severity (moderate, high, and very high, as shown on Figure 15-2), were overlaid with planning area general building stock, Census data at the block level, and critical facility locations.

15.3.1 Population

Total Exposed Population

Table 15-4 summarizes the total population living in the highest-severity wildfire hazard areas. These estimates were developed by multiplying the total planning area population by the percentage of total residential buildings that are within the mapped hazard areas. See Appendix E for a detailed breakdown of exposure by sub-area.

Table 15-4. Total Exposed Population in Mapped Fire Hazard Severity Zones

	Moderate FHSZ	High FHSZ	Very High FHSZ
Population Exposed	11,411	12,064	43,615
% of Total Planning Area Population	2.7%	2.9%	10.4%

In addition to populations who reside in risk areas where fires may occur, hikers and campers in the mountains may be exposed to wildfires, and the entire population of the planning area has the potential to be exposed to smoke from nearby wildfires.

Socially Vulnerable Populations

The socially vulnerable populations in the high and very-high wildfire severity zones were estimated based on data for the Census-defined blocks that lie at least partially within the mapped zones. Because many of those Census blocks extend outside the hazard zone, the estimates are greater than the actual exposed populations, but they provide reasonable relative data for use in mitigation planning. Table 15-5 summarizes the estimated socially vulnerable populations.

15.3.2 Property

Buildings

Table 15-6 summarizes the Hazus-estimated number and value of properties within the highest-severity wildfire hazard zones. See Appendix E for a breakdown by sub-area.

Land Use

Table 15-7 shows the occupancy class of all buildings in the highest-severity wildfire hazard zones. See Appendix E for a breakdown by sub-area.

Table 15-5. Relative Exposure of Socially Vulnerable Populations in Wildfire Hazard Zone

	Number[a]	% of Total in High and Very-High FHSZ
Exposed Population by Age		
Over 65 Years	9,770	15.5%
Under 16	12,348	19.6%
Exposed Population by Race[b]		
White	33,416	53.1%
Black or African American	12,952	20.6%
American Indian and Alaska Native	127	0.2%
Asian	7,727	12.3%
Native Hawaiian and Other Pacific Islander	132	0.2%
Some other race	239	0.4%
Exposed Population by Ethnicity		
Hispanic or Latino (of any race)	5,327	8.5%
Exposed Households by Income		
Households with Income Below $50,000	5,476	21.2%
Totals Used for Calculating Percentages[a]		
Population	62,887	
Households	25,836	

a. The methodology used for this analysis overestimates exposed population and households. Results presented in this table should be used to evaluate relative exposure between groups rather than absolute numbers of exposed persons or households.
b. Race data shown are as-is output from Hazus, suitable for comparing exposure between groups listed. Data are for persons identifying as one race only, and do not add up to the total exposed population.

Table 15-6. Exposed Property in Mapped Fire Hazard Severity Zones

	Moderate FHSZ	High FHSZ	Very High FHSZ
Number of Buildings Exposed	3,563	3,845	15,403
Value of Exposed Structures	$1,241,025,632	$1,312,861,862	$5,933,027,216
Value of Exposed Contents	$824,701,758	$941,218,776	$3,618,290,879
Total Exposed Property Value	**$2,065,727,390**	**$2,254,080,639**	**$9,551,318,096**
Total Exposed Value as % of Planning Area Total	1.8%	1.9%	8.1%

Table 15-7. Building Occupancy Classes in Fire Hazard Severity Zones

Building Occupancy Class	Moderate FHSZ		High FHSZ		Very High FHSZ	
	Building Count	% of Total Exposed	Building Count	% of Total Exposed	Building Count	% of Total Exposed
Residential	3,504	98.34	3,814	99.19	15,160	98.42
Commercial	30	0.84	8	0.21	143	0.93
Industrial	0	0	0	0	1	0.01
Agriculture	0	0	0	0	1	0.01
Religion	11	0.31	4	0.10	28	0.18
Government	6	0.17	7	0.18	39	0.25
Education	12	0.34	12	0.32	31	0.20
Total	**3,563**	**100**	**3,845**	**100**	**15,403**	**100**

15.3.3 Critical Facilities

The breakdown of critical facilities exposure in the high and very high wildfire risk areas is shown in Figure 15-3.

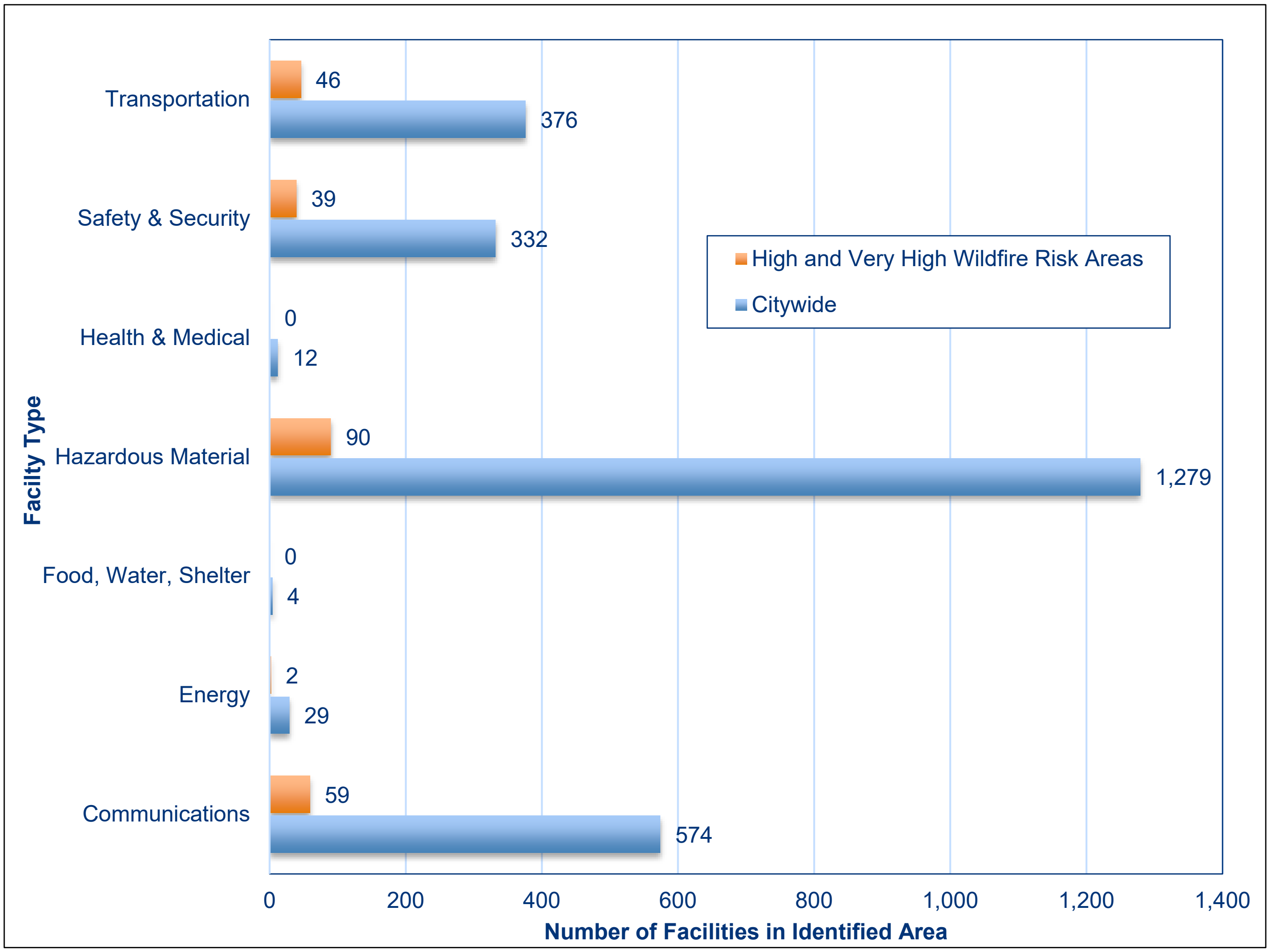


Figure 15-3. Critical Facilities in High and Very High Wildfire Risk Areas and Citywide

15.3.4 Environment

The environment in all areas within the highest-severity wildfire hazard zones is exposed to the wildfire hazard.

15.4 VULNERABILITY

15.4.1 Population

All people exposed to the wildfire hazard are potentially vulnerable to wildfire impacts. Persons with access and functional needs, the elderly and very young may be especially vulnerable to a wildfire if there is not adequate warning time for them to evacuate if needed. In addition, people outside the mapped risk areas are susceptible to health hazards associated with smoke and air pollution from wildfires, especially sensitive populations including children, the elderly, and those with respiratory and cardiovascular diseases. In addition, wildfires threaten the health and safety of those fighting the fires.

15.4.2 Property

All property exposed to the wildfire hazard is vulnerable. Structures that were not constructed to standards designed to protect a building from a wildfire may be especially vulnerable. As of 2008, California State Building code requires minimum standards be met for new buildings in fire hazard severity zones. Most housing in the planning area—84 percent—was built prior to this code requirement (U.S. Census, 2020). It is unknown how many of these structures are in fire hazard zones.

Estimates were developed to indicate the loss that would occur if wildfire damage were equal to 10, 30 or 50 percent of the exposed property value, as summarized in Table 15-8. Damage in excess of 50 percent is considered to be substantial by most building codes and typically requires total reconstruction of the structure.

Table 15-8. Loss Estimates for Fire Hazard Severity Zones

	Exposed Value	Loss Value	Loss as % of Total Planning Area Replacement Value
Moderate FHSZ			
Loss = 1% of Exposed Value	$2.1 billion	$21 million	Less than 1%
Loss = 10% of Exposed Value		$206 million	Less than 1%
Loss = 30% of Exposed Value		$618 million	Less than 1%
Loss = 50% of Exposed Value		$1.030 billion	Less than 1%
High FHSZ			
Loss = 1% of Exposed Value	$2.2 billion	$22.5 million	Less than 1%
Loss = 10% of Exposed Value		$225 million	Less than 1%
Loss = 30% of Exposed Value		$675 million	Less than 1%
Loss = 50% of Exposed Value		$1.125 billion	Less than 1%
Very FHSZ			
Loss = 1% of Exposed Value	$9.6 billion	$95 million	Less than 1%
Loss = 10% of Exposed Value		$955 million	Less than 1%
Loss = 30% of Exposed Value		$2.865 billion	2.4%
Loss = 50% of Exposed Value		$4.775 billion	4.04%

15.4.3 Critical Facilities

Critical facilities not built to fire protection standards, utility poles and lines, and facilities containing hazardous materials are most vulnerable to the wildfire hazard. Most roads would not be damaged except in the worst scenarios, although roads and bridges can be blocked by debris or other wildfire-related conditions and become impassable. The following critical facilities are located in very high and high severity zones and their vulnerability could complicate response and recovery efforts during and following an event:

- **Hazardous Materials and Fuel Storage**—During a wildfire event, these materials could rupture due to excessive heat and act as fuel for the fire, causing rapid spreading and escalating the fire to unmanageable levels. In addition, they could leak into surrounding areas, saturating soils and seeping into surface waters, and have a disastrous effect on the environment.

- **Communication Facilities**—If these facilities are damaged and become inoperable, it would exacerbate already difficult communication in the planning area.
- **Protective Function Facilities (Police and Fire)**—Approximately 12 percent of these types of facilities are within the high or very high severity wildfire zone.

15.4.4 Environment

Fire is a natural and critical ecosystem process in most terrestrial ecosystems, dictating in part the types, structure, and spatial extent of native vegetation. However, wildfires can cause severe environmental impacts:

- Damaged Fisheries—Critical fisheries can suffer from increased water temperatures, sedimentation, and changes in water quality.
- Soil Erosion—The protective covering provided by foliage and dead organic matter is removed, leaving the soil fully exposed to wind and water erosion. Accelerated soil erosion occurs, causing landslides and threatening aquatic habitats.
- Spread of Invasive Plant Species—Non-native woody plant species frequently invade burned areas. When weeds become established, they can dominate the plant cover over broad landscapes, and become difficult and costly to control.
- Disease and Insect Infestations—Unless diseased or insect-infested trees are swiftly removed, infestations and disease can spread to healthy forests and private lands. Timely active management actions are needed to remove diseased or infested trees.
- Destroyed Endangered Species Habitat—Catastrophic fires can have devastating consequences for endangered species.
- Soil Sterilization—Topsoil exposed to extreme heat can become water repellant, and soil nutrients may be lost. It can take decades for ecosystems to recover. Some fires burn so hot that they sterilize the soil.

Many ecosystems are adapted to historical patterns of fire occurrence. These patterns, called “fire regimes,” include temporal attributes (e.g., frequency and seasonality), spatial attributes (e.g., size and spatial complexity), and magnitude attributes (e.g., intensity and severity), each of which have ranges of natural variability. Ecosystem stability is threatened when any of the attributes for a given fire regime diverge from its range of natural variability.

15.5 FUTURE TRENDS IN DEVELOPMENT

Risks associated with the expansion of the WUI as development occurs can be best managed with strong land use and building codes. The planning area is equipped with these tools, and this planning process has assessed their capabilities. These tools can be enhanced with higher standards as appropriate to address known risks as better data and science become available. As the planning area experiences future growth, the City will need to monitor the effectiveness of these regulatory tools for managing risk with, the objective that wildfire risk within the City will see no net increase with new development.

The California Building Code includes minimum standards related to the design and construction of buildings in fire hazard zones. Any newly permitted buildings within the City must conform to standards that manage flammable materials from around the building (defensible space laws) and construct buildings from fire resistant material (Chapter 7A or the Building Code). New residential construction permitted in the City with wildfire risk have been built according to the standards of the 2007 California Building Code Chapter 7A, "Materials and Construction Methods for Exterior Wildfire Exposure" (effective January 1, 2008). In addition, the City of Oakland General Plan includes policies that address managing development in fire hazard severity zones. As the planning area experiences future growth, and if the recommendations of this plan are implemented, it is anticipated that the exposure to this hazard will remain as assessed or even decrease over time due to these capabilities.

To further address wildfire hazards the City of Oakland applies a Standard Condition of Approval to all projects involving construction of new facilities in the designated Very High Fire Severity Zone. Details are provided in Appendix D.

15.6 SCENARIO

The City of Oakland has in essence already experienced its worst-case wildfire scenario with the 1991 Oakland Hills Fire. Smoldering embers from a small fire that was extinguished the day before erupted into what was at the time, the worst firestorm in the State of California's history. At its height, 1,500 firefighters and 450 engines from all over Northern California were fighting it. By the time it burned out, it had consumed 2.5 square miles of mostly residential neighborhoods. Twenty-five people were killed and 150 injured. The fire destroyed 3,469 homes and apartment units and 2,000 automobiles. Ten thousand people were evacuated. NOAA estimates that the fire cost $3.9 billion in present-day dollars. At the time it was the largest single fire in California history in terms of cost, homes lost, and people killed.

The Oakland Hills fire was the first of what has become the norm in the State of California in the beginning of the 21st century. Wildfire behavior has changed markedly in the west driven prolonged period of drought and warmer, windier falls that create ideal fire conditions. Looking forward, a major wildfire in the planning area might begin with a wet spring, adding to fuels already present on the forest floor. Flashy fuels would build throughout the spring. The summer could see the onset of insect infestation. A dry summer could follow the wet spring, exacerbated by dry hot winds. Carelessness with combustible materials or a tossed lit cigarette, or a sudden lightning storm could trigger a multitude of small isolated fires.

The embers from these smaller fires could be carried miles by hot, dry winds. The deposition zone for these embers could be deep in forested areas. Fires that start in flat areas move slower, but wind still pushes them. It is not unusual for a wildfire pushed by wind to burn the ground fuel and later climb into the crown and reverse its track. This is one of many ways that fires can escape containment, typically during periods when response capabilities are overwhelmed. These new small fires would most likely merge. Suppression resources would be redirected from protecting the natural resources to saving more remote subdivisions.

The worst-case scenario would include an active fire season throughout the American west, spreading resources thin. Firefighting teams would be exhausted or unavailable. Many federal assets would be responding to other fires that started earlier in the season.

To further complicate the problem, heavy rains could follow, causing flooding and landslides and releasing tons of sediment into rivers, permanently changing floodplains and damaging sensitive habitat and riparian areas. Such a fire followed by rain could release millions of cubic yards of sediment into streams for years, creating new floodplains and changing existing ones. With the forests removed from the watershed, stream flows could easily double. Floods that could be expected every 50 years may occur every couple of years. With the streambeds unable to carry the increased discharge because of increased sediment, the floodplains and floodplain elevations would increase.

15.7 ISSUES

The major issues for wildfire are the following:

- The number of annual wildfire events within Alameda County has held steady over the last 10 years at about 40 fires per year. Any of these 40 fires could have the potential to escalate, especially in the Oakland Hills as was seen in 1991.
- Over 13 percent of the planning area’s population lives in either high or very-high wildfire severity zones.
- Much of the planning area’s building stock is of wood-frame construction built before 2008 when California building codes began requiring minimum standards for buildings in fire hazard severity zones. Large clusters of structures are wood-frame structures in high and very high severity zones.
- An estimated 35 percent of the critical facilities in the planning area are located in wildfire risk areas. A large number of the facilities are believed to be wood-frame structures. These facilities could have a significant amount of functional downtime after a wildfire. This creates not only a need for mitigation but also a need for continuity of operations planning to develop procedures for providing services without access to critical facilities.
- There are vulnerable and isolated populations in areas of high and very high risk for wildfire.
- Public education and outreach to people living in the fire hazard zones should include information about and assistance with mitigation activities such as defensible space, and advance identification of evacuation routes and safe zones.
- Wildfires could cause landslides as a secondary natural hazard.
- Analyses based on the degree of wildfire risk should be updated to match new calculations.
- Regional consistency, application and enforcement of higher building code standards such as residential sprinkler requirements and prohibitive combustible roof standards.
- Fire departments require reliable water supply in high risk wildfire areas.
- The Oakland WUI is fully built out, and evacuation in the event of a widespread fire can be restricted by a dense population attempting to leave the area in many vehicles at the same time. This can be compounded by narrow urban streets with parked cars creating barriers to evacuation. Planners and traffic engineers must look at the entire evacuation route. Most roads leading out of the City’s hills are one lane in each direction. This could inform mitigation strategies that address road infrastructure projects in the WUI.

16. CLIMATE CHANGE

16.1 GENERAL BACKGROUND

16.1.1 Climate Change and the Role of Greenhouse Gases

Climate, consisting of patterns of temperature, precipitation, humidity, wind and seasons, plays a fundamental role in shaping natural ecosystems and the human economies and cultures that depend on them. "Climate change" refers to changes over a long period of time.

The well-established worldwide warming trend of recent decades and its related impacts are caused by increasing concentrations in the earth's atmosphere of greenhouse gases from human activities. Greenhouse gases are gases that trap heat in the atmosphere, resulting in a warming effect. The major greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_2), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6).

Emissions of these gases come from a variety of sources, such as fossil fuel combustion for energy and transportation, wastewater treatment, agricultural production, livestock, landfills, and changes in land use. Figure 16-1 shows emissions in California by type of gas from 2000 through 2018 and by economic sector for 2018. CO_2 accounted for more than all other greenhouse gas emissions for the time period shown, and transportation was its largest source, accounting for 41 percent of the total emissions.

According to the National Aeronautics and Space Administration (NASA), carbon dioxide concentrations in the atmosphere measured about 280 parts per million (ppm) before the industrial era began in the late 1700s and have risen dramatically since then, surpassing 400 ppm in 2013 for the first time in recorded history (see Figure 16-2).

16.1.2 How Climate Change Affects Hazard Mitigation

Climate change will affect the people, property, economy, and ecosystems of the planning area in a variety of ways. Consequences of climate change include increased flood vulnerability, and increased heat-related illnesses. The most important effect for the development of this plan is that climate change will have a measurable impact on the occurrence and severity of natural hazards.

An essential aspect of hazard mitigation is predicting the likelihood of hazard events in a planning area. Typically, predictions are based on statistical projections from records of past events. This approach assumes that the likelihood of hazard events remains essentially unchanged over time. Thus, averages based on the past frequencies of, for example, floods are used to estimate future frequencies: if a river has flooded an average of once every 5 years for the past 100 years, then it can be expected to continue to flood an average of once every 5 years.

Source: California Air Resources Board, 2021

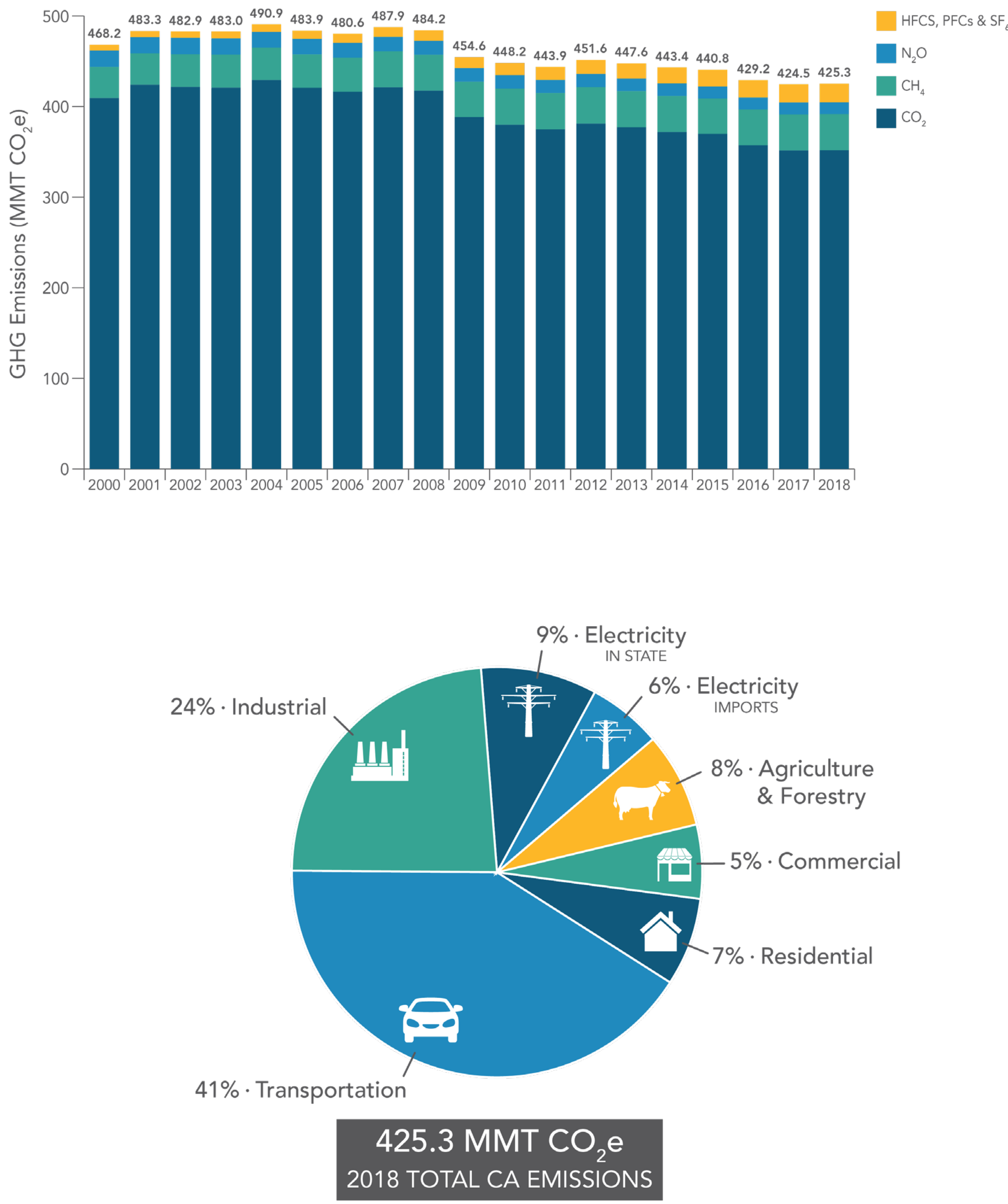


Figure 16-1. California's 2018 Greenhouse Gas Emission Inventory by Gas (left) and Sector (right)

Source: NASA, 2020b

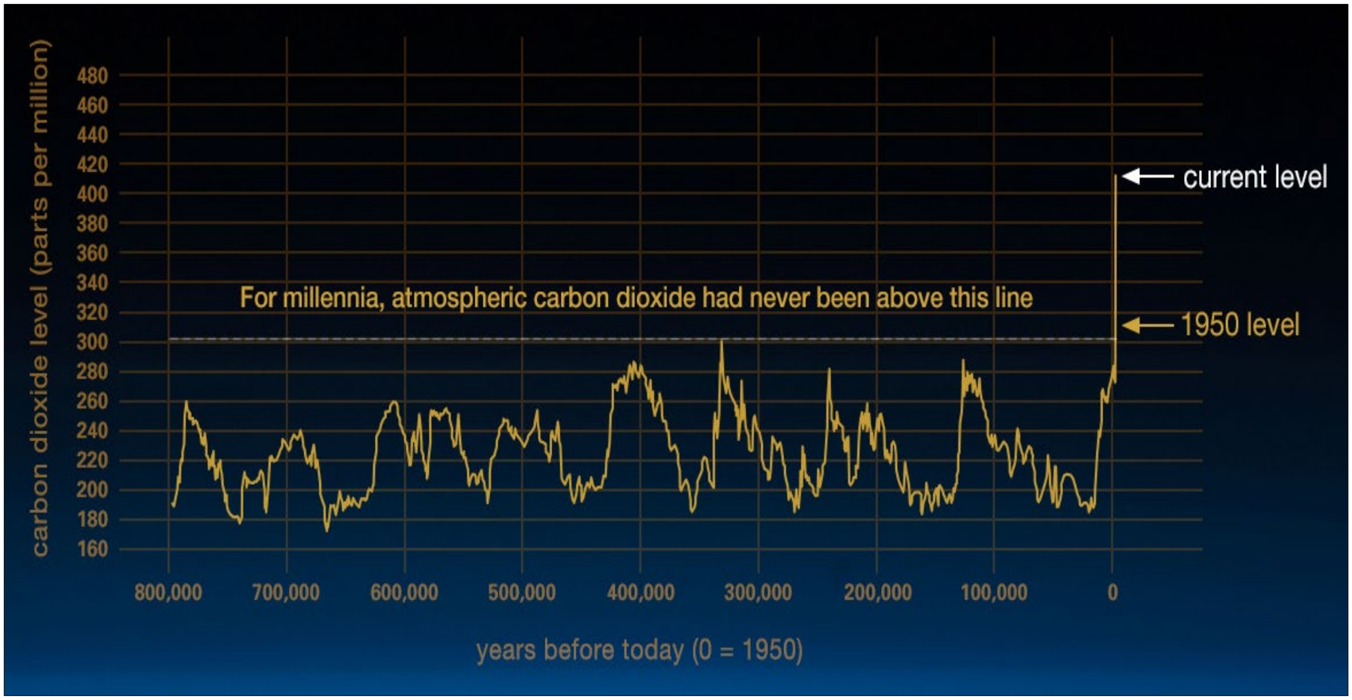


Figure 16-2. Global Carbon Dioxide Concentrations Over Time

For hazards that are affected by climate conditions, the assumption that future behavior will be equivalent to past behavior is not valid if climate conditions are changing. As flooding is generally associated with precipitation frequency and quantity, for example, the frequency of flooding will not remain constant if broad precipitation patterns change over time. As hydrology changes, a flood that is considered to have a 1 percent annual chance of occurrence today could become more likely in the future, leaving communities at greater risk. The risks of landslide, severe storms, and wildfire are all affected by climate patterns as well. For this reason, an understanding of climate change is pertinent to efforts to mitigate natural hazards. Information about how climate patterns are changing provides insight on the reliability of future hazard projections used in mitigation analysis.

16.1.3 Current Indicators of Climate Change

Global Indicators

The major scientific agencies of the United States—including NASA and the National Oceanic and Atmospheric Administration (NOAA)—have presented evidence that climate change is occurring. NASA summarizes key evidence as follows (NASA, 2020a):

- **Global Temperature Rise**—The planet's average surface temperature has risen about 1.62 ºF since the late 19th century, a change driven largely by increased carbon dioxide and other human-made emissions into the atmosphere. Most of the warming occurred in the past 35 years, with the five warmest years on record taking place since 2010.
- **Warming Oceans**—The oceans have absorbed much of this increased heat, with the top 2,300 feet of ocean showing warming of more than 0.4 ºF since 1969.

- **Shrinking Ice Sheets**—The Greenland and Antarctic ice sheets have decreased in mass. Greenland lost an average of 286 billion tons of ice per year between 1993 and 2016, and Antarctica lost about 127 billion tons of ice per year during the same time period. The rate of Antarctica ice mass loss has tripled in the last decade.
- **Glacial Retreat**—Glaciers are retreating almost everywhere around the world—including in the Alps, Himalayas, Andes, Rockies, Alaska and Africa.
- **Decreased Snow Cover**—Satellite observations reveal that the amount of spring snow cover in the Northern Hemisphere has decreased over the past five decades and that the snow is melting earlier.
- **Sea-level rise**—Global sea level rose about 8 inches in the last century. The rate in the last two decades is nearly double that of the last century and is accelerating slightly every year.
- **Declining Arctic Sea Ice**—Both the extent and thickness of Arctic sea ice has declined rapidly over the last several decades.
- **Extreme Events**—The number of record high temperature events in the United States has been increasing since 1950, while the number of record low temperature events has been decreasing. The U.S. has also witnessed increasing numbers of intense rainfall events.
- **Ocean Acidification**—Since the beginning of the Industrial Revolution, the acidity of surface ocean waters has increased by about 30 percent. The amount of carbon dioxide absorbed by the upper layer of the oceans is increasing by about 2 billion tons per year.

California Indicators

The California Office of Environmental Health Hazard Assessment conducts research and develops reports to describe how California's climate is changing and how these changes are affecting the state. The 2018 report presents 36 indicators—scientifically based measurements that track trends in various aspects of climate change—in four categories (California Office of Environmental Health Hazard Assessment, 2015):

- Human-influenced drivers of climate change, such as greenhouse gas emissions
- Changes in the state's climate
- Impacts of climate change on physical systems, such as oceans and snowpack
- Impacts of climate change on biological systems – humans, vegetation, and wildlife.

Based on trends for these indicators, the report concludes that climate change is continuing to occur in California and is having significant, measurable impacts on the state and its people, as summarized in the sections below.

Human-Influenced Drivers of Climate Change

California has pioneered efforts to curb greenhouse gases despite an increase in the state's population and economic output. Since 1990, there has been a downward trend of California's greenhouse gas emissions due to declining emissions per capita and per dollar of gross domestic product. However, the state's reduced emissions have not been sufficient to address rising global effects in the air and oceans:

- **Atmospheric Concentrations**—CO_2 concentrations in the atmosphere continue to increase. In just under 60 years, CO_2 concentrations increased from 315 parts per million (ppm) to over 400 ppm. It is expected that the levels will remain above 400 ppm for many generations because CO_2 persists in the atmosphere for centuries.

- **Ocean Acidification—**Ocean acidification is increasing due to the increase in atmospheric concentrations of CO_2. Each year, the ocean absorbs approximately 30 percent of the CO_2 released into the atmosphere.

Changes in the State's Climate

Climate is often referred to as "average weather" in describing the temperature, precipitation and wind in a given time period. Each of the last three decades in California has been warmer on average than any preceding decade. Throughout the state, annual average air temperatures have increased since 1895. Beginning in the 1980s the temperatures rose at a faster rate. Night time temperatures, or minimum temperatures, have increased at a rate of 2.3 °F per century, while day time maximum temperatures have increased by 1.3 °F per century. In the past 30 years, extreme heat days and nights have increased at a faster rate; heat waves of five or more consecutive days have also increased.

The Palmer Drought Severity Index shows that California has become drier. The extreme drought in California, when index values fell below -3, occurred for eight years between 2007 and 2016. The most extreme drought since instrumental records began in 1895 occurred from 2012 to 2016. During these years, there was record warmth and dry weather, including a year of record low snowpack.

Other indicators of changes in climate show that:

- Energy used to cool buildings during warm weather has increased, while energy used to heat buildings during cold weather has decreased.
- Seven of the last 10 years had precipitation below the statewide average of 22.9 inches. 2012 through 2015 were the driest consecutive four years in California history.
- The precipitation that falls as rain, rather than snow, over the watersheds that provide most of California's water supply has been increasing.

Impacts of Climate Change on Physical Systems

The physical systems in California on which the state depends—the ocean, lakes, rivers, and snowpack— have been altered due to warming temperatures and changing precipitation patterns. The following are examples of these changes:

- Winter air temperature determines whether precipitation falls as rain or snow, affecting glacier mass gain, while summer air temperature affects glacier loss. Some of the largest glaciers in the Sierra Nevada lost an average of about 70 percent of their area from the beginning of the 20th century to 2014. Reductions ranged from about 50 to 85 percent of each glacier's area in 1903.
- Mean sea level has increased by about 7 inches at San Francisco since 1900, and by about 6 inches at La Jolla since 1924. Sea-level rise threatens existing or planned infrastructure, development, and ecosystems along California's coast.
- Average water temperatures in Lake Tahoe have increased by nearly 1 °F since 1970, at an average rate of 0.02 °F per year.
- Coastal ocean temperatures at three sites in California have warmed over the past century.
- Oxygen concentrations at three water depths offshore of San Diego indicate overall decreases as well as low-oxygen events.

Impacts of Climate Change on Biological Systems

Humans

Public health is threatened by climate change in many ways. Extreme events may contribute to injuries and fatalities, and poor air quality can cause respiratory stress. Indicators of the impacts of climate change on human health include the following:

- Heat-related deaths and illnesses typically increase during heat waves.
- Vector-borne pathogen transmission and disease patterns can be affected by warming temperatures and changes in precipitation.

Vegetation

Vegetation can be stressed by warming temperatures, declining snowpack, and earlier spring snowmelt runoff. The structure and composition of the state's forests and woodlands are changing. There are fewer large trees than in the 1930s. There are fewer pine trees statewide and, in certain parts of the state, oaks cover larger areas. The decline in large trees and increased abundance of oaks are associated with statewide increases in climatic water deficit. Since the 2012-2016 drought, tree deaths have increased dramatically. Trees were more vulnerable to insects and pathogen attacks from the higher temperatures and decreased water availability. Approximately 129 million trees died between 2012 and December 2017.

Since 1950, wildfires have burned more areas each year, as temperatures have been warmer in spring and summer, and spring snowmelt has occurred earlier. Very low precipitation, low snowpack, and unusually warm temperatures create conditions for extreme, high severity wildfires that spread rapidly. Five of the largest fire years have occurred since 2006.

Wildlife

The timing of key life cycle events for plants and animals and their habitat may be altered due to changes in temperature, precipitation, food sources, competition for prey, and other physical or biological features. Indicators of the impacts of climate change on wildlife include the following:

- In three study regions of the Sierra Nevada Mountains, certain birds and mammals are found at different elevations today than a century ago. Range shifts have been observed in almost 75 percent of the small mammal species and over 80 percent of the bird species surveyed. This could be from a sensitivity to temperature, precipitation or other physical factors, or a change in food sources, vegetation, and interactions with competitors.
- Unusually warm sea surface temperatures may cause marine species to respond to changing ocean conditions. A nudibranch sea slug expanded its range 130 miles—from the Monterey Peninsula to Bodega Bay—in response to warming ocean conditions.
- Over the past 45 years, butterfly species in the Central Valley have been appearing earlier in the spring. Their earlier emergence is linked with hotter and drier regional winter conditions.
- Ocean conditions strongly influence marine organisms, as seen with copepod populations. At the base of the food chain, the abundance and types of copepod species have been correlated with the abundance of many fish species.
- Extreme mortality events among juvenile salmon have caused fluctuation in the number of adult Chinook salmon returning from the ocean to the Sacramento River for the past two decades.

- During years when sea surface temperatures are unusually warm in their breeding area, there have been fewer California sea lion pup births, higher pup mortality, and poor pup conditions at San Miguel Island off Santa Barbara.

16.1.4 Responses to Climate Change

Communities and governments worldwide are working to address, evaluate and prepare for climate changes that are likely to impact communities in coming decades. Generally, climate change discussions encompass two separate but inter-related considerations: mitigation and adaptation. The term “mitigation” can be confusing because its meaning changes across disciplines:

- Mitigation in emergency management—as generally addressed in this hazard mitigation plan—is typically defined as the effort to reduce loss of life and property by lessening the impact of disasters.
- Mitigation in climate change discussions is defined as a human intervention to reduce impacts on the climate system. It includes strategies to reduce greenhouse gas sources and emissions and enhance greenhouse gas sinks.

In this chapter, mitigation is used as defined by the climate change community. In the other chapters of this plan, mitigation is primarily used in an emergency management context.

Adaptation refers to adjustments in natural or human systems in response to the actual or anticipated effects of climate change and associated impacts. These adjustments may moderate harm or exploit beneficial opportunities. Mitigation and adaptation are related, as the world’s ability to reduce greenhouse gas emissions will affect the degree of adaptation that will be necessary. Some actions can both reduce greenhouse gas emissions and support adaptation to likely future conditions.

Societies across the world are facing the need to adapt to changing conditions associated with natural disasters and climate change. Farmers are altering crops and agricultural methods to deal with changing rainfall and rising temperature; architects and engineers are redesigning buildings; planners are looking at managing water supplies to deal with droughts or flooding.

Adaptive capacity goes beyond human systems, as some ecosystems are able to adapt to change and to buffer surrounding areas from the impacts of change. Forests can bind soils and hold large volumes of water during times of plenty, releasing it through the year; floodplains can absorb vast volumes of water during peak flows; coastal ecosystems can hold out against storms, attenuating waves and reducing erosion. Other ecosystem services—such as food provision, timber, materials, medicines and recreation—can provide a buffer to societies in the face of changing conditions. Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall strategy to help people adapt to the adverse effects of climate change. This includes the sustainable management, conservation and restoration of specific ecosystems that provide key services.

Oakland 2030 Equitable Climate Action Plan

In 2020, the City of Oakland adopted the *2030 Equitable Climate Action Plan* (ECAP). The ECAP establishes actions the City will take to equitably reduce Oakland’s climate emissions and adapt to a changing climate. It was developed in response to the City Council’s adopted 2030 greenhouse gas emission reduction target of 56 percent relative to 2005 levels and the City’s 2018 Climate Emergency and Just Transition Resolution.

The 2030 ECAP is rooted in equity and community engagement. It identifies actions to combat climate change while ensuring that communities that have been harmed by environmental injustice and that are likely to be hurt first and worst by the impacts of climate change will benefit first and foremost from climate action. The ECAP focuses on actions that will result in cleaner air, improved economic security, green jobs, and more resilient communities, while minimizing contributions to climate change. It leverages existing City resources and puts equity at its center in order to build "everyday resilience" in Oakland's climate change response. Measurements of success include the following:

- The incorporation of the ECAP's vulnerability assessment and adaptation plan into the Local Hazard Mitigation Plan
- The implementation of recommendations from the adaptation plan
- The number and service area of local resilience hubs
- The number and investment of green infrastructure projects completed

To further address climate change impacts and ensure that the City meets the greenhouse gas emissions reduction goals outlined in the ECAP, the City requires all development projects subject to environmental review to complete an Equitable Climate Action Plan Consistency Checklist and to commit to implementing the measures described in the checklist. If a project does not commit to all of the greenhouse gas emissions reductions described on the ECAP Consistency Checklist, then the applicant must submit a greenhouse gas reduction plan that at minimum includes a detailed emissions inventory for the project that shows how additional emissions reductions will be achieved through alternate reduction programs. These policies are incorporated and applied through City of Oakland Standard Conditions of Approval 41 and 42.

Resilient Oakland Playbook

The *Resilient Oakland Playbook* focuses on the following:

- Increasing collaboration inside City government through the launch of a new Civic Design Lab
- Building new and innovative partnerships among regional governments
- Co-designing community engagement processes with those who live and work in Oakland.

The City will participate in regional resilience partnerships with organizations including the Bay Area Regional Collective, Coastal Hazards Adaptation Resiliency Group, and SuperPublic. The Bay Area Regional Collective, with support from a Caltrans Regional Planning Grant, will coordinate planning efforts to ensure the Bay Area transportation system is more resilient to increased flooding and sea-level rise, while improving the safety and sustainability of communities, particularly the most vulnerable and disadvantaged communities.

The City will also participate in regional pilots and programs. For example, the City of Oakland serves on the executive board of the Bay Area Resilient by Design challenge, a nine-county pilot to co-create a vision for climate adaptation along shorelines as the rate of sea-level rise, extreme storms, and urban flooding accelerates.

Oakland will proactively prepare its infrastructure and communities for climate and seismic risks through physical retrofits, planning, and community engagement. Oakland will use green infrastructure to manage stormwater, which can reduce flood risks while providing urban greening benefits, such as improved air quality and reduced urban heat island effects. This is especially beneficial for neighborhoods that have limited access to parks and green space.

Bringing Oakland into the 21st century will require a significant amount of investment. Oakland is exploring piloting new financing opportunities and will replicate the most promising methods.

16.2 POTENTIAL IMPACT ON HAZARDS OF CONCERN

The following sections provide information on how each hazard of concern identified for this planning process may be impacted by climate change and how these impacts may alter current exposure and vulnerability to these hazards for the people, property, critical facilities and environment in the planning area.

16.2.1 Dam Failure

Climate Change Impacts on the Hazard

On average, changes in California's annual precipitation levels are not expected to be dramatic; however, small changes may have significant impacts for water resource systems, including dams. Dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all of its designed margin of safety, also known as freeboard.

If the freeboard of a dam is reduced, dam operators may be forced to release increased volumes earlier in a storm cycle in order to maintain the required margins of safety. Such early releases of increased volumes can increase flood potential downstream. The California Division of Safety of Dams has indicated that climate change may result in the need for increased safety precautions to address higher winter runoff, frequent fluctuations of water levels, and increased potential for sedimentation and debris accumulation from changing erosion patterns and increases in wildfires. According to the Division of Safety of Dams, climate change also will impact the ability of dam operators to estimate extreme flood events (DWR, 2008).

Exposure and Vulnerability

The following summarizes changes in exposure and vulnerability to the dam failure hazard resulting from climate change:

- **Population**—Population exposure and vulnerability to the dam failure hazard are unlikely to change because of climate change.
- **Property**—Property exposure and vulnerability to the dam failure hazard are unlikely to change because of climate change.
- **Critical facilities**—The exposure and vulnerability of critical facilities are unlikely to change as result of climate change. Dam owners and operators are sensitive to the risk and may need to alter maintenance and operations to account for changes in the hydrograph and increased sedimentation. Critical facility owners and operators in levee failure inundation areas should always be aware of residual risk from flood events that may overtop the levee system.
- **Environment**—The exposure and vulnerability of the environment to dam and levee failure are unlikely to change because of climate change. Ecosystem services may be used to mitigate some factors that could increase the risk of design failures, such as increasing the natural water storage capacity in watersheds above dams.

- **Economy**—Changes in the dam failure hazard related to climate change are unlikely to affect the local economy. Economic impacts may result from changes to the levee failure hazard if accreditation is lost.

16.2.2 Drought

Climate Change Impacts on the Hazards

The long-term effects of climate change on regional water resources are unknown, but global water resources are already experiencing the following stresses without climate change:

- Growing populations
- Increased competition for available water
- Poor water quality
- Environmental claims
- Uncertain reserved water rights
- Groundwater overdraft
- Aging urban water infrastructure

With a warmer climate, droughts could become more frequent, more severe, and longer lasting. The *Fourth National Climate Assessment Report for the United States* indicates that "rising air and water temperatures and changes in precipitation are intensifying droughts" while "heat-related deaths are projected to increase…[with] increases in heat-related deaths…expected to outpace reductions in cold-related deaths" (Globalchange.gov, 2018).

Because changes in precipitation patterns are still uncertain, the potential impacts and likelihood of drought are uncertain. The Department of Water Resources (DWR) has noted impacts of climate change on statewide water resources by charting changes in snowpack, sea level, and river flow. As temperatures rise and more precipitation comes in the form of rain instead of snow, these changes will likely continue or grow even more significant. DWR estimates that parts of the state will experience a 48 to 65 percent loss in snowpack by the end of the century compared to historical averages (DWR, 2013). Increasing temperatures may also increase net evaporation from reservoirs by 15 to 37 percent (DWR, 2013). The planning area's water supply is derived from groundwater. Increased incidence of drought may cause a drawdown in groundwater resources without allowing for the opportunity for aquifer recharge.

The increase in average surface temperatures can lead to more intense extreme heat events that can be exacerbated in the City of Oakland. Evidence suggests that extreme heat events are already increasing, especially in western states. Extreme heat days in the planning area are likely to increase, potentially leading to increased power outage, increased utility rates, and heat-related illnesses and/or deaths. These effects are likely to be exacerbated within the City of Oakland's vulnerable populations.

Exposure and Vulnerability

The following summarizes changes in exposure and vulnerability to the drought hazard resulting from climate change:

- **Population**—Population exposure and vulnerability to drought are unlikely to increase because of climate change. While greater numbers of people may need to engage in behavior change, such as water saving efforts, significant life or health impacts are unlikely.
- **Property**—Property exposure and vulnerability may increase as a result of increased drought resulting from climate change, although this would most likely occur in non-structural property such as crops and landscaping. It is unlikely that structure exposure and vulnerability would increase as a direct result of drought, although secondary impacts of drought, such as wildfire and power outages, may increase and threaten structures.
- **Critical facilities**—Critical facility exposure and vulnerability are unlikely to increase as a result of increased drought resulting from climate change; however, critical facility operators may be sensitive to changes and need to alter standard management practices and actively manage resources, particularly in water-related service sectors.
- **Environment**—The vulnerability of the environment may increase because of increased drought resulting from climate change. Prolonged or more frequent drought resulting from climate change may stress ecosystems in the region, including any special-status species.
- **Economy**—Increased incidence of drought could increase the potential for impacts on the local economy. Water-related businesses (such as sales of boats and fishing equipment) may experience reduced revenue.

16.2.3 Earthquake

Climate Change Impacts on the Hazard

The impacts of global climate change on earthquake probability are unknown. Secondary impacts of earthquakes could be magnified by climate change. Soils saturated by repetitive storms or heavy precipitation could experience liquefaction during seismic activity due to the increased saturation. Dams storing increased volumes of water due to changes in the hydrograph could fail during seismic events.

Exposure and Vulnerability

Because impacts of climate change on the earthquake hazard are not well understood, increases in exposure and vulnerability of the local resources are not able to be determined.

16.2.4 Flood

Climate Change Impacts on the Hazard

Use of historical hydrologic data has long been the standard of practice for designing and operating water supply and flood protection projects. For example, historical data are used for flood forecasting models and to forecast snowmelt runoff for water supply. This method of forecasting assumes that the climate of the future will be similar to that of the period of historical record. However, scientists project greater storm intensity with climate change, resulting in more direct runoff and flooding. High frequency flood events (e.g. 10-year floods) in particular will likely increase with a changing climate. What is currently considered a 1-percent-annual-chance (100-year flood) also may strike more often, leaving many communities at greater risk. Going forward, model calibration must happen more frequently, new forecast-based tools must be developed, and a standard of practice that explicitly considers climate change must be adopted.

Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied on to forecast the water future.
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management and ecosystem functions.
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness and emergency response.

The amount of snow is critical for water supply and environmental needs, but so is the timing of snowmelt runoff into rivers and streams. Rising snowlines caused by climate change will allow more mountain areas, such as the Sierra Nevada watersheds, to contribute to peak storm runoff. Changes in watershed vegetation and soil moisture conditions will likewise change runoff and recharge patterns. As stream flows and velocities change, erosion patterns will also change, altering channel shapes and depths, possibly increasing sedimentation behind dams, and affecting habitat and water quality.

Exposure and Vulnerability

The following summarizes changes in exposure and vulnerability to the flood hazard resulting from climate change:

- **Population and Property**—Population and property exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change, resulting in flooding in areas where it has not previously occurred.
- **Critical facilities—**Critical facility exposure and vulnerability may increase as a result of climate change impacts on the flood hazard. Runoff patterns may change, resulting in risk to facilities that have not historically been at risk from flooding. Changes in the management and design of flood protection critical facilities may be needed as additional stress is placed on these systems. Planners will need to factor a new level of safety into the design, operation, and regulation of flood protection facilities such as dams, bypass channels and levees, as well as the design of local sewers and storm drains.
- **Environment—**The exposure and vulnerability of the environment may increase as a result of climate change impacts on the flood hazard. Changes in the timing and frequency of flood events may have broader ecosystem impacts that alter the ability of already stressed species to survive.
- **Economy—**If flooding becomes more frequent, there may be impacts on the local economy. More resources may need to be directed to response and recovery efforts, and businesses may need to close more frequently due to loss of service or access during flood events.

16.2.5 Landslide

Climate Change Impacts on the Hazard

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature is likely to affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences.

Exposure and Vulnerability

The following summarizes changes in exposure and vulnerability to the landslide hazard resulting from climate change:

- **Population and Property**—Population and property exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the landslide hazard. Landslide events may occur more frequently, but the extent and location should be contained within mapped hazard areas or recently burned areas.
- **Critical facilities**—Critical facility exposure and vulnerability would be unlikely to increase as a result of climate change impacts on the landslide hazard; however, critical facility owners and operators may experience more frequent disruption to service provision as a result of landslide hazards. For example, transportation systems may experience more frequent delays if slides blocking these systems occur more frequently. In addition, increased sedimentation resulting from landslides may negatively impact flood control facilities, such as dams.
- **Environment**—Exposure and vulnerability of the environment would be unlikely to increase as a result of climate change, but more frequent slides in river systems may impact water quality and have negative impacts on stressed species.
- **Economy**—Changes to the landslide hazard resulting from climate change are unlikely to result in impacts on the local economy; but impacts may be felt if the limited major highways in the planning area are repeatedly impacted.

16.2.6 Sea-Level Rise

Climate Change Impacts on the Hazard

Climate change is expected to have a large effect on sea-level rise. As temperatures increase, polar ice caps are expected to melt at an increasingly expedited rate. Sea-level rise will likely result in non-rain flood conditions, as well as the extension of tsunami inundation areas further into Oakland communities. Infrastructure systems that support Oakland businesses and communities will also likely be impacted as rising sea levels expose infrastructure to salt water.

Exposure and Vulnerability

As land area in Oakland is likely to be inundated by sea-level rise over the next few decades, exposure and vulnerability to sea-level rise are highly likely to increase for population, property, critical facilities, and the environment. Changes to the sea-level rise hazard from climate change may result in greater economic vulnerability in a larger number of communities, businesses, and economic centers in Oakland, as well as their supporting infrastructure systems.

16.2.7 Severe Weather

Climate Change Impacts on the Hazard

Climate change presents a challenge for risk management associated with severe weather. The science for linking the severity of specific severe weather events to climate change is still evolving; however, some trends provide an indication of how climate change may be impacting these events.

The increase in average surface temperatures can lead to more intense heat waves. Evidence suggests that heat waves are already increasing, especially in western states. Extreme heat days in the planning area are likely to increase. The *Fourth National Climate Assessment Report for the United States* indicates that "heat-related deaths are projected to increase…[with] increases in heat-related deaths…expected to outpace reductions in cold-related deaths" (Globalchange.gov, 2018).

Climate change impacts on other severe weather events, such as high winds and thunderstorms, are still not well understood.

Exposure and Vulnerability

The following summarizes changes in exposure and vulnerability to the extreme heat hazard resulting from climate change:

- **Population**—Population exposure and vulnerability to extreme heat are likely to increase because of climate change. Due to secondary impacts, such as more frequent power outages, extreme heat events may result in more people being exposed to high temperatures without access to cooling capabilities.
- **Property**—Property exposure and vulnerability may increase as a result of increased extreme heat resulting from climate change, although this would most likely occur in non-structural property such as crops and landscaping. It is unlikely that structure exposure and vulnerability would increase as a direct result of extreme heat, although secondary impacts, such as wildfire and power outages, may increase and threaten structures.
- **Critical facilities**—Critical facility exposure and vulnerability are unlikely to increase as a result of increased extreme heat resulting from climate change; however, facility owners and operators may experience more frequent disruption to service provision. For example, more frequent and intense heat events may cause more frequent disruptions in power service.
- **Environment**—Exposure and vulnerability of the environment would be unlikely to increase from extreme heat events; however, more frequent heat events may place additional stress on already stressed systems.
- **Economy**—Extreme heat events may impact the local economy through more frequent disruption to services, such as power outages.

16.2.8 Tsunami/Seiche

Climate Change Impacts on the Hazard

The impacts of global climate change on tsunami probability are unknown. Even if climate change does not increase the frequency with which tsunamis occur, it may result in more destructive waves. As sea levels continue to rise, tsunami inundation areas would likely reach further into communities than current mapping indicates.

Exposure and Vulnerability

As land area likely to be inundated by tsunami waves increases, exposure and vulnerability to the tsunami hazard may increase for population, property, critical facilities, and the environment. Changes to the tsunami hazard from climate change may result in more direct economic impacts on a greater number of businesses and economic centers, as well as the infrastructure systems that support those businesses.

16.2.9 Wildfire

Climate Change Impacts on the Hazard

Climate change has the potential to affect multiple elements of the wildfire system: fire behavior, ignitions, fire management, and vegetation fuels. Hot dry spells create the highest fire risk. Increased temperatures may intensify wildfire danger by warming and drying out vegetation. *California's Fourth Climate Change Assessment – North Coast Regional Report* states that "wildfires will continue to be a major disturbance in the region. Future wildfire projections suggest a longer fire season, an increase in wildfire frequency, and an expansion of the area susceptible to fire."

Changes in climate patterns may impact the distribution and perseverance of insect outbreaks that create dead trees (increase fuel). When climate alters fuel loads and fuel moisture, forest susceptibility to wildfires changes. Climate change also may increase winds that spread fires. Faster fires are harder to contain, and thus are more likely to expand into residential neighborhoods.

Exposure and Vulnerability

The following summarizes changes in exposure and vulnerability to the wildfire hazard resulting from climate change:

- **Population, Property and Critical facilities** —Any increase in the frequency and physical extent of wildfires has the potential to increase the exposure and vulnerability of people, property, and critical facilities if the increased fire range extends into developed, populated areas.
- **Environment**—It is possible that the exposure and vulnerability of the environment will be impacted by changes in wildfire risk due to climate change. Natural fire regimes may change, resulting in more or less frequent or higher intensity burns. These impacts may alter the composition of the ecosystems in areas in and surrounding the planning area. If more acres are burned every year, wildlife may be more stressed as the suitable habitat is lost.
- **Economy**—If more acres of timber burn every year, the local economy may be impacted. Secondary impacts, such as decreased air quality and visibility, may also impact the local economy.

16.3 ISSUES

The major issues for climate change are the following:

- Planning for climate-change-related impacts can be difficult due to inherent uncertainties in projection methodologies.
- Average temperatures are expected to continue to increase in the planning area, which may lead to a host of primary and secondary impacts, such as an increased incidence of heat waves.
- Expected changes in precipitation patterns are still poorly understood and could have significant impacts on localized flooding in the planning area.
- Heavy rain events may result in flooding after stormwater management systems are overwhelmed.

17. HAZARDS OF INTEREST

17.1 HAZARDOUS MATERIALS AND RADIOLOGICAL INCIDENTS

Hazardous materials are present in every city and county in the United States in facilities that produce, store, or use them. Hazardous material is defined in different ways, depending on different laws and regulations administered by the Environmental Protection Agency, the Occupational Safety and Health Administration, the U.S. Department of Transportation, and the U.S. Nuclear Regulatory Commission. Title 49 of the CFR lists thousands of materials that are hazardous. Hazardous materials, hazardous substances, and toxic materials are defined by their properties and use. State regulated substances that have the greatest probability of adversely impacting the community are listed in the California Code of Regulations Title 19.

The Safety Element of the Oakland General Plan includes a detailed discussion of hazardous materials. The California Environmental Protection Agency has designated the Alameda County Department of Environmental Health as the Certified Unified Program Agency for the City of Oakland.

17.2 PUBLIC HEALTH INCIDENTS

17.2.1 Pandemic

Widespread public health emergencies, referred to as pandemics, occur when a disease emerges to which the population has little immunity. Public health experts are always concerned about the risk of a pandemic where a disease spreads between and among species. Depending on the nature of such a disease, between 25 and 35 percent of the population can become ill, potentially disrupting all aspects of society and severely affecting the economy.

The current COVID-19 pandemic has made this a clearly recognized hazard in all parts of the world, but such events have historical precedent as well. The 20th century saw three severe pandemics, the most notable of which was the 1918 Spanish influenza pandemic that was responsible for 20 to 40 million deaths worldwide.

Alameda County was included in the 2020 federal disaster declaration for the COVID-19 pandemic. As of February 2021, there were almost 80,000 cases in Alameda County, with almost 25,000 coming from the City of Oakland (Alameda County Health Care Services Agency, 2020).

17.2.2 Economic-Related Public Health Issues

According to the Alameda County Public Health Department, the high cost of housing has created a public health crisis for the county. In data published between 2012 and 2014, Alameda County residents who spent 35 percent of their income on housing were twice as likely to be hospitalized for hypertension or mental illness as residents who spent less than 25 percent on their income on housing (SFGate, 2016). Hypertension and asthma rates also are increasing due to increased rents and a lack of stability for residents.

An emerging picture from a new data analysis suggests that as the housing crisis continues to deepen in Oakland. Lower-income residents are in effect becoming trapped in the only housing they can afford—with housing conditions that have the potential to cause serious health consequences, especially to young children. Key health outcomes include lead poisoning and asthma, which occur at higher rates in neighborhoods lacking safe, decent, and affordable housing. These neighborhoods have higher poverty, fewer resources, and weaker infrastructure to support good health, as well as greater exposure to health risks. The shortest life expectancies are concentrated in these places. Recent data (2011 – 2015) showed a 20-year difference in life expectancy between a community in West Oakland and a community in the Northwest Hills of Oakland (Alameda County Public Health, 2018).

17.2.3 Alameda County Public Health Department

Alameda County Public Health Department has an array of programs and services to protect the health and safety of County residents. The agency serves 1.5 million residents in unincorporated county areas and 13 cities (Albany, Emeryville, Alameda, Piedmont, Oakland, San Leandro, Hayward, Union City, Fremont, Newark, Dublin, Pleasanton, Livermore; the City of Berkeley has its own health department). The backbone of Public Health includes assessments of the health status of residents, disease prevention and control, community mobilization and outreach, policy development, education, and assurance of access to quality medical and health care services. To be effective, they actively seek community involvement – partnerships with grass roots and corporate entities, with individuals and groups.

17.3 TERRORISM, ACTIVE SHOOTER, CYBER-TERRORISM, CIVIL UNREST

Terrorism, active shooter incidents, cyber-terrorism and civil unrest are similar in that they are all human-caused and criminal activities. Some rise to the level of a disaster, and some are more localized. Businesses, government agencies, transportation infrastructure, historic sites, and cultural facilities are all vulnerable to a terrorist attack. Terrorism is a continuing threat throughout worldwide. Due to the hardening of previous terrorism targets, a recent trend is for terrorists to pursue soft targets where numerous people gather that remain relatively unprotected —shopping malls, hotels, concert or sports venues, restaurants, bars, nightclubs, movie theaters, and transportation centers. Terrorists typically target civilians with a goal of instilling fear to advance their agenda. The media interest generated by terrorist attacks makes this a high visibility threat. A variety of political, social, religious, cultural, and economic factors underlie terrorist activities.

According to the Federal Bureau of Investigation, cyberterrorism is any "premeditated, politically motivated attack against information, computer systems, computer programs, and data which results in violence against non-combatant targets by sub-national groups or clandestine agents."

Civil unrest refers to acts of violence and disorder detrimental to the public law and order. It includes riots, vandalism, insurrections, unlawful obstructions, or assemblages. Federal law defines "civil disorder" as any public disturbance involving acts of violence by assemblages of three or more persons, which causes an immediate danger of or results in damage or injury to the property or person of any other individual.

Oakland has not had any acts of terrorism in the city. There have been riotous activities in the city, but none classified at the level of civil unrest. There have been shootings in the city, but no active shooter incidents.

18. RISK RANKING

FEMA requires all hazard mitigation plans to include mitigation actions based on local risk, vulnerability, and community priorities (FEMA, 2011). For this plan, risk was calculated by multiplying probability by impact on people, property and the economy. The risk estimates were generated using methodologies promoted by FEMA. The Steering Committee reviewed, discussed, and approved the methodology and results.

Numerical ratings of probability and impact were based on the hazard profiles and exposure and vulnerability evaluations presented in Chapters 7 through 15. Using that data, the City ranked the risk of all the natural hazards of concern described in this plan. When available, estimates of risk were generated with data from Hazus or GIS. For hazards of concern with less specific data available, qualitative assessments were used. As appropriate, results were adjusted based on local knowledge and other information not captured in the quantitative assessments. The hazards of interest described in Chapter 17 were not ranked for the following reasons:

- A key component of risk for the planning effort is probability of occurrence. The hazards of interest lack historical precedent for establishing recurrence intervals.
- Federal hazard mitigation planning regulations do not require the assessment of non-natural hazards (44 CFR, 201.6). It is FEMA's position that this is a local decision.

Risk ranking results are used to help establish mitigation priorities and inform the development of a mitigation action plan. The action plan includes mitigation actions, at a minimum, to address each hazard with a "high" or "medium" risk ranking. Actions that address hazards with a low or no hazard ranking are optional.

Risk was ranked for each hazard of concern by sub-area within the City. Each sub-area has received its own separate ranking of risk. The following sections provide the aggregate results for the City as a whole. See Appendix E for the ranking of risk by sub-area.

18.1 PROBABILITY OF OCCURRENCE

The probability of occurrence of a hazard is indicated by a factor based on likelihood of annual occurrence:

- High—Hazard event is likely to occur within 25 years (Probability Factor = 3)
- Medium—Hazard event is likely to occur within 100 years (Probability Factor =2)
- Low—Hazard event is not likely to occur within 100 years (Probability Factor =1)
- No exposure—There is no probability of occurrence (Probability Factor = 0)

The assessment of hazard frequency is generally based on past natural hazard events in the area. Table 18-1 summarizes the probability assessment for each natural hazard of concern for this plan.

Table 18-1. Probability of Hazards

Hazard Event	Probability (high, medium, low)	Probability Factor
Dam Failure	Medium	2
Drought	High	3
Earthquake	High	3
Flood	High	3
Landslide	High	3
Sea-level rise	High	3
Severe Weather (Heat and Wind)	High	3
Tsunami/Seiche	Low	1
Wildfire	High	3

18.2 IMPACT

Hazard impacts were assessed in three categories: impacts on people, impacts on property and impacts on the local economy. Numerical impact factors were assigned as follows:

- **People**—Values were assigned based on the percentage of the total ***population exposed*** to the hazard event. The degree of impact on individuals will vary and is not measurable, so the calculation assumes for simplicity and consistency that all people exposed to a hazard because they live in a hazard zone will be equally impacted when a hazard event occurs. Impact factors were assigned as follows:
  - High—50 percent or more of the population is exposed to a hazard (Impact Factor = 3)
  - Medium—25 percent to 49 percent of the population is exposed to a hazard (Impact Factor = 2)
  - Low—25 percent or less of the population is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the population is exposed to a hazard (Impact Factor = 0)

  These quantitative values may be subjectively modified based on known experience.
- **Property**—Values were assigned based on the percentage of the total ***property value exposed*** to the hazard event:
  - High—30 percent or more of the total assessed property value is exposed to a hazard (Impact Factor = 3)
  - Medium—15 percent to 29 percent of the total assessed property value is exposed to a hazard (Impact Factor = 2)
  - Low—14 percent or less of the total assessed property value is exposed to the hazard (Impact Factor = 1)
  - No impact—None of the total assessed property value is exposed to a hazard (Impact Factor = 0)
- **Economy**—Values were assigned based on the percentage of the total ***property value vulnerable*** to the hazard event. Values represent estimates of the loss from a major event of each hazard in comparison to the total replacement value of the property exposed to the hazard. For some hazards, such as severe weather, vulnerability was considered to be the same as exposure due to the lack of loss estimation tools specific to those hazards. Loss estimates separate from the exposure estimates were generated for the earthquake and flood hazards using Hazus.
  - High—Estimated loss from the hazard is 20 percent or more of the total exposed property value (Impact Factor = 3)
  - Medium—Estimated loss from the hazard is 10 percent to 19 percent of the total exposed property value (Impact Factor = 2)

- Low—Estimated loss from the hazard is 9 percent or less of the total exposed property value (Impact Factor = 1)
- No impact—No loss is estimated from the hazard (Impact Factor = 0)

The impacts of each hazard were assigned a weighting factor to reflect the significance of the impact. These weighting factors are consistent with those typically used for measuring the benefits of hazard mitigation actions: impact on people was given a weighting factor of 3; impact on property was given a weighting factor of 2; and impact on the economy was given a weighting factor of 1. Table 18-2 summarizes the impact ratings of each hazard.

Table 18-2. Impact of Hazards on People, Property, and the Economy

	Impact on People			Impact on Property			Impact on Economy		
Hazard Event	Impact	Impact Factor[a]	Multiplied by Weighting Factor[b]	Impact	Impact Factor[a]	Multiplied by Weighting Factor[b]	Impact	Impact Factor[a]	Multiplied by Weighting Factor[b]
Dam Failure	Medium	2	3x2=6	Medium	2	2x2=4	Medium	2	1x2=2
Drought	None	0	3x0=0	None	0	2x0=0	Medium	2	1x2=2
Earthquake	High	3	3x3=9	*High*	3	2x3=6	High	3	1x3=3
Flood	Low	1	3x1=3	Low	1	2x1=2	Low	1	1x1=1
Landslide	High	3	3x3=9	Medium	2	2x2=4	Low	1	1x1=1
Sea-Level Rise	Low	1	3x1=3	Medium	2	2x2=4	Low	1	1x1=1
Severe Weather	High	3	3x3=9	Low	1	2x1=2	Medium	2	1x2=2
Tsunami	Low	1	3x1=3	Medium	2	2x2=4	Medium	2	1x2=2
Wildfire	Medium	2	3x2=6	Medium	2	2x2=4	Low	1	1x1=1

a. Impact factors as follows: None = 0; Low = 1; Medium = 2; High = 3
b. Weighting factors as follows: 3 for impacts on people; 2 for impacts on property; 1 for impacts on the economy

18.3 RISK RATING AND RANKING

The risk rating for each hazard was determined by multiplying the probability factor by the sum of the weighted impact factors for people, property, and the economy, as summarized in Table 18-3. Based on these ratings, a priority of high, medium, or low was assigned to each hazard, as shown on Figure 18-1.

Table 18-3. Hazard Risk Rating

Hazard Event	Probability Factor	Sum of Weighted Impact Factors	Total (Probability x Impact)
Dam Failure	2	(6+4+2) = 12	2x12=24
Drought	3	(0+0+2) = 2	3x2=6
Earthquake	3	(9+6+3) = 18	3x18=54
Flood	3	(3+2+1) = 6	3x6 = 18
Landslide	3	(9+4+1) = 14	3x14=42
Sea-level rise	3	(3+4+1) = 8	3x8 = 24
Severe Weather	3	(9+2+2) = 13	3x13= 39
Tsunami	1	(3+4+2) = 9	1x9=9
Wildfire	3	(6+4+1) = 11	3x11 = 33

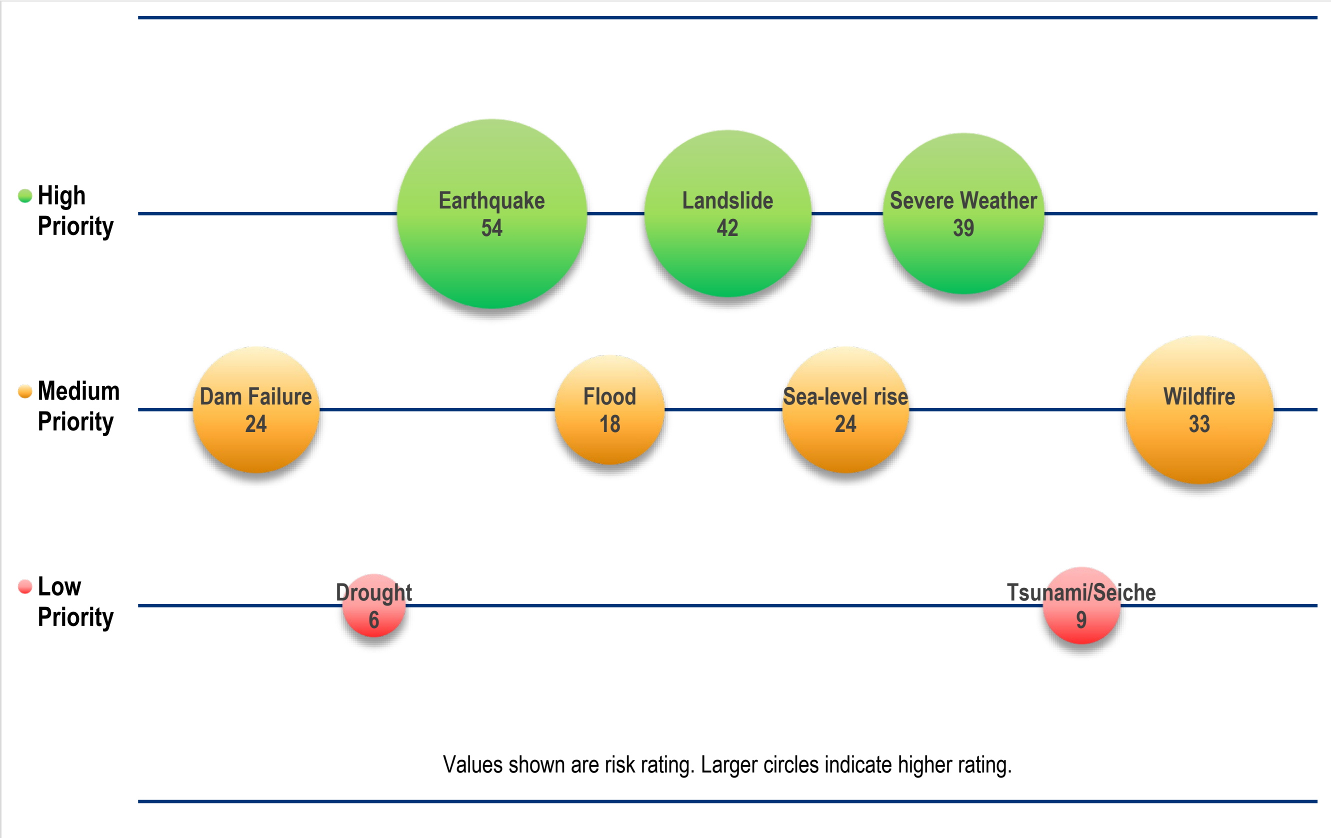


Figure 18-1. Hazard Risk Ranking

City of Oakland 2021 – 2026 Hazard Mitigation Plan

PART 3—MITIGATION STRATEGY

19. MISSION STATEMENT, GOALS AND OBJECTIVES

Hazard mitigation plans must identify goals for reducing long-term vulnerabilities to identified hazards (44 CFR Section 201.6(c)(3)(i)). The Steering Committee established a mission statement, a set of goals and measurable objectives for this plan, based on data from the preliminary risk assessment and the results of the public involvement strategy. The mission statement, goals, objectives, and actions in this plan all support each other. Goals were selected to support the mission statement. Objectives were selected that meet multiple goals. Actions were prioritized based on ability to accomplish multiple objectives.

19.1 MISSION STATEMENT

The City's 2016 hazard mitigation plan did not include a mission statement. The Steering Committee determined the need for a mission statement for the current plan, reviewed several example mission statements, and approved the following as the statement through consensus of the Steering Committee members:

> To equitably reduce risk and increase resilience, the mission of the City of Oakland Local Hazard Mitigation Plan is to establish and promote a comprehensive mitigation strategy and efforts to protect the Whole Community and environment from identified natural and manmade hazards.

19.2 GOALS

The Steering Committee revised the goals and objectives from the previous plan through an exercise consisting of the review of numerous example goals. The committee selected the following goals for the 2021 hazard mitigation plan:

1. Protect life, property, the environment, and natural and cultural resources.
2. Increase public awareness of and the prevention and preparedness for risks.
3. Coordinate with other programs that can support or enhance hazard mitigation.
4. Increase the effectiveness of emergency services provided to the City.
5. Pursue feasible, cost-effective, and environmentally sound hazard mitigation measures.
6. Increase adaptive capacity to reduce risk from hazard impacts based on a changing climate.
7. Reduce racial disparities in how communities prepare for, respond to, and recover from local hazards.

19.3 OBJECTIVES

The Steering Committee reviewed example objectives and identified the following objectives for this plan, based on approval by more than 50 percent of committee members:

1. Reduce repetitive losses due to flood, fire, and earthquake by informing land use, design, and construction policies.
2. Identify natural and manmade hazards that threaten life and property in the City.
3. Use best available hazard data while reviewing proposed development opportunities.
4. Encourage the incorporation of hazard mitigation measures into repairs, major alterations, new development, and redevelopment practices, especially in areas subject to substantial hazard risk.
5. Encourage and support leadership within the private sector, non-profit agencies and community-based organizations to promote and implement local hazard mitigation activities.
6. Incorporate risk reduction considerations in new and updated infrastructure and development plans to reduce the impacts of hazards.
7. Continue providing City emergency services staff with training and equipment to address all identified hazards.
8. Develop and provide updated information about threats, hazards, vulnerabilities, and mitigation strategies to state, regional, and local agencies, as well as private sector and nonprofit groups.
9. Establish and maintain partnerships among all levels of government, private sector, community groups, and institutions of higher learning that improve and implement methods to protect life and property.
10. Create financial and regulatory incentives to motivate stakeholders such as homeowners, private sector businesses, and nonprofit community organizations to mitigate hazards and risk.
11. Continue developing and strengthening inter-jurisdictional coordination and cooperation in the area of emergency services.
12. Support the protection of vital records, and strengthen or replace buildings, infrastructure, and lifelines to minimize post-disaster disruption and facilitate short-term and long-term recovery.
13. Coordinate state and local efforts to reduce greenhouse gas emissions and implement climate action strategies through hazard mitigation plans and actions.
14. Implement hazard mitigation programs and projects that protect life, property, and the environment.
15. Promote and implement hazard mitigation plans and projects that are consistent with state, regional and local climate adaptation goals, policies, and programs.
16. Advance community resilience through preparation, adoption, and implementation of state, regional, and local multi-hazard mitigation plans and projects.
17. Prioritize vulnerable populations in policy responses, including but not limited to, low-income individuals and families; people of color; the young; the elderly; people with disabilities; people with existing health issues; and people with limited English proficiency.

20. MITIGATION BEST PRACTICES AND ADAPTIVE CAPACITY

20.1 MITIGATION BEST PRACTICES

Catalogs of hazard mitigation best practices were developed that present a broad range of alternatives to be considered for use in the mitigation action plan, in compliance with 44 CFR (Section 201.6(c)(3)(ii)). One catalog was developed for each hazard of concern evaluated in this plan. The catalogs present alternatives that are categorized in two ways:

- By who would have responsibility for implementation:
  - Individuals (personal scale)
  - Businesses (corporate scale)
  - Government (government scale).
- By what the alternative would do:
  - Manipulate the hazard
  - Reduce exposure to the hazard
  - Reduce vulnerability to the hazard
  - Increase the ability to respond to or be prepared for the hazard.

The catalogs are lists of what could be considered to reduce risk from natural hazards in the planning area. They include practices that will mitigate current risk from hazards or help reduce new risk resulting from climate change. The catalogs provide a baseline of mitigation alternatives that are backed by a planning process and are consistent with the established goals and objectives. Best practices in the catalog that are not included in the action plan were omitted for one or more of the following reasons:

- The action is not feasible.
- The action is already being implemented.
- The City does not have the capability to implement the action.
- There is an apparently more cost-effective alternative.
- The action does not have public or political support.

The collections for each hazard are presented in Table 20-1 through Table-20-9.

Table 20-1. Alternatives to Mitigate the Dam Failure Hazard

Personal-Scale	Corporate-Scale	Government-Scale
Manipulate the hazard: ❖ None **Reduce exposure to the hazard:** ❖ Relocate out of dam failure inundation zone. **Reduce vulnerability to the hazard:** ❖ Elevate home to appropriate levels. **Increase the ability to respond to or be prepared for the hazard:** ❖ Learn about risk reduction for the dam failure hazard. ❖ Learn the evacuation routes for a dam failure event. ❖ Educate yourself on early warning systems and the dissemination of warnings.	**Manipulate the hazard:** ❖ Remove dams. ❖ Remove levees. ❖ Harden dams. **Reduce exposure to the hazard:** ❖ Relocate critical facilities out of dam failure inundation zone. **Reduce vulnerability to the hazard:** ❖ Flood-proof facilities within dam failure inundation zone. **Increase the ability to respond to or be prepared for the hazard:** ❖ Educate employees on the probable impacts of a dam failure. ❖ Develop a continuity of operations plan.	**Manipulate the hazard:** ❖ Remove dams. ❖ Remove levees. ❖ Harden dams. **Reduce exposure to the hazard:** ❖ Relocate critical facilities out of dam failure inundation zone. ❖ Consider open space land use in designated dam failure inundation zone. **Reduce vulnerability to the hazard:** ❖ Adopt higher floodplain standards in mapped dam failure inundation zone. ❖ Retrofit critical facilities within dam failure inundation zone. **Increase the ability to respond to or be prepared for the hazard:** ❖ Map dam failure inundation zone. ❖ Enhance emergency operations plan to include a dam failure component. ❖ Institute monthly communications checks with dam operators. ❖ Inform the public on risk reduction techniques ❖ Adopt real-estate disclosure requirements for the re-sale of property located within dam failure inundation zone. ❖ Consider the probable impacts of climate in assessing the risk associated with the dam failure hazard. ❖ Establish early warning capability downstream of listed high hazard dams. ❖ Consider the residual risk associated with protection provided by dams in future land use decisions.

Table 20-2. Alternatives to Mitigate the Drought Hazard

Personal-Scale	Corporate-Scale	Government-Scale
Manipulate the hazard: ❖ None **Reduce exposure to the hazard:** ❖ None **Reduce vulnerability to the hazard:** ❖ Drought-resistant landscapes ❖ Reduce water system losses ❖ Modify plumbing systems (through water saving kits) **Increase the ability to respond to or be prepared for the hazard:** ❖ Practice active water conservation	**Manipulate the hazard:** ❖ None **Reduce exposure to the hazard:** ❖ None **Reduce vulnerability to the hazard:** ❖ Drought-resistant landscapes ❖ Reduce private water system losses **Increase the ability to respond to or be prepared for the hazard:** ❖ Practice active water conservation	**Manipulate the hazard:** ❖ Groundwater recharge through stormwater management **Reduce exposure to the hazard:** ❖ None **Reduce vulnerability to the hazard:** ❖ Identify and create groundwater backup sources ❖ Water use conflict regulations ❖ Reduce water system losses ❖ Distribute water saving kits **Increase the ability to respond to or be prepared for the hazard:** ❖ Public education on drought resistance ❖ Encourage recycling ❖ Identify alternative water supplies for times of drought; mutual aid agreements with alternative suppliers ❖ Develop drought contingency plan ❖ Develop criteria “triggers” for drought-related actions ❖ Improve accuracy of water supply forecasts ❖ Modify rate structure to influence active water conservation techniques

Table 20-3. Alternatives to Mitigate the Earthquake Hazard

Personal-Scale	Corporate-Scale	Government-Scale
Manipulate the hazard: ❖ None **Reduce exposure to the hazard:** ❖ Locate outside of hazard area (off soft soils) **Reduce vulnerability to the hazard:** ❖ Retrofit structure (anchor house structure to foundation) ❖ Secure household items that can cause injury or damage (such as water heaters, bookcases, and other appliances) ❖ Build to higher design **Increase the ability to respond to or be prepared for the hazard:** ❖ Practice "drop, cover, and hold" ❖ Develop household mitigation plan, such as creating a retrofit savings account, communication capability with outside, 72-hour self-sufficiency during an event ❖ Keep cash reserves for reconstruction ❖ Become informed on the hazard and risk reduction alternatives available. ❖ Develop a post-disaster action plan for your household	**Manipulate the hazard:** ❖ None **Reduce exposure to the hazard:** ❖ Locate or relocate mission-critical functions outside hazard area where possible **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical functions and facilities ❖ Retrofit critical buildings and areas housing mission-critical functions **Increase the ability to respond to or be prepared for the hazard:** ❖ Adopt higher standard for new construction; consider "performance-based design" when building new structures ❖ Keep cash reserves for reconstruction ❖ Inform your employees on the possible impacts of earthquake and how to deal with them at your work facility. ❖ Develop a continuity of operations plan	**Manipulate the hazard:** ❖ None **Reduce exposure to the hazard:** ❖ Locate critical facilities or functions outside hazard area where possible **Reduce vulnerability to the hazard:** ❖ Harden infrastructure ❖ Provide redundancy for critical functions ❖ Adopt higher regulatory standards **Increase the ability to respond to or be prepared for the hazard:** ❖ Provide better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (e.g., tax incentives, information) ❖ Include retrofitting and replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components such as pipe, power line, and road repair materials ❖ Develop and adopt a continuity of operations plan ❖ Initiate triggers guiding improvements (such as <50% substantial damage or improvements) ❖ Further enhance seismic risk assessment to target high hazard buildings for mitigation opportunities. ❖ Develop a post-disaster action plan that includes grant funding and debris removal components.

Table 20-4. Alternatives to Mitigate the Flood Hazard

Personal-Scale	Corporate-Scale	Government-Scale
Manipulate the hazard: ❖ Clear storm drains and culverts ❖ Use low-impact development techniques **Reduce exposure to the hazard:** ❖ Locate outside of hazard area ❖ Elevate utilities above base flood elevation ❖ Use low-impact development techniques **Reduce vulnerability to the hazard:** ❖ Raise structures above base flood elevation ❖ Elevate items within house above base flood elevation ❖ Build new homes above base flood elevation ❖ Flood-proof structures **Increase the ability to respond to or be prepared for the hazard:** ❖ Buy flood insurance ❖ Develop household plan, such as retrofit savings, communication with outside, 72-hour self-sufficiency during and after an event	**Manipulate the hazard:** ❖ Clear storm drains and culverts ❖ Use low-impact development techniques **Reduce exposure to the hazard:** ❖ Locate critical facilities or functions outside hazard area ❖ Use low-impact development techniques **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical functions or retrofit critical buildings ❖ Provide flood-proofing when new critical infrastructure must be located in floodplains **Increase the ability to respond to or be prepared for the hazard:** ❖ Keep cash reserves for reconstruction ❖ Support and implement hazard disclosure for sale of property in risk zones. ❖ Solicit cost-sharing with others on projects with multiple benefits.	**Manipulate the hazard:** ❖ Maintain drainage system ❖ Institute low-impact development techniques on property ❖ Dredging, levee construction, and providing regional retention areas ❖ Structural flood control, levees, channelization, or revetments. ❖ Stormwater management regulations and master planning ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff **Reduce exposure to the hazard:** ❖ Locate or relocate critical facilities outside of hazard area ❖ Acquire or relocate identified repetitive loss properties ❖ Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks. ❖ Adopt land development criteria such as planned unit developments, density transfers, clustering ❖ Institute low impact development techniques on property ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff **Reduce vulnerability to the hazard:** ❖ Harden infrastructure, bridge replacement program ❖ Provide redundancy for critical functions and infrastructure ❖ Adopt regulatory standards such as freeboard standards, cumulative substantial improvement or damage, lower substantial damage threshold; compensatory storage, non-conversion deed restrictions. ❖ Stormwater management regulations and master planning. ❖ Adopt "no-adverse impact" floodplain management policies that strive to not increase the flood risk on downstream communities. **Increase the ability to respond to or be prepared for the hazard:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) ❖ Incorporate retrofitting or replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Consider participation in the Community Rating System ❖ Maintain and collect data to define risks and vulnerability ❖ Train emergency responders ❖ Create an elevation inventory of structures in the floodplain ❖ Develop and implement a public information strategy ❖ Charge a hazard mitigation fee ❖ Integrate floodplain management policies into other planning mechanisms within the planning area. ❖ Consider the probable impacts of climate change on the risk associated with the flood hazard ❖ Consider residual risk associated with flood control in land use decisions ❖ Enforce National Flood Insurance Program ❖ Adopt a Stormwater Management Master Plan

Table-20-5. Alternatives to Mitigate the Landslide Hazard

Personal-Scale	Corporate-Scale	Government-Scale
Manipulate the hazard: ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope ❖ Minimize vegetation removal and the addition of impervious surfaces. **Reduce exposure to the hazard:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) **Reduce vulnerability to the hazard:** ❖ Retrofit home **Build local capacity to respond to or prepare for the hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Educate yourself on risk reduction techniques for landslide hazards	**Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope **Reduce exposure to the hazard:** ❖ Locate structures outside of hazard area (off unstable land and away from slide-run out area) **Reduce vulnerability to the hazard:** ❖ Retrofit at-risk facilities **Build local capacity to respond to or prepare for the hazard:** ❖ Institute warning system, and develop evacuation plan ❖ Keep cash reserves for reconstruction ❖ Develop a continuity of operations plan ❖ Educate employees on the potential exposure to landslide hazards and emergency response protocol.	**Manipulate the hazard:** ❖ Stabilize slope (dewater, armor toe) ❖ Reduce weight on top of slope **Reduce exposure to the hazard:** ❖ Acquire properties in high-risk landslide areas. ❖ Adopt land use policies that prohibit the placement of habitable structures in high-risk landslide areas. **Reduce vulnerability to the hazard:** ❖ Adopt higher regulatory standards for new development within unstable slope areas. ❖ Armor/retrofit critical infrastructure against the impact of landslides. **Build local capacity to respond to or prepare for the hazard:** ❖ Produce better hazard maps ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas: better land controls, tax incentives, information ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Warehouse critical infrastructure components ❖ Develop and adopt a continuity of operations plan ❖ Educate the public on the landslide hazard and appropriate risk reduction alternatives. ❖ Consider the probable impacts of climate change on the risk associated with the landslide hazard

Table-20-6. Alternatives to Mitigate the Sea-Level Rise Hazard

Personal-Scale	Corporate-Scale	Government-Scale
Manipulate the hazard: ❖ Barriers (Sea Wall) ❖ Pump Stations **Reduce exposure to the hazard:** ❖ Voluntary Retreat ❖ Elevate on fill above sea-level rise elevation ❖ Elevate utilities above base flood elevation ❖ Use low-impact development techniques **Reduce vulnerability to the hazard:** ❖ Elevate ❖ Floodproof **Build local capacity to respond to or prepare for the hazard:** ❖ Buy flood insurance ❖ Develop household plan, such as retrofit savings, communication with outside, 72-hour self-sufficiency during and after an event	**Manipulate the hazard:** ❖ Barriers (sea wall) ❖ Pump Stations **Reduce exposure to the hazard:** ❖ Relocate out hazard zone ❖ Elevate on fill above sea-level rise elevation ❖ Locate critical facilities or functions outside hazard area ❖ Use low-impact development techniques **Reduce vulnerability to the hazard:** ❖ Build redundancy for critical functions or retrofit critical buildings ❖ Provide flood-proofing when new critical infrastructure must be located in floodplains **Build local capacity to respond to or prepare for the hazard:** ❖ Be informed and understand future impacts of sea-level rise on your business ❖ Develop a Continuity of Operations Plan	**Manipulate the hazard:** ❖ Barriers (Sea wall) ❖ Pump Stations **Reduce exposure to the hazard:** ❖ Buyout/Relocation Program ❖ Promote open space uses in identified high hazard areas via techniques such as: planned unit developments, easements, setbacks, greenways, sensitive area tracks. ❖ Adopt land development criteria such as planned unit developments, density transfers, clustering ❖ Institute low impact development techniques on property ❖ Acquire vacant land or promote open space uses in developing watersheds to control increases in runoff **Reduce vulnerability to the hazard:** ❖ Harden Infrastructure ❖ Provide redundancy for critical functions and infrastructure ❖ Adopt higher regulatory standards in sea-level rise zones ❖ Facilitate managed retreat from, or upgrade of, the most at-risk areas ❖ Require accounting of sea-level rise in all applications for new development in shoreline areas **Build local capacity to respond to or prepare for the hazard:** ❖ Provide technical information and guidance ❖ Enact tools to help manage development in hazard areas (stronger controls, tax incentives, and information) ❖ Incorporate retrofitting or replacement of critical system elements in capital improvement plan ❖ Develop strategy to take advantage of post-disaster opportunities ❖ Provide incentives to guide development away from hazard areas or to retrofit in place ❖ Provide residents with sea-level rise inundation maps

Table 20-7. Alternatives to Mitigate the Severe Weather Hazard

Personal-Scale	Corporate-Scale	Government-Scale
Manipulate the hazard: ❖ None **Reduce exposure to the hazard:** ❖ None **Reduce vulnerability to the hazard:** ❖ Insulate house ❖ Provide redundant heat and power ❖ Insulate structure ❖ Plant appropriate trees near home and power lines ("Right tree, right place" National Arbor Day Foundation Program) **Increase the ability to respond to or be prepared for the hazard:** ❖ Trim or remove trees that could affect power lines ❖ Promote 72-hour self-sufficiency ❖ Obtain a NOAA weather radio. ❖ Obtain an emergency generator.	**Manipulate the hazard:** ❖ None **Reduce exposure to the hazard:** ❖ None **Reduce vulnerability to the hazard:** ❖ Relocate critical infrastructure (such as power lines) underground ❖ Reinforce or relocate critical infrastructure such as power lines to meet performance expectations ❖ Install tree wire **Increase the ability to respond to or be prepared for the hazard:** ❖ Trim or remove trees that could affect power lines ❖ Create redundancy ❖ Equip facilities with a NOAA weather radio ❖ Equip vital facilities with emergency power sources.	**Manipulate the hazard:** ❖ None **Reduce exposure to the hazard:** ❖ None **Reduce vulnerability to the hazard:** ❖ Harden infrastructure such as locating utilities underground ❖ Trim trees back from power lines ❖ Consider "cool roofs" and "green roofs" **Increase the ability to respond to or be prepared for the hazard:** ❖ Support programs such as "Tree Watch" that proactively manage problem areas through use of selective removal of hazardous trees, tree replacement, etc. ❖ Establish and enforce building codes that require all roofs to withstand snow loads ❖ Increase communication alternatives ❖ Modify land use and environmental regulations to support vegetation management activities that improve reliability in utility corridors. ❖ Modify landscape and other ordinances to encourage appropriate planting near overhead power, cable, and phone lines ❖ Provide NOAA weather radios to the public

Table 20-8. Alternatives to Mitigate the Tsunami Hazard

Personal-Scale	Corporate-Scale	Government-Scale
Manipulate the hazard: ❖ None **Reduce exposure to the hazard:** ❖ Locate outside of hazard area **Reduce vulnerability to the hazard:** ❖ Apply personal property mitigation techniques to your home such as anchoring your foundation and foundation openings to allow flow though. **Build local capacity to respond to or prepare for the hazard:** ❖ Develop and practice a household evacuation plan ❖ Educate yourself on the risk exposure from the tsunami hazard and ways to minimize that risk ❖ Understand tsunami warning signs and signals	**Manipulate the hazard:** ❖ None **Reduce exposure to the hazard:** ❖ Locate structure or mission critical functions outside of hazard area whenever possible **Reduce vulnerability to the hazard:** ❖ Mitigate personal property for the impacts of tsunami **Build local capacity to respond to or prepare for the hazard:** ❖ Develop and practice a corporate evacuation plan ❖ Educate employees on the risk exposure from the tsunami hazard and ways to minimize that risk	**Manipulate the hazard:** ❖ Build wave abatement structures (e.g. the "Jacks" looking structure designed by the Japanese) **Reduce exposure to the hazard:** ❖ Locate structure or functions outside of hazard area whenever possible ❖ Harden infrastructure for tsunami impacts ❖ Relocate identified critical facilities located in tsunami high hazard areas **Reduce vulnerability to the hazard:** ❖ Adopt higher regulatory standards that will provide higher levels of protection to structures built in a tsunami inundation area ❖ Utilize tsunami mapping to guide development away from high risk areas through land use planning **Build local capacity to respond to or prepare for the hazard:** ❖ Use probabilistic tsunami mapping and land use guidance from the state when published ❖ Provide incentives to guide development away from hazard areas ❖ Improve the tsunami warning and response system ❖ Provide residents with tsunami inundation maps ❖ Join NOAA's Tsunami Ready program ❖ Develop and communicate evacuation routes ❖ Enhance the public information program to include risk reduction options for the tsunami hazard

Table-20-9. Alternatives to Mitigate the Wildfire Hazard

Personal-Scale	Corporate-Scale	Government-Scale
Manipulate the hazard: ❖ Clear potential fuels on property such as dry overgrown underbrush and diseased trees **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures ❖ Locate outside of hazard area ❖ Mow regularly **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and provide water on site ❖ Use fire-resistant building materials ❖ Create defensible spaces around home **Build local capacity to respond to or prepare for the hazard:** ❖ Employ techniques from the National Fire Protection Association's Firewise USA program to safeguard home ❖ Identify alternative water supplies for fire fighting ❖ Install/replace roofing material with non-combustible roofing materials and implement other strategies to harden homes from embers and flame impingement	**Manipulate the hazard:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure and provide water on site ❖ Use fire-resistant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat. **Build local capacity to respond to or prepare for the hazard:** ❖ Support Firewise USA community initiatives. ❖ Create /establish stored water supplies to be utilized for firefighting.	**Manipulate the hazard:** ❖ Clear potential fuels on property such as dry underbrush and diseased trees ❖ Implement best management practices on public lands **Reduce exposure to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Locate outside of hazard area ❖ Enhance building code to include use of fire resistant materials in high hazard area. **Reduce vulnerability to the hazard:** ❖ Create and maintain defensible space around structures and infrastructure ❖ Use fire-resistant building materials ❖ Use fire-resistant plantings in buffer areas of high wildfire threat. ❖ Consider higher regulatory standards (such as Class A roofing) ❖ Establish biomass reclamation initiatives ❖ Reintroduce fire (controlled or prescribed burns) to fire-prone ecosystems ❖ Manage fuel load through thinning and brush removal ❖ Sequester additional carbon and water in soils to extend plant life and minimize fuel loads ❖ Establish integrated performance standards for new development to harden homes. **Build local capacity to respond to or prepare for the hazard:** ❖ More public outreach and education efforts, including an active Firewise USA program ❖ Possible weapons of mass destruction funds available to enhance fire capability in high-risk areas ❖ Identify fire response and alternative evacuation routes and establish where needed ❖ Seek alternative water supplies ❖ Become a Firewise USA community ❖ Use academia to study impacts/solutions to wildfire risk ❖ Establish/maintain mutual aid agreements between fire service agencies ❖ Develop, adopt, and implement integrated plans for mitigating wildfire impacts in wildland areas bordering on development ❖ Consider the probable impacts of climate change on the risk associated with the wildfire hazard in future land use decisions ❖ Establish a management program to track forest and rangeland health ❖ Provide incentives to for existing structures to be hardened against wildfire. ❖ Develop and implement soil sequestration programs on public and private property

20.2 ADAPTIVE CAPACITY

Adaptive capacity is defined as "the ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2014). This term is typically used while discussing climate change adaptation; however, it is similar to the alternatives presented in the tables for building local capacity. In addition to hazard-specific capacity building, the following list provides general alternatives that the City considered to build capacity for adapting to both current and future risks (Cal EMA, et al., 2012a and 2012b):

- Incorporate climate change adaptation into relevant local and regional plans and projects.
- Establish a climate change adaptation and hazard mitigation public outreach and education program.
- Build collaborative relationships between regional entities and neighboring communities to promote complementary adaptation and mitigation strategy development and regional approaches.
- Establish an ongoing monitoring program to track local and regional climate impacts and adaptation strategy effectiveness.
- Increase participation of low-income, immigrant, non-English-speaking, racially and ethnically diverse, and special-needs residents in planning and implementation.
- Ask local employers and business associations to participate in local efforts to address climate change and natural hazard risk reduction.
- Conduct a communitywide assessment and develop a program to address health, socioeconomic, and equity vulnerabilities.
- Focus planning and intervention programs on neighborhoods that currently experience social or environmental injustice or bear a disproportionate burden of potential public health impacts.
- Use performance metrics and data to evaluate and monitor the impacts of climate change and natural hazard risk reduction strategies on public health and social equity.
- Develop coordinated plans for mitigating future flood, landslide, and related impacts through concurrent adoption of updated general plan safety elements and local hazard mitigation plans.
- Update safety elements to reflect existing hazards and projected climate change impacts on hazards.
- Implement general plan safety elements through zoning and subdivision practices that restrict development in floodplains, landslide, and other natural hazard areas.
- Identify and protect locations where native species may shift or lose habitat due to climate change impacts (sea-level rise, loss of wetlands, warmer temperatures, drought).
- Collaborate with agencies managing public lands to identify, develop, or maintain corridors and linkages between undeveloped areas.
- Promote economic diversity.
- Incorporate consideration of climate change impacts as part of infrastructure planning and operations.
- Conduct a climate impact assessment on community infrastructure.
- Identify gaps in legal and regulatory capabilities and develop ordinances or guidelines to address those gaps.
- Identify and pursue new sources of funding for mitigation and adaptation activities.

- Hire new staff or provide training to current staff to ensure an adequate level of administrative and technical capability to pursue mitigation and adaptation activities.
- Create and implement soil amendment programs to sequester carbon and water in soils in fire-prone areas, both as part of a comprehensive organics management program and as part of the City's climate programs.

21. MITIGATION ACTION PLAN

21.1 STATUS OF PREVIOUS PLAN ACTIONS

The *2016-2021 Local Hazard Mitigation Plan* identified 20 mitigation actions. City staff reviewed these actions for the current update. For each action, it was determined whether the action had been completed, was in progress or had not been started. Incomplete actions were reviewed to determine if they should be carried over to the current update or removed from the plan due to a change in priorities, capabilities, or feasibility.

The review found that four of the identified actions have been completed, one has been partially completed, and four are no longer considered feasible. The remaining 11 actions and the partially completed action have been carried over to this update. Each carried over has a new action number assigned to it for the 2021 update, and many were reworded to more clearly state their intent. Appendix F summarizes the status of the recommended actions from the *2016 – 2021 Local Hazard Mitigation Plan*.

The *2016 – 2021 Local Hazard Mitigation Plan* (Section 6.4.1) describes the status of mitigation actions and measures from the *2010 – 2015 Local Hazard Mitigation Plan*.

21.2 ACTION PLAN

The Steering Committee reviewed the collections of hazard mitigation alternatives and selected actions to be included in the hazard mitigation action plan. The selection of actions was based on the risk assessment of identified hazards of concern and the defined hazard mitigation goals and objectives. Table 21-1 lists the recommended hazard mitigation actions that make up the action plan. The timeframe indicated in the table is defined as follows:

- Short Term = to be completed in 1 to 5 years
- Long Term = to be completed in greater than 5 years
- Ongoing = currently being funded and implemented under existing programs.

Table 21-1. Action Plan

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
O-1: Safer Housing for Oakland: Soft Story Apartment Retrofit Program—Under this action, the City will invest in and seek grant funding to support the seismic structural retrofit to the over 22,000 identified soft-story structures within the city. *Hazards Mitigated*: Earthquake						
Existing	1, 4, 5, 10	DHCD	PBD	High	FEMA HMA Grants, CDBG-DR/CDBG-MIT, City Funds through DHCD/PBD	Ongoing
O-2: Continue the Earthquake Safe Homes Program—The Earthquake-Safe Homes Program will have three primary components: (1) re-establishing a single-family seismic retrofit program previously funded through the City's Redevelopment Agency; (2) leveraging the City's existing community outreach network, current pipeline of homes in need of retrofit, and existing housing rehab intake process to solicit and process applications expeditiously; (3) deploying financial assistance to homeowners to complete code-compliant seismic retrofits. This action will be conducted in coordination with O-1. *Hazards Mitigated*: Earthquake						
Existing	1, 4, 5, 10	DHCD	PBD	High	FEMA HMA Grants, CDBG-DR/CDBG-MIT, City Funds through DHCD/PBD	Ongoing
O-3: Green Stormwater Infrastructure Program—The City will implement its Green Stormwater Infrastructure (GSI) Plan to include GSI where feasible in public capital projects such as streetscape renovations, park projects, and parking lot retrofits, among others. GSI is a term for engineered stormwater detention systems that are designed to capture specific runoff volumes of various design storms and remove stormwater pollutants. Examples include bioretention areas (rain gardens), engineered tree well filters, green roofs, flow-through planters, and permeable pavement. *Hazards Mitigated:* Dam Failure, Drought, Flood, Severe Weather, Sea-Level Rise, and Tsunami						
New & Existing	1, 3, 4, 5, 6, 10, 13	OPW	--	High	FEMA HMA Grants, EPA grants, City Funds through OPW/PBD	Short Term
O-4: Identify feasible and cost-effective stormwater infrastructure projects that have been identified in the City's capital improvement program and/or Storm Drain Master Plan, that would be good target projects for which to pursue funding under FEMA's Hazard Mitigation Assistance (HMA) grant programs. *Hazards Mitigated:* Flood and Severe Weather						
New & Existing	1, 4, 6, 14	WSM	OPW	High	FEMA HMA, City CIP funding	Short Term
O-5: Defensible Space Vegetation Program to manage wildfire hazards; preparation of a Vegetation Management Plan—This is an ongoing program to implement the defensible space vegetation program that includes the clearing or thinning of non-fire-resistive vegetation within 10 feet of access and evacuation roads and routes to critical facilities, or all non-native species (such as eucalyptus and pine, but not necessarily oaks) within 10 feet of access and evacuation roads and routes to critical facilities. Clearing a 30-foot fuel reduction zone around all buildings/structures. Additional space may be required based on site conditions and/or topography. *Hazards Mitigated:* Wildfire						
New & Existing	1, 4, 5, 14, 16	Oakland Fire	EMSD	Low	General Fund (Oakland Fire Department budget), grants	Ongoing
O-6: Continuity of Operations Emergency Planning—The Oakland Fire Department will continue to develop a continuity of operations plan that includes backup storage of vital records, such as plans and backup procedures to pay employees and vendors if normal finance department operations are disrupted, as well as other essential electronic files. *Hazards Mitigated:* Dam Failure, Drought, Earthquake, Flood Landside, Severe Weather, Sea-Level Rise, Tsunami, and Wildfire						
New & Existing	7, 8, 9, 11, 16	EMSD	CAO	Low	EMPG, HSGP, General Fund (Oakland Fire Department budget)	Ongoing

<table>
<tr><th>Applies to New or Existing Assets</th><th>Objectives Met</th><th>Lead Agency</th><th>Support Agency</th><th>Estimated Cost</th><th>Sources of Funding</th><th>Timeline[a]</th></tr>
<tr><td colspan="7">O-7: Implement the City’s Energy Assurance Plan that is a key part of the City’s emergency and recovery planning efforts. Components of the plan to be implemented under this strategy are:
Energy Assessment of Key Facilities (i.e. pre-wire for rapid connection and provision of supplemental backup generators for sustained re-occupation and continuing use of City Hall, Police Administration Building, etc.)
Community Charging Stations
Energy Backup at Emergency Shelters and Communication Hubs: (1) Identify methods to connect portable generators of unknown sizes (the City will not know which size is available in advance) to existing building infrastructure at shelter sites such as recreation centers and at communication hubs such as libraries that are near shelter sites; (2) Create electric load management strategies that disaster recovery teams can implement to operate equipment in a clear order of priority to power their sites with portable generator of various sizes; (3) Practice the load management strategies. The City will develop the Energy Backup plan in coordination with PG&E.
Hazards Mitigated: Dam Failure, Drought, Earthquake, Flood Landside, Severe Weather, Sea-Level Rise, Tsunami, and Wildfire</td></tr>
<tr><td>New & Existing</td><td>7, 8, 9, 11, 16</td><td>OPW</td><td>EMSD</td><td>Medium</td><td>Cal OES Grants, City funds through OPW and Oakland Fire</td><td>Ongoing</td></tr>
<tr><td colspan="7">O-8: Assessment and retrofits of critical facilities & infrastructure—Assessment and retrofit plans of critical facilities are complete, but funding is needed to retrofit or replace critical lifeline facilities and/or their backup facilities that are shown to be vulnerable to damage in natural disasters.
Hazards Mitigated: Dam Failure, Drought, Earthquake, Flood Landside, Severe Weather, Sea-Level Rise, Tsunami, and Wildfire</td></tr>
<tr><td>Existing</td><td>1, 4, 6, 14</td><td>OPW</td><td>EMSD</td><td>High</td><td>FEMA HMA grant programs, City Funds through OPW and EMSD</td><td>Long Term</td></tr>
<tr><td colspan="7">O-9: Continue to maintain the City’s good standing and compliance under the NFIP through implementation of floodplain management programs that, at a minimum, meet the NFIP requirements:
Enforce the flood damage prevention ordinance.
Participate in floodplain identification and mapping updates.
Provide public assistance/information on floodplain requirements and impacts.
Hazards Mitigated: Dam Failure, Flood, Sea-Level Rise, and Tsunami</td></tr>
<tr><td>New & Existing</td><td>1, 3, 4, 6, 16</td><td>Department of Transportation</td><td>OPW</td><td>Low</td><td>City Funds</td><td>Ongoing</td></tr>
<tr><td colspan="7">O-10: Create a comprehensive master plan for three city facilities to reliably serve as resilience hubs, or places of respite during hazard events.
Hazard Mitigated: Dam Failure, Drought, Earthquake, Flood Landside, Severe Weather, Sea-Level Rise, Tsunami, and Wildfire</td></tr>
<tr><td>New & Existing</td><td>1, 6, 7, 9, 13, 14, 16</td><td>CAO</td><td>OPW</td><td>High</td><td>FEMA BRIC C&CB, The California Energy Commission’s Energy Conservation Assistance Act, City Funds through the CAO and OPW departments</td><td>Long Term</td></tr>
<tr><td colspan="7">O-11: Develop an “integrated preparedness plan” that will consider the range of preparedness activities within the Integrated Preparedness Cycle, and along with the guidance provided by senior leaders, identify and set preparedness priorities, and schedule preparedness activities for the multi-year integrated preparedness plan.
Hazard Mitigated: Dam Failure, Drought, Earthquake, Flood Landside, Severe Weather, Sea-Level Rise, Tsunami, and Wildfire</td></tr>
<tr><td>New & Existing</td><td>7, 8, 9, 11, 16</td><td>EMSD</td><td>Oakland Fire</td><td>Medium</td><td>EMPG, HSGP, City funds through Oakland Fire</td><td>Short term</td></tr>
</table>

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
O-12: To support implementation of and future updates to the City's local hazard mitigation plan, Safety Element, and Environmental Just Element, utilize the best available local data to identify racial disparities in the City of Oakland that can be used by the City to rank risk and prioritize mitigation strategies that incorporate a racial equity lens. *Hazard Mitigated:* Dam Failure, Drought, Earthquake, Flood Landside, Severe Weather, Sea-Level Rise, Tsunami, and Wildfire						
New & Existing	3, 5, 8, 9, 11, 16	DRE	EMSD	High	FEMA BRIC C&CB, City funds through DRE and EMSD departments	Short term
O-13: Maritime Terminal Study on Liquefaction Potential—The Port of Oakland is located in a geographic area highly prone to liquefaction and, as a result, infrastructure damage from seismic activity. The Port has determined that in order to mitigate risk and prepare for imminent seismic events, it is necessary to conduct a liquefaction study at the marine terminals. This study will evaluate the liquefaction potential throughout the marine terminals at the Port of Oakland and its effects on Port infrastructure. The study will identify areas and facilities most at risk for liquefaction and outline a plan for mitigation, retrofit, and emergency response. *Hazards Mitigated*: Earthquake						
Existing	1, 4, 6, 14	Port of Oakland	--	High	FEMA BRIC C&CB, Port of Oakland Funding	Long Term
O-14: Middle Harbor Shoreline Park dike repair—The Middle Harbor Shoreline Park is owned by the Port of Oakland and maintained by East Bay Regional Parks District. The park is located adjacent to the southwest corner of the Port of Oakland, next to the Oakland International Container Terminal. Over the past years, the existing dike facing the Oakland Inner Harbor channel at the park has been slowly sliding into the channel and is now significantly lower than before. Initial site investigation and assumptions indicate that this could be a result of channel dredging undercutting the dike, or seismic activity from the recent earthquake in the Sonoma Valley. Before construction activities can occur to repair the seawall, a geotechnical study will need to be conducted to determine the source of slipping. The study will identify a design option that can be implemented to fix/repair the dike. The park provides an open space and Bay viewing access for the public. *Hazards Mitigated*: Flood, Tsunami, and Sea-Level Rise						
Existing	1, 4, 6, 14	Port of Oakland	East Bay Regional Park District	Medium	FEMA BRIC C&CB, Port of Oakland Funding	Short Term
O-15: Maritime Intelligent Transportation System—The Intelligent Transportation System project is meant to improve Port of Oakland operation efficiencies, provide congestion relief, and support hazard mitigation. The project would allow Port staff to view real-time traffic through CCTV video cameras and provide advanced traffic information to travelers to the Port at specific gateways and outside the Port. The project would also establish improved transportation communication with the City of Oakland and Caltrans District 4 as well as collect data for future improvements. *Hazards Mitigated*: Dam Failure, Earthquake, Flood, Sea-Level Rise, and Tsunami						
Existing	7, 8, 9, 11, 16	Port of Oakland	Alameda Co. Transportation Commission	Low	Port of Oakland and Alameda Co. Transportation Commission	Short term

Applies to New or Existing Assets	Objectives Met	Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline[a]
O-16: Maritime Area Seismic Monitors—The Port of Oakland's Seaport terminals are generally constructed of a pile-supported wharf structure with a riprap bulkhead retaining the soil at the back of the terminals. The Port proposes to implement additional seismic monitoring equipment at Berths 23-26 and Berths 57-58, as well as repair existing equipment at Berths 35-37. Port personnel have identified that there is likely to be difficulty in assessing potential damage to its terminals after a major earthquake, which is an essential step before a terminal can resume operations, due to the limited amount of functioning seismic monitoring equipment at the Port of Oakland's Seaport terminals. The proposed installations will fill gaps in the current monitoring system by providing a more complete picture at Inner Harbor, Middle Harbor and Outer Harbor locations. The proposed installations will also allow Port engineers to focus on areas that are most susceptible to damage during inspection and proceed with any needed repair to resume operations in the timeliest manner. *Hazards Mitigated*: Earthquake						
Existing	7, 8, 9, 11, 16	Port of Oakland	--	High	FEMA BRIC C&CB, Port of Oakland Funding	Long Term
O-17: Sea-Level Rise Vulnerability and Assessment Improvement Plan—The Port of Oakland's Sea-Level Rise Vulnerability and Assessment Improvement Plan will assess the potential effects of sea-level rise on maritime facilities. The study will assess facilities Port-wide for sea-level rise vulnerability and develop an implementation plan for near-term and long-term strategies to address the potential impacts. The study will analyze the need for infrastructure such as sea walls, wharf improvements, and changes in port operations. In addition, the study will help to establish design standards. *Hazards Mitigated:* Sea-Level Rise and Tsunami						
Existing	1, 4, 6, 14	Port of Oakland	--	High	FEMA BRIC C&CB, Port of Oakland Funding	Long Term
O-18: Tree Planning—Implement the component of the City's Storm Drain Master Plan that looks to quantify the stormwater capture and pollutant benefit removal of tree planting and modeling where in the city stormwater runoff reduction could be achieved through increased tree canopy. Coordinate with Tree Services Division to make sure it corresponds to the Urban Forestry Master Plan. *Hazards Mitigated:* Flood and Severe Weather (Extreme Heat)						
New & Existing	3, 4, 6, 14, 15, 16	WSM	TSD	Medium	FEMA HMA grant programs, City Funds through WSM and TSD	Short Term
O-19: Reestablish Full Compliance and Good Standing Under the NFIP—The City will coordinate with FEMA Region IX and DWR to address all identified issues from the open September 2017 Community Assistance Visit (CAV) to reestablish the City's full compliance and good standing under the NFIP *Hazards Mitigated*: Dam Failure, Flood, Sea Level Rise, Tsunami						
New and Existing	1, 3, 4, 6, 16	To Be Determined	To Be Determined	Low	City funds	Short Term
O-20: Update Sea Level Rise Road Map—Update the City's 2017 Sea Level Rise Road Map to reflect the best and most up-to-date climate science with relevant policies and regulations, and vulnerability and risk assessments conducted to date *Hazards Mitigated*: Flood, Sea-Level Rise, and Tsunami						
Existing	3, 5, 8, 9, 11, 16	OPW	PBD	Low	City funds	Short Term
O-21: Vulnerability Assessment and Adaptation Plan—In conjunction with the update or adoption of the local hazard mitigation plan, complete a citywide vulnerability assessment and comprehensive adaptation plan, addressing climate risks using forward-looking projections and including community stakeholder engagement. Implement key recommendations of these plans by 2025 to address major climate risks in frontline communities first and update these documents every 5 years with evolving climate and risk projections and adaptation best practices. *Hazards Mitigated:* Dam Failure, Drought, Earthquake, Flood Landside, Severe Weather, Sea-Level Rise, Tsunami, and Wildfire						
Existing	3, 5, 8, 9, 11, 16	PBD	OPW	Medium	Council-appropriated funds	Short Term

21.3 ACTION PLAN PRIORITIZATION

The actions recommended in the action plan were prioritized based on the following factors:

- Cost and availability of funding
- Benefit, based on likely risk reduction to be achieved
- Number of plan objectives achieved
- Timeframe for project implementation
- Eligibility for grand funding programs

Two priorities were assigned for each action:

- A high, medium or low priority for implementing the action
- A high, medium or low priority for pursuing grant funding for the action.

The sections below describe the analysis of benefits and costs and the assignment of the two priority ratings.

21.3.1 Benefit/Cost Review

The action plan must be prioritized according to a benefit/cost analysis of the proposed actions (44 CFR, Section 201.6(c)(3)(iii)). For this hazard mitigation plan, a qualitative benefit-cost review was performed for each action by assigning ratings for benefit and cost as follows:

- Cost:
  - **High**—Existing funding will not cover the cost of the action; implementation would require new revenue through an alternative source (for example, bonds, grants, and fee increases).
  - **Medium**—The action could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the action would have to be spread over multiple years.
  - **Low**—The action could be funded under the existing budget. The action is part of or can be part of an ongoing existing program.
- Benefit:
  - **High—**Action will provide an immediate reduction of risk exposure for life and property.
  - **Medium—**Action will have a long-term impact on the reduction of risk exposure for life and property, or action will provide an immediate reduction in the risk exposure for property.
  - **Low—**Long-term benefits of the action are difficult to quantify in the short term.

To assign priorities, each action with a benefit rating equal to or higher than its cost rating (such as high benefit/medium cost, medium benefit/medium cost, medium benefit/low cost, etc.) was considered to be cost-beneficial. This is not the detailed level of benefit/cost analysis required for some FEMA hazard-related grant programs. Such analysis would be performed at the time a given action is being submitted for grant funding.

21.3.2 Implementation Priority

Implementation priority ratings were assigned as follows:

- **High Priority**—An action that meets multiple objectives, has benefits that exceed costs, and has a secured source of funding. Action can be completed in the short term (1 to 5 years).
- **Medium Priority**—An action that meets multiple objectives, has benefits that exceed costs, and is eligible for funding though no funding has yet been secured for it. Action can be completed in the short term (1 to 5 years), once funding is secured. Medium-priority actions become high-priority actions once funding is secured.
- **Low Priority**—An action that will mitigate the risk of a hazard, has benefits that do not exceed the costs or are difficult to quantify, has no secured source of funding, and is not eligible for any known grant funding. Action can be completed in the long term (1 to 10 years). Low-priority actions may be eligible for grant funding from programs that have not yet been identified.

21.3.3 Grant Pursuit Priority

Grant pursuit priority ratings were assigned as follows:

- **High Priority**—An action that meets identified grant eligibility requirements, has high benefits, and is listed as high or medium implementation priority; local funding options are unavailable or available local funds could be used instead for actions that are not eligible for grant funding.
- **Medium Priority**—An action that meets identified grant eligibility requirements, has medium or low benefits, and is listed as medium or low implementation priority; local funding options are unavailable.
- **Low Priority**—An action that has not been identified as meeting any grant eligibility requirements.

21.3.4 Prioritization Summary for Mitigation Actions

Table 21-2 lists the priority of each action.

21.4 CLASSIFICATION OF ACTIONS

Each recommended action was classified based on the hazard it addresses and the type of mitigation it involves. Mitigation types used for this classification are as follows:

- **Prevention**—Government, administrative or regulatory actions that influence the way land and buildings are developed to reduce hazard losses. Includes planning and zoning, floodplain laws, capital improvement programs, open space preservation, and stormwater management regulations.
- **Property Protection**—Modification of buildings or structures to protect them from a hazard or removal of structures from a hazard area. Includes acquisition, elevation, relocation, structural retrofit, storm shutters, and shatter-resistant glass.
- **Public Education and Awareness**—Actions to inform residents and elected officials about hazards and ways to mitigate them. Includes outreach projects, real estate disclosure, hazard information centers, and school-age and adult education.
- **Natural Resource Protection**—Actions that minimize hazard loss and preserve or restore the functions of natural systems. Includes sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, wetland restoration and preservation, and green infrastructure.

Table 21-2. Prioritization of Actions

Action #	# of Objectives Met	Benefits	Costs	Do Benefits Equal or Exceed Costs?	Is Project Grant-Eligible?	Can Project Be Funded Under Existing Programs/ Budgets?	Implementation Priority	Grant Priority
O-1	4	High	High	Yes	Yes	No	Medium	High
O-2	4	High	High	Yes	Yes	No	Medium	High
O-3	8	High	High	Yes	Yes	No	Medium	High
O-4	4	High	High	Yes	Yes	No	Medium	High
O-5	5	High	Low	Yes	Yes	Yes	High	Medium
O-6	5	Medium	Low	Yes	Yes	Yes	High	Medium
O-7	5	Medium	Medium	Yes	No	Yes	Medium	N/A
O-8	4	High	High	Yes	Yes	No	Medium	High
O-9	5	High	Low	Yes	No	Yes	High	N/A
O-10	7	High	High	Yes	Yes	No	Medium	High
O-11	5	Medium	Medium	Yes	Yes	Yes	High	Medium
O-12	6	High	High	Yes	Yes	No	High	High
O-13	4	High	High	Yes	Yes	No	Medium	High
O-14	4	Medium	Medium	Yes	Yes	Yes	High	Medium
O-15	5	Medium	Low	Yes	No	Yes	High	N/A
O-16	5	High	High	Yes	Yes	No	Medium	High
O-17	4	High	High	Yes	Yes	No	Medium	High
O-18	6	Medium	Medium	Yes	Yes	Yes	High	Medium
O-19	5	Medium	Low	Yes	No	Yes	High	N/A
O-20	6	Medium	Low	Yes	No	Yes	High	N/A
O-21	6	Medium	Medium	Yes	Yes	Yes	High	Medium

- **Emergency Services**—Actions that protect people and property during and immediately after a hazard event. Includes warning systems, emergency response services, and the protection of essential facilities.
- **Structural Projects**—Actions that involve the construction of structures to reduce the impact of a hazard. Includes dams, setback levees, floodwalls, retaining walls, and safe rooms.
- **Climate Resiliency**—Actions that incorporate methods to mitigate and/or adapt to the impacts of climate change. Includes aquifer storage and recovery activities, incorporating future conditions projections in project design or planning, or actions that specifically address jurisdiction-specific climate change risks, such as sea-level rise or urban heat island effect.
- **Community Capacity Building**—Actions that increase or enhance local capabilities to adjust to potential damage, to take advantage of opportunities, or to respond to consequences. Includes staff training, memorandums of understanding, development of plans and studies, and monitoring programs.

Table 21-3 shows the classification based on this analysis.

Table 21-3. Classification of Actions

Hazard Type	Actions That Address the Hazard, by Mitigation Type							
	Prevention	Property Protection	Public Education & Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resiliency	Community Capacity Building
High Ranked Hazards								
Earthquake	O-10, O-12	O-1, O-2, O-8, O-13, O-16		O-21	O-6, O-11		O-10, O-21	O-7, O-10, O-12, O-15, O-21
Landslide	O-10, O-12	O-8		O-21	O-6, O-11		O-10, O-21	O-7, O-10, O-12, O-21
Severe Weather	O-9, O-10, O-12, O-18	O-8, O-9	O-9	O-3, O-21	O-6, O-11	O-3, O-4	O-3, O-10, O-18, O-21	O-7, O-9, O-10, O-12, O-21
Medium Ranked Hazards								
Wildfire	O-10, O-12	O-5, O-8		O-5, O-21	O-6, O-11		O-5, O-10, O-21	O-7, O-10, O-12, O-21
Sea-Level Rise	O-9, O-10, O-12, O-17, O-19	O-8, O-9, O-19	O-9, O-19	O-3, O-21	O-6, O-11	O-3, O-14	O-3, O-10, O-20, O-21	O-7, O-9, O-10, O-12, O-15, O-19, O-20, O-21
Dam Failure	O-9, O-10, O-12, O-19	O-8, O-9, O-19	O-9, O-19	O-3, O-21	O-6, O-11	O-3	O-3, O-10, O-21	O-7, O-9, O-10, O-12, O-15, O-19, O-21
Flood	O-9, O-10, O-12, O-18, O-19	O-8, O-9, O-19	O-9, O-19	O-21	O-6, O-11	O-3, O-4, O-14	O-3, O-10, O-18, O-20, O-21	O-7, O-9, O-10, O-12, O-15, O-19, O-20, O-21
Low Ranked Hazards								
Tsunami	O-9, O-10, O-12, O-17, O-19	O-8, O-9, O-19	O-9, O-19	O-21	O-6, O-11	O-3, O-14	O-3, O-10, O-20, O-21	O-7, O-9, O-10, O-12, O-15, O-19, O-20, O-21
Drought	O-10, O-12	O-8		O-21	O-6 O-11		O-10, O-21	O-7, O-10, O-12, O-21

22. PLAN ADOPTION, IMPLEMENTATION AND MAINTENANCE

22.1 PLAN ADOPTION

A hazard mitigation plan must document that it has been formally adopted by the governing body of the jurisdiction requesting federal approval of the plan (44 CFR Section 201.6(c)(5)). DMA compliance and its benefits cannot be achieved until the plan is adopted. This plan was submitted for a pre-adoption review to Cal OES and FEMA prior to adoption. Once pre-adoption approval was provided, the City of Oakland formally adopted the plan. A copy of the resolution is provided in Appendix G.

22.2 PLAN IMPLEMENTATION

The effectiveness of the hazard mitigation plan depends on its implementation and incorporation of its action items into existing local plans, policies and programs. Together, the action items in the plan provide a framework for activities that the City of Oakland can implement over the next 5 years. The planning team and the Steering Committee have established goals and objectives and have prioritized mitigation actions that will be implemented through existing plans, policies, and programs.

The City of Oakland's Emergency Management Services Division (EMSD) Manager and the Planning and Building Department will have co-lead responsibility for overseeing the plan implementation and maintenance strategy. Plan implementation and evaluation will be a shared responsibility among all agencies identified as lead agencies in the mitigation action plan.

During the five-year implementation period for this hazard mitigation plan, the City also will be developing a comprehensive update to its General Plan, starting with adoption of the updated Safety Element, updated Housing Element, and new Environmental Justice Element as soon as January 2023. This City will capitalize on the assessment conducted for this hazard mitigation plan to inform the update to the Safety Element. The update to the Safety Element will serve as an extension and continuation of the community outreach process undertaken during this hazard mitigation plan's development. This will provide the public and the City with further opportunities to propose additional mitigation actions that serve to address the hazards presented.

22.3 PLAN MAINTENANCE

Plan maintenance is the formal process for achieving the following:

- Ensuring that the hazard mitigation plan remains an active and relevant document and that the City maintains its eligibility for applicable funding sources
- Monitoring and evaluating the plan annually and producing an updated plan every five years

- Integrating public participation throughout the plan maintenance and implementation process
- Incorporating the mitigation strategies outlined in this plan into existing planning mechanisms and programs, such as any relevant comprehensive land-use planning process, capital improvement planning process, and building code enforcement and implementation.

To achieve these ends, a hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

- A method and schedule for monitoring, evaluating, and updating the mitigation plan within a 5-year cycle
- An approach for how the community will continue public participation in the plan maintenance process.
- A process by which local governments will incorporate the requirements of the mitigation plan into other planning mechanisms, such as comprehensive or capital improvement plans, when appropriate.

Table 22-1 summarizes the plan maintenance strategy. The sections below further describe each element.

Table 22-1. Plan Maintenance Matrix

Approach	Timeline	Lead Responsibility
Integration into Other Planning Mechanisms		
Create a linkage between the hazard mitigation plan and the City's general plan or similar plans identified in the core capability assessments	Continuous over the 5-year performance period of the plan	Planning and Building Department
Plan Monitoring		
Track the implementation of actions over the performance period of the plan	Continuous over the 5-year performance period of the plan	EMSD Manager
Plan Evaluation and Progress Reporting		
Review the status of previous actions; assess changes in risk; evaluate success of integration; revise action plan as warranted	Annually	EMSD Manager
Grant Monitoring and Coordination		
As grant opportunities present themselves, the City will consider options to pursue grants to fund actions identified in this plan	As grants become available	EMSD Manager
Plan Update		
Begin the process, at a minimum, every 5 years to develop a comprehensive update of the plan.	Every 5 years or upon comprehensive update to General Plan or major disaster	EMSD Manager
Continuing Public Participation		
Keep the website maintained, bring the plan to the Disaster Council meeting for review once a year (these meetings are also televised and on public notices in community newspaper). The website and comments will be maintained over the course of the plan.	Continuous over the 5-year performance period of the plan	EMSD Manager

22.3.1 Integration with Other Planning Mechanisms

It is the intent of the City of Oakland to fully integrate the Hazard Mitigation Plan into existing plans and programs, such as comprehensive land-use planning processes, capital improvement planning, and building enforcement implementation. The hazard mitigation plan's format allows sections to be reviewed and updated as new data becomes available, resulting in a plan that remains current and relevant.

The City of Oakland, through adoption of a General Plan and zoning ordinance, has planned for the impact of natural hazards. The process of updating this hazard mitigation plan provided the opportunity to review and expand on policies in these planning mechanisms. The information on hazard, risk, vulnerability, and mitigation contained in this hazard mitigation plan is based on the best science and technology available at the time this plan was prepared. The General Plan and the hazard mitigation plan are complementary documents that work together to achieve the goal of reducing risk exposure. The General Plan is an integral part of this plan. An update to the General Plan may trigger an update to the hazard mitigation plan.

The City of Oakland will create a linkage between the hazard mitigation plan and the General Plan by identifying a mitigation action as such and giving that action a high priority. Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- City of Oakland General Plan
- Climate action plans
- Resilience plans
- Recovery plan
- Emergency response plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Master fire protection plans
- ADA transition plans

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation. As information becomes available from other planning mechanisms that can enhance this plan, that information will be integrated via the update process.

22.3.2 Plan Monitoring

The City of Oakland's EMSD will be the lead agency responsible for monitoring the plan by tracking the status of all recommended mitigation actions in the action plan.

22.3.3 Plan Evaluation and Progress Reporting

The plan will be evaluated by how successfully the implementation of identified actions has helped to achieve the goals and objectives identified of the plan. This will be assessed by a review of the changes in risk that occur over the performance period and by the degree to which mitigation goals and objectives are incorporated into existing plans, policies, and programs. Upon completion, plan evaluation will be the responsibility of EMSD.

Based on the plan evaluation, the EMSD manager will prepare a progress report annually that identifies actions completed, actions that should be removed from the action plan, and any new actions to be incorporated into the plan. An template for the annual progress report is provided in Appendix H. Upon completion, the report will be reviewed by an oversight committee to be organized by the City of Oakland. Once reviewed and approved, the report will be posted to the hazard mitigation website, and changes to the action plan will represent an amendment to this hazard mitigation plan.

22.3.4 Grant Monitoring and Coordination

The City of Oakland EMSD will identify grant funding opportunities. Once these opportunities are identified, City agency stakeholders will convene in a short meeting to review the hazard mitigation plan and pursue a strategy to capture that grant funding. EMSD will assume lead responsibility for planning and facilitating grant opportunity meetings. Review of the hazard mitigation plan at these meetings can include the following:

- Discussion of any hazard events that occurred during the prior year and their impact on the planning area
- Impact of potential grant opportunities on the implementation of mitigation actions
- Re-evaluation of the action plans to determine if the timeline for identified actions needs to be amended (such as changing a long-term action to a short-term action because of funding availability)
- Recommendations for new actions
- Impact of any other planning programs or actions that involve hazard mitigation.

22.3.5 Plan Update

FEMA requires the hazard mitigation plan to be revised and resubmitted for review and approval by Cal OES and FEMA prior to the five-year anniversary date of the plan's adoption in order to remain eligible for benefits under the DMA (44 CFR, Section 201.6(d)(3)). To meet this timeline, EMSD will implement the steering committee's plan revision process at least one year prior to the anniversary date of the adoption. This cycle may be accelerated to less than five years based on the following triggers:

- A federal disaster declaration that impacts the City of Oakland.
- A hazard event that causes loss of life.
- A comprehensive update of the City of Oakland general plan.

The hazard mitigation plan five-year revision will, at a minimum, include the following elements:

- The revision process will be convened through a new steering committee.
- The hazard risk assessment will be reviewed and, if necessary, revised using best available information and technologies.
- The action plan will be reviewed for any actions completed, ongoing, or withdrawn, and will be reconciled to account for changes in the risk assessment or new policies identified under other plans (such as the general plan).
- The draft plan revision will be sent to appropriate departments and divisions for comment.
- The public will be given an opportunity to comment on the revised plan prior to adoption.
- The Oakland City Council will adopt the updated plan once the reviews by Cal OES and FEMA have been conducted.

22.3.6 Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the EMSD website and by providing copies of biennial progress reports on the EMSD website and through posting them in locations throughout the City for the public to review. In addition, the City will maintain and update the "Story-map" that was constructed in support of this plan update. The "story-map" is intended to be am implementation tool that will aid the City's risk communication efforts and a principle access point for the public to this plan and its implementation. The website will house the final plan, and provide information regarding the plan, plan implementation, and beginning of the revision process. Copies of the plan will be distributed to the City of Oakland library system. Upon initiation of future update processes, a new public involvement strategy will be initiated based on guidance from a new steering committee. This strategy will be based on the needs and capabilities of the City of Oakland at the time of the update.

Further, to ensure continued public engagement on issues relating to hazard mitigation, all comments received from the public and from interested agencies on this hazard mitigation plan will also be reviewed as part of the City of Oakland's next update to the Safety Element of the General Plan, which is anticipated to be completed by 2023.

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City of Oakland 2021 – 2026 Hazard Mitigation Plan

Appendix A. Public Outreach Activities

A.1 Public Outreach Activities—Steering Committee Meeting Summaries

Date/Time of Meeting:	Thursday, January 21, 2021
Location:	Digital
Subject:	Steering Committee Meeting No. 1
Project Name:	City of Oakland Local Hazard Mitigation Plan Update
In Attendance	**City of Oakland Attendees:** *Jessica Feil, Angela Robinson Pinon, Kelly Nguyen, Alex McBride, Christina Ferracane, Daniel Findley, Shayna Hirshfield-Gold, Ed Manasse, Julian Ware, Micaela Pronio, Daniel Hamilton, Kristin Hathaway, Jimmy Mach, Ahn Nguyen, Karen Boyd, Orlando Arriola, Warren Logan, Joe DeVries, Paul Hess, Nick Luby, Megan Wier* **Tetra Tech Team:** Bart Spencer, Rob Flaner, Carol Baumann, Jeana Wiser, Des Alexander
Not Present:	*Michael Branson, Scott Means, Dana Riley, Michael Hunt, Greg Elliot, Wlad Wlassowsky, Tim Burch, Matt Lee. Issam Shahrouri is no longer with the city and will be removed from the list.*
Summary Prepared by:	Des Alexander
Quorum – Yes or No	Yes (established as 51% attendance)

Welcome and Introductions

- Jessica Feil welcomed everyone to the call at 10:02 am
- After reviewing the agenda, Jessica passed the meeting to Des Alexander for the roll call

Steering Committee Role

- Bart Spencer discusses the purpose of the steering committee. He explains that the steering committee serves as an advisory body for the LHMP and that they do not set policy or govern decisions for the City of Oakland. The committee should include organizations or departments that affect hazard mitigation in the City of Oakland. Meetings are open to the public.
- Bart then discusses the expectations and the organizational structure. He states that all members commit to attending meetings and that both a chair and vice-chair need to be selected. After discussion, Jessica Feil is selected as Chair and Daniel Findley is selected as Vice-Chair. During the voting discussion, it is determined that the steering committee will also include members of the Core Planning Team, which brings the total membership to 31.
- While discussing the ground rules, the standing date for the next three steering committee meetings is the 3rd Thursday of the month from 10am-11am. Alternates will be eliminated, and Quorum is determined to be 51% of committee in attendance, and consensus rather than voting will be the way motions are passed. There were no comments on the decision-making ground rules as written.
- In the public engagement portion, clarification was requested regarding each member's responsibility for their department's public engagement. Jessica discussed the city's plan to use the website as a primary point of outreach and that strategies are being discussed in depth

within the Core Planning Team. She states that steering committee members should seek to amplify any messaging that comes from the Core Planning Team within their own communities.

Planning Process

- Bart discusses the importance of establishing the mission statement, goals, and objectives. He explains that each of these serves to guide each phase of the project and that the objectives get specifically tied to the plan's action items at the end. The project will ultimately serve two purposes: providing Oakland with a hazard mitigation direction and helping the city identify grant-eligible projects.
- A motion to approve the mission statement was made by Joe DeVries and seconded by Warren Logan. The mission statement was then approved by consensus with no dissent.
- A motion to approve the goals was made by Joe DeVries and seconded by Daniel Findley. The goals were then approved by consensus with no dissent.
- The objectives will be tabled until the next steering committee. In the meantime, the CPT will make refinements and reach out to the SC for comment. An initial comment was made to address disabilities within the objectives.
- Bart then briefly discussed the project's status. The Tetra Tech team is currently identifying hazards and completing the associated profiles. He states that the GIS staff will put together information on the hazards identified by the Core Planning Team using several data sources. Des Alexander will then write the specific hazard profiles.
- Given the expedited timeframe, Bart emphasizes the importance of remaining on track with the process. CalOES and FEMA are aware of the expedited timeline.

Hazard Analysis

- Bart briefly updates the committee on progress. The hazards have been identified and the TT team is currently developing the profiles.

Public Engagement

- Jeana discusses the public engagement process and updates the group on progress. Regarding messaging, all communications will be directed back to the website and an associated email address. She is working with Michael Hunt and Jessica Feil to streamline messaging so that no one will have to draft their own, and she stated that Michael Hunt is the likely final POC for messaging and communication approval.
- The website has been launched, as have the media release and survey. As of 1/21, there were 131 responses to the survey, which will be available for residents and stakeholders through mid-February. The top 3 concerns thus far were earthquake, pandemic, and wildfire, although severe weather was also highly ranked. The media release has gone to both the Mayor and the major PIO staff in the city. Michael Hunt shared an interview for East Bay News Service on the process and will also be working on the social media push.
- Once the messaging is streamlined, all emails will be ready for delivery to key community and city officials. Jeana reiterates that since the SC meetings will be open to the public, that can be another way for the public to provide comment.

Requests and Comments

- Bart opens the meeting up for additional comment from the committee. One comment reiterates the importance of addressing equity concerns within the plan and asks that they be centered within the process. A Core Planning Team member states that focus groups will also be included as part of the public outreach process.
- A committee member from Public Works also asks about how hazard mitigation planning interfaces will be discussed in future meetings. Rob Flaner then explains the Core Capability Assessment to the committee and discusses the importance of plans such as Capital Improvements being important to the plan. He states that the tables that have been posted in the drive will be shared with the department.
- It is highlighted that since this process is preceding a lot of similar plans within the city, it is highly likely that the LHMP process will inform land use policy and overlap with future efforts in the City of Oakland (ex. Safety Element update in July 2021). Rob states that as other plans are being adopted, Tetra Tech wants city officials to be made aware of the LHMP and to have discussions on how the plan can be integrated into their projects and vice versa.

Next Steering Committee Meeting

- Thursday, February 18, 2021 at 10am
- The objectives and appropriate links will be provided prior to the meeting
- All meeting minutes and agendas will be published on the website

Adjourn

- Motion by Joe DeVries, Seconded by Paul Hess
- Meeting adjourned at 12:02 PM

City of Oakland Local Hazard Mitigation Plan Steering Committee Meeting #2

Date/Time of Meeting:	Thursday, February 18, 2021
Location:	Digital
Subject:	Steering Committee Meeting No. 2
Project Name:	City of Oakland Local Hazard Mitigation Plan Update
In Attendance	**Attendees:** *Michael Branson, Julian Ware, Daniel Hamilton, Kristin Hathaway, Jimmy Mach, Scott Means, Anh Nguyen, Michael Hunt, Orlando Arriola, Greg Elliot, Warren Logan, Paul Hess, Nick Luby, Megan Wier* **Planning Team:** Jessica Feil, Daniel Findley, Alex McBride, Bart Spencer, Rob Flaner, Carol Baumann, Jeana Wiser, Des Alexander
Not Present:	*Angela Robinson Pinon, Kelly Nguyen, Christina Ferracane, Shayna Hirshfield-Gold, Ed Manasse, Micaela Pronio, Dana Riley, Karen Boyd, Loyd Ware, Wlad Wlassowsky, Tim Birch, Joe DeVries, Matt Lee*
Summary Prepared by:	Des Alexander
Quorum – Yes or No	Yes

Welcome and Introductions

- Jessica Feil welcomed the steering committee to the second meeting and briefly reviews the agenda.
- Des Alexander takes the roll.
- Jessica asks the committee to review and approve the meeting summary from the previous meeting. Upon hearing no comment, Warren Logan moves to approve the summary and is seconded by Paul Hess. The motion and the meeting minutes are approved without dissent.

Planning Process

- Bart Spencer provides a brief overview of the project status and the timeline. Currently the project is on track. Next steps will involve developing action items that are grant-eligible and would benefit the city; developing a plan maintenance strategy for continued public outreach regarding the LHMP; and then developing a draft plan for comment and submittal.
- Once the draft plan has been commented on, it will be submitted to CalOES and FEMA for concurrent review. Once that happens, it will be sent back to the city for approval pending adoption by the city council. Daniel Findley asked how long the review process would last; Bart stated that it is typically 45 days for both agencies.

Hazard Analysis

- Rob Flaner provides a progress update on the hazard analysis. The loss matrix is shown for dam failure, displaying that the largest populations exposed to dam failure are in the Central East

Oakland and the Coliseum/Airport jurisdictions. He explains that these tools will be good for the creation of public facing maps and that this loss matrix will be shared with the steering committee. Exposure analysis is also complete and will communicate risk; models still need to be run to get damage estimates.

- Rob then states the natural hazards of concern again (dam failure, drought/extreme heat, flood, landslide, sea level rise, earthquake, climate change, tsunami, wildfire). He also explains that the plan will examine human-caused hazards such as terrorism, public health, and hazardous materials, though those profiles will be more qualitative. Rob explains that the data comes from sources like effective FIRM, building assessor records, LIDAR (for flood depth grids), etc. The CPT is currently not coordinating with Alameda Flood Control District and given the constricted timeframe, there is no time to use new data. Jessica states that Oakland can examine the updated data for use in the next plan and that this could be included in the plan maintenance strategy. Rob says that Jeana will now go over the StoryMap, which is an analysis tool that can be used to display hazard data.

Public Engagement

- Jeana Wiser presented the StoryMap to the Oakland Steering Committee, focusing on the functionality of the city hazard mapper and other hazard mitigation functions. She explained that the StoryMap will provide an opportunity for the Oakland community to engage with the hazard data, visualizing hazards at the level of addresses and census blocks. The GIS layers used in the StoryMap will be provided to the steering committee, and the next step is to populate the hazard tabs that will mirror plan content. The StoryMap is scheduled to go live during the first week of March, prior to the public comment period.
- Jeana explained that there are several public meetings scheduled for engagement surrounding the plan. Town halls are currently arranged for the 22nd, 24th, and 28th of February, as well as a meeting on March 9th. Other town hall dates will be posted on the website once they are confirmed. Another meeting may also be added for public comment, as the team is still reaching out to community-based organizations for their participation. The StoryMap can be previewed at these meetings without being live and a tab for the survey results will be added once they are compiled.
- There are currently 733 completed surveys from the community. Jeana says that the plan is to leave the survey open through the end of February to obtain further public comment.

Steering Committee Requests/Comments

- Comments focused around steering committee members obtaining survey results. Jessica informed the committee that they will be published on the StoryMap.
- There was also a request for guidance around the fire cleanup process. This comment will be forwarded to the fire protection bureau.

Next Meeting Date

- Thursday, March 18, 2021

Adjournment

- Motion to adjourn made by Daniel Hamilton, then seconded by Warren Logan
- Motion is approved at 10:52 AM

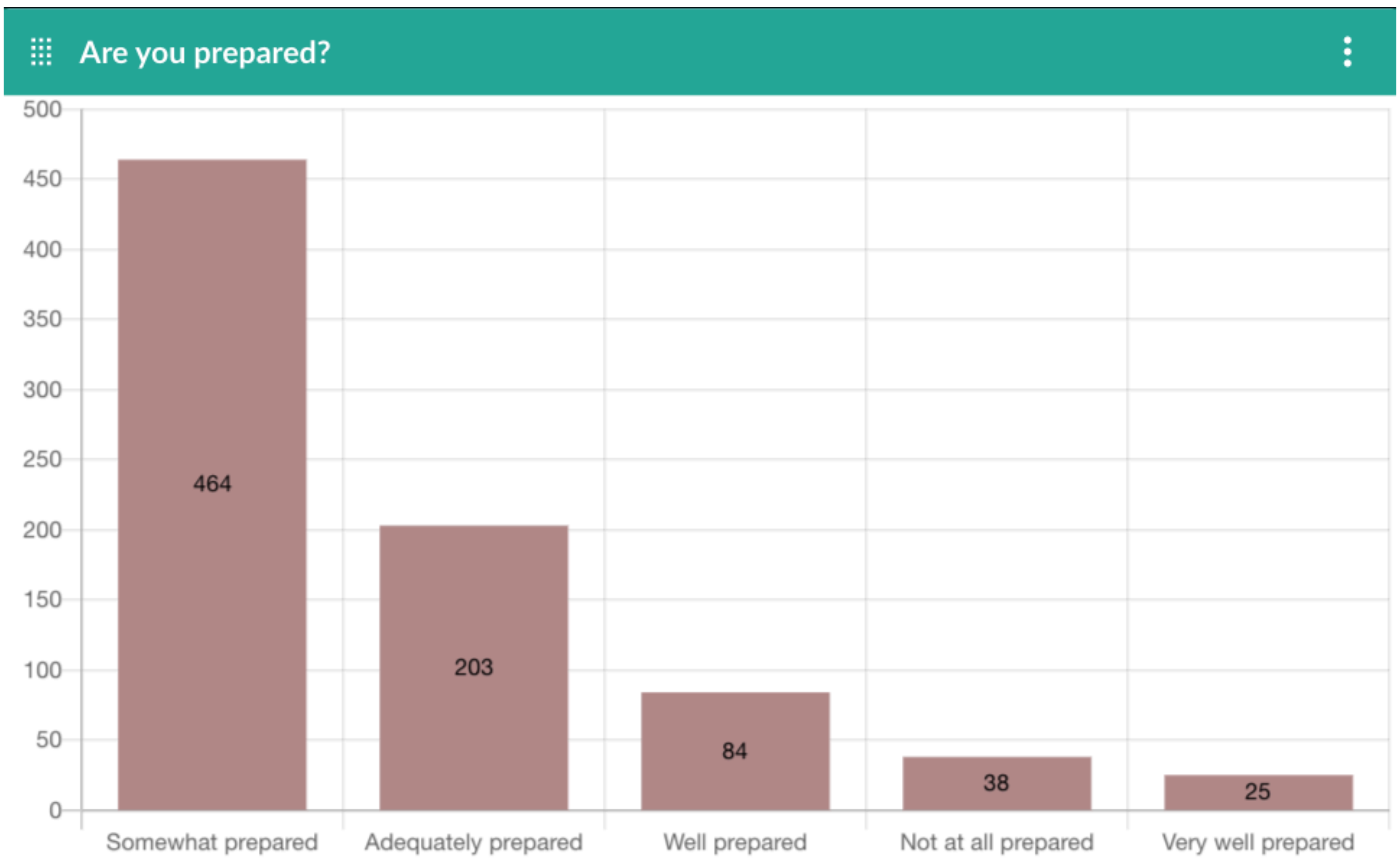
A.2 Public Outreach Activities—Survey Results

Which of the following natural hazard events have you or anyone in your household experienced or been affected by ever within Oakland?

Hazards Experienced

Public Health - Epidemic or Pandemic	658
Earthquake	590
Severe Weather - Wind, Extreme Cold, Extreme Heat, etc.	482
Wildfire	478
Flooding from Storm	116
Other (please specify)	75
- No Value -	17
Dam Failure or Flooding	16
Total	825

How prepared is your family, household or business to deal with a hazard event?



What has helped you become more prepared for emergencies and disasters?

Becoming More Prepared

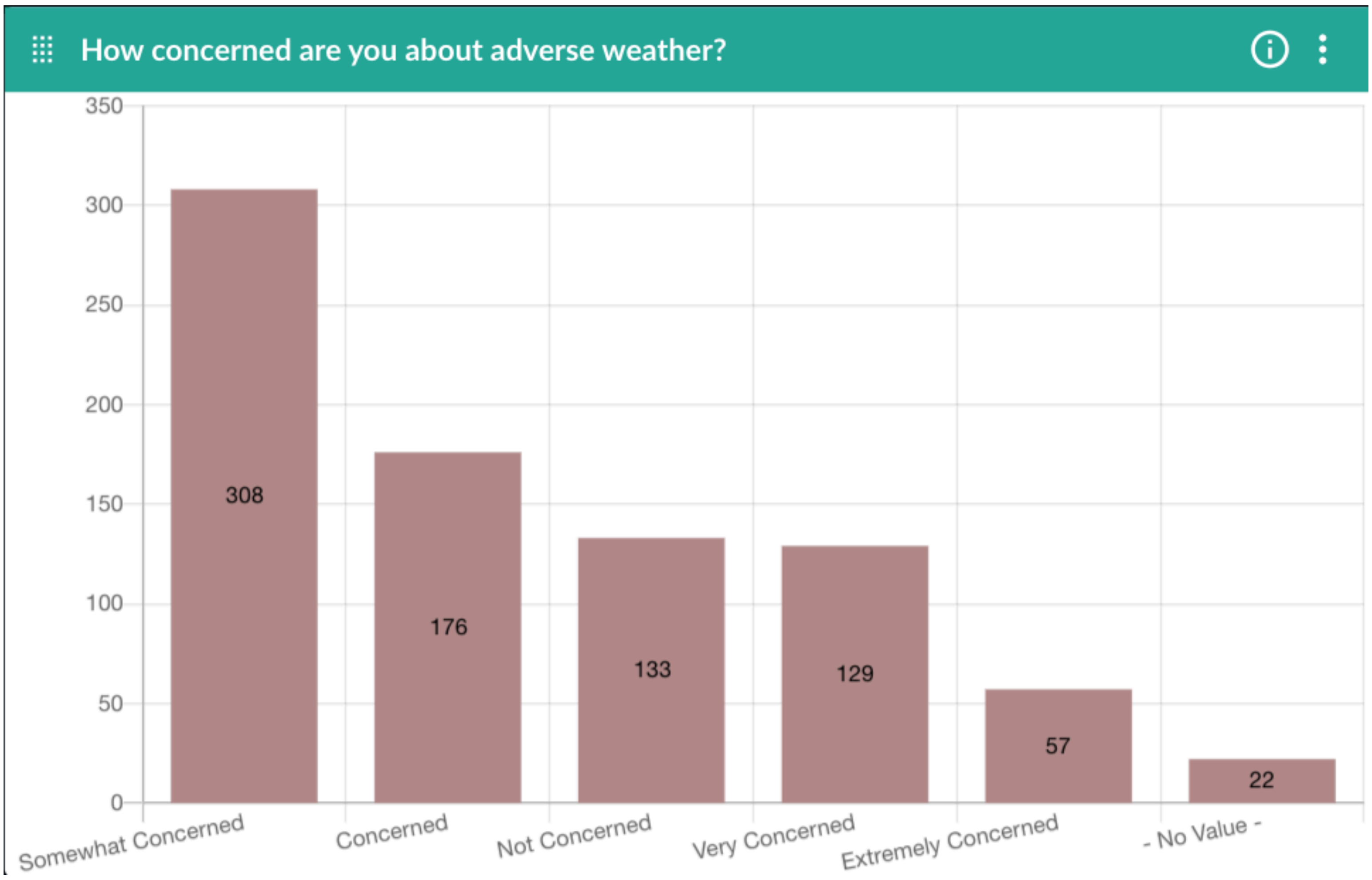
Experience living through one or more hazards or disasters	499
Emergency preparedness information from a government source (e.g., federal, state, or local emergency management)	487
Locally provided news or other media information	461
Participated in a disaster training program like Communities of Oakland Respond to Emergencies (CORE), Community Emergency Response Training (CERT), or other disaster training program	274
Attended meetings that have provided information on disaster preparedness	216
Other (please specify)	113
Schools or other academic institutions	76
- No Value -	22
Total	825

My family, household, or business and I have taken the following steps to prepare for a disaster?

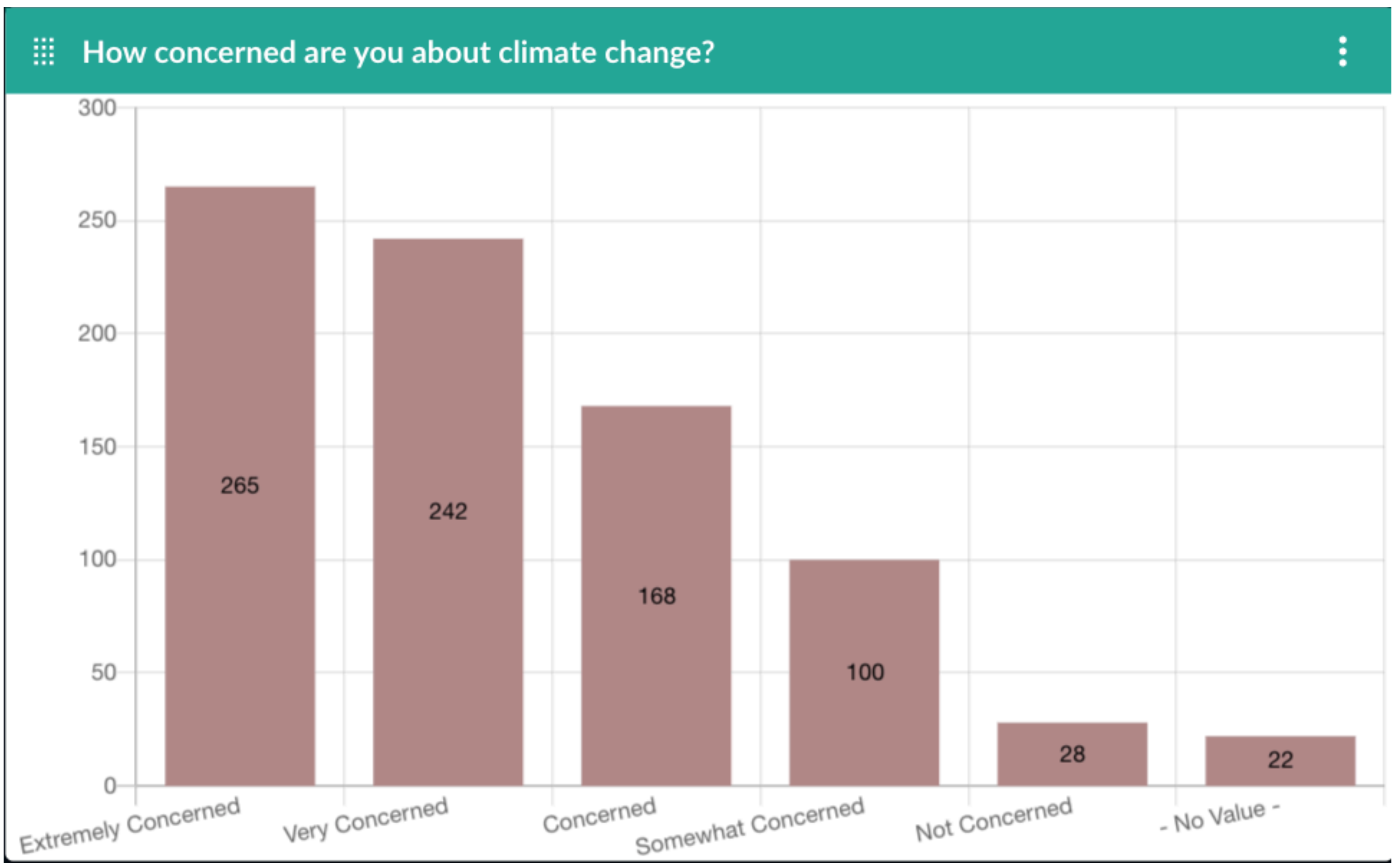
Family, Household and Business Steps Taken to Prepa...	
Installed smoke and carbon monoxide detectors on each level of the house	714
Stored flashlights and batteries	691
Stored medical supplies (first aid kit, medications)	613
Stored enough food and water to last 72 hours	590
Prepared a disaster supply kit	574
Identified utility shutoffs	518
Stored a battery-powered radio	503
Stored a regularly inspected fire extinguisher	431
Received First Aid/CPR training	354
Made a fire escape plan	333
Individual/family preparedness/planning	329
Designated an evacuation meeting place	258
Participated in neighborhood preparedness/planning	155
Other (please specify)	70
Written and practiced your family disaster plan	58
- No Value -	16
Total	825

How concerned are you about the following hazards in Oakland?

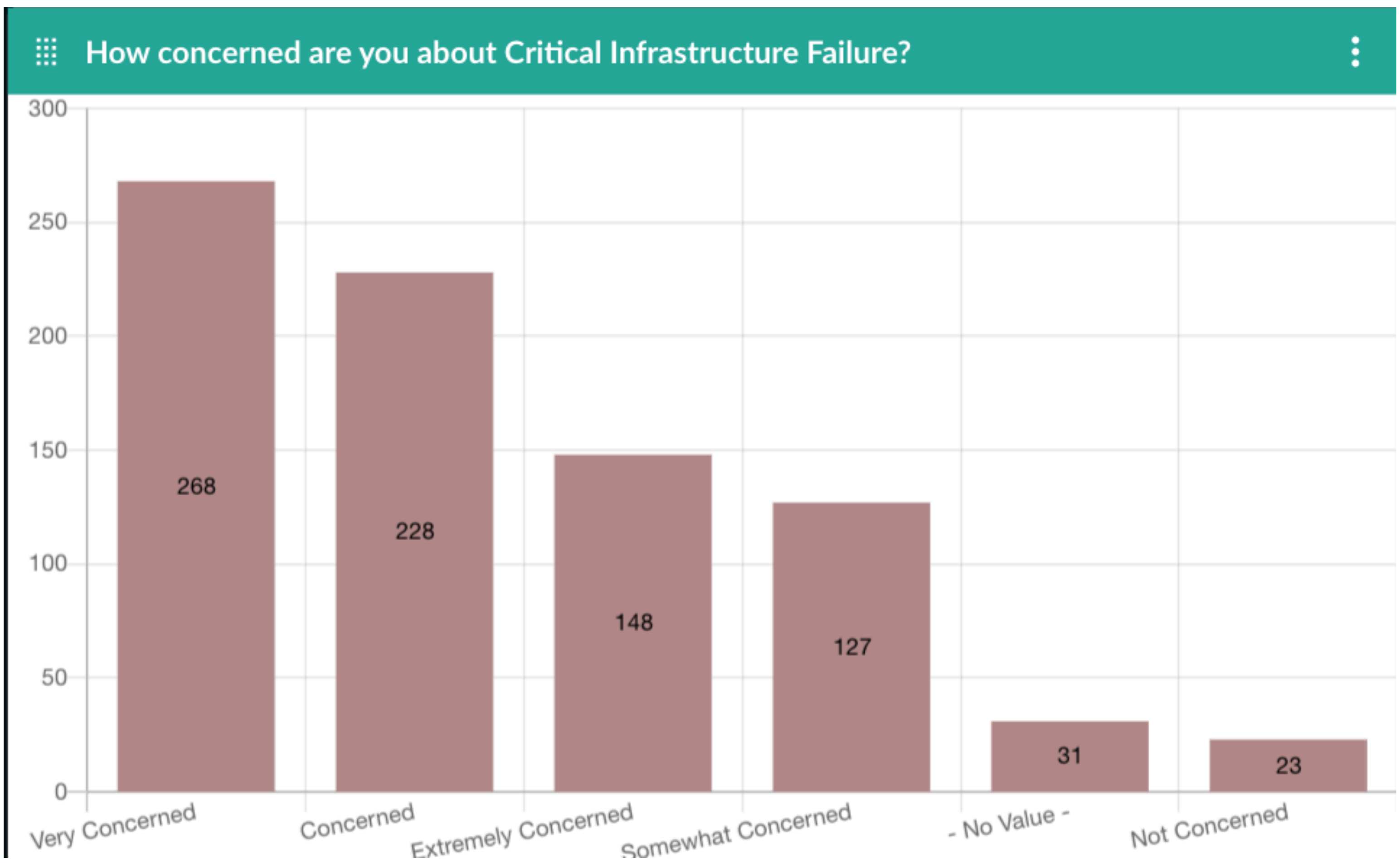
Adverse Weather



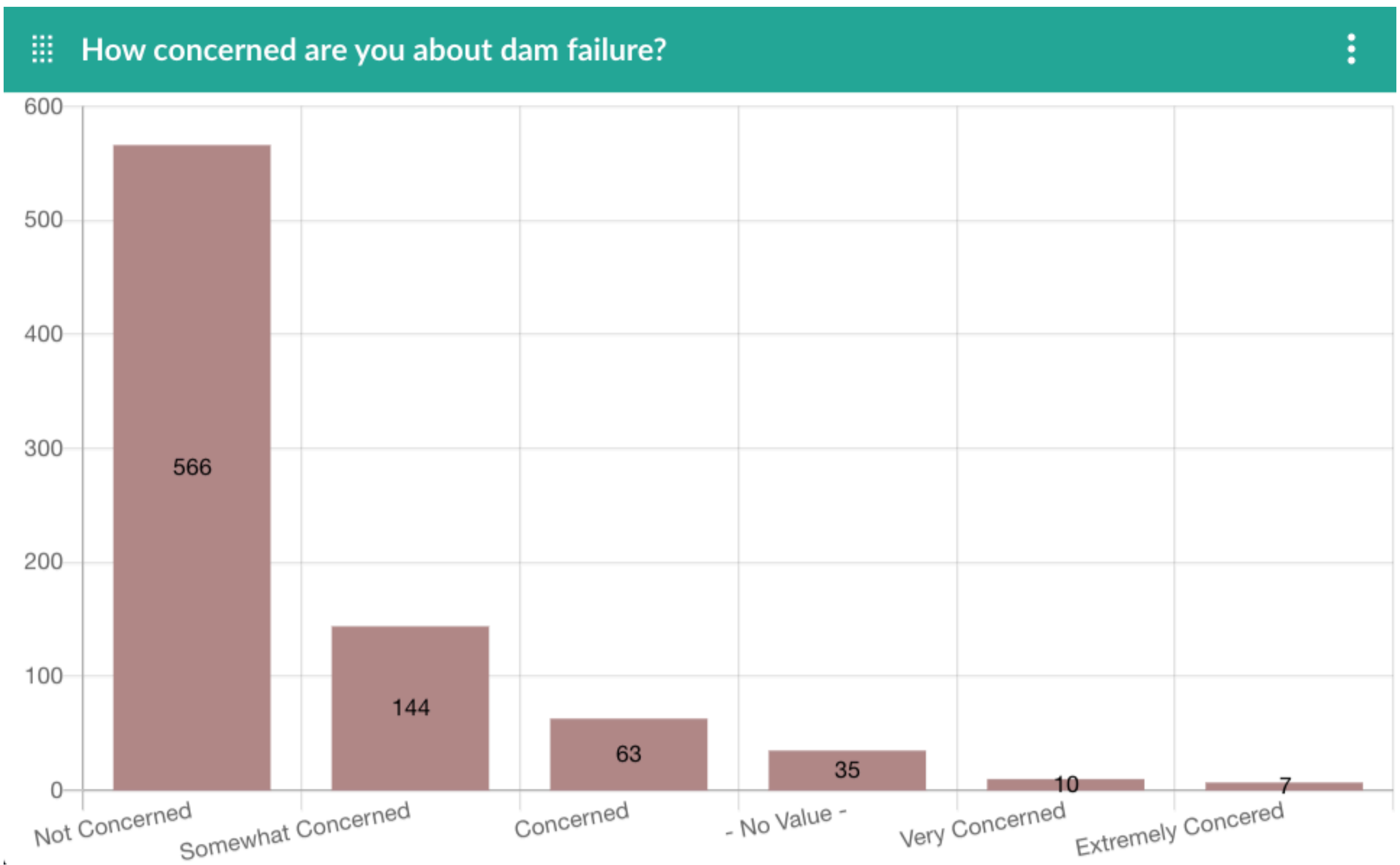
Climate Change



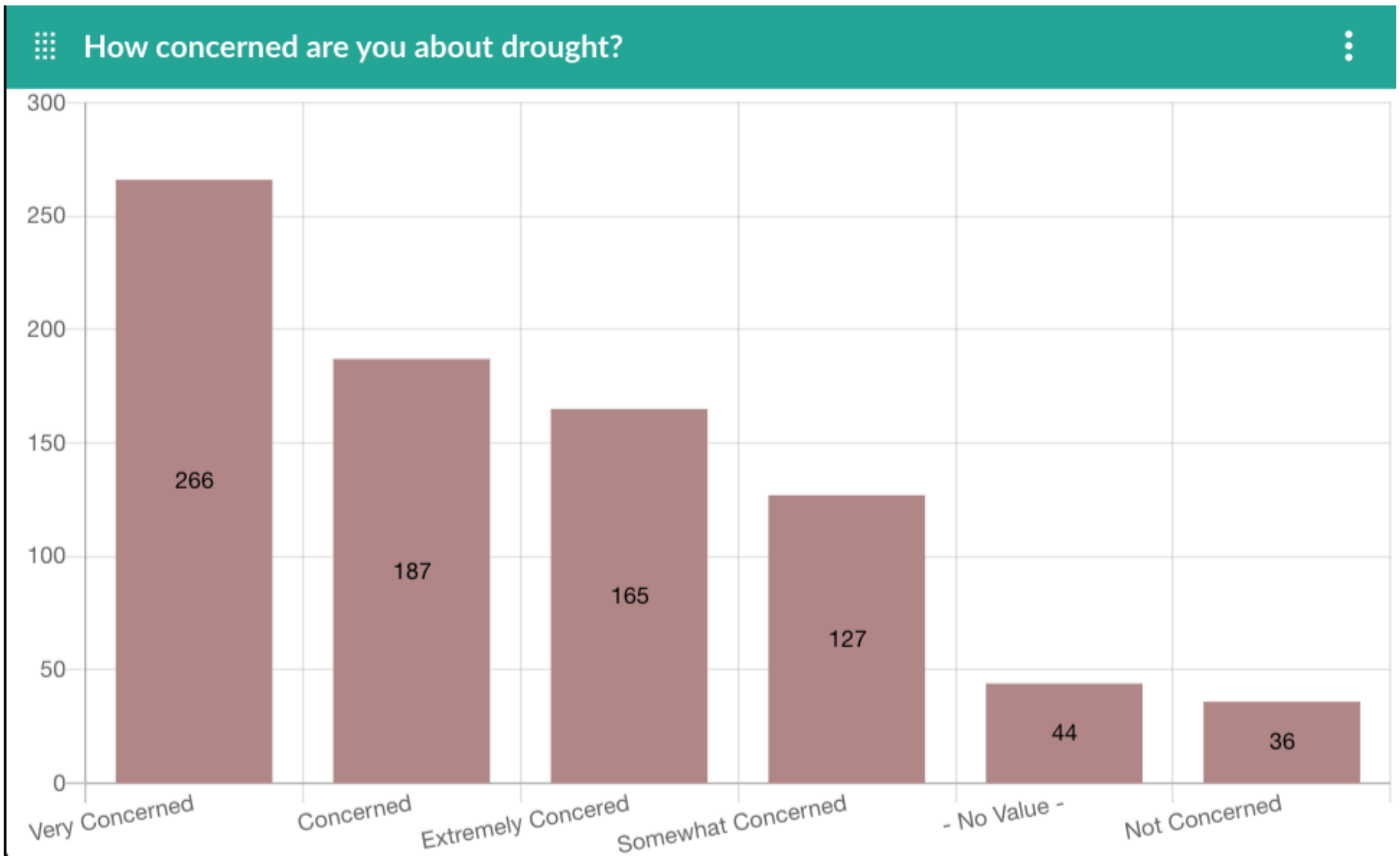
Critical Infrastructure Failure



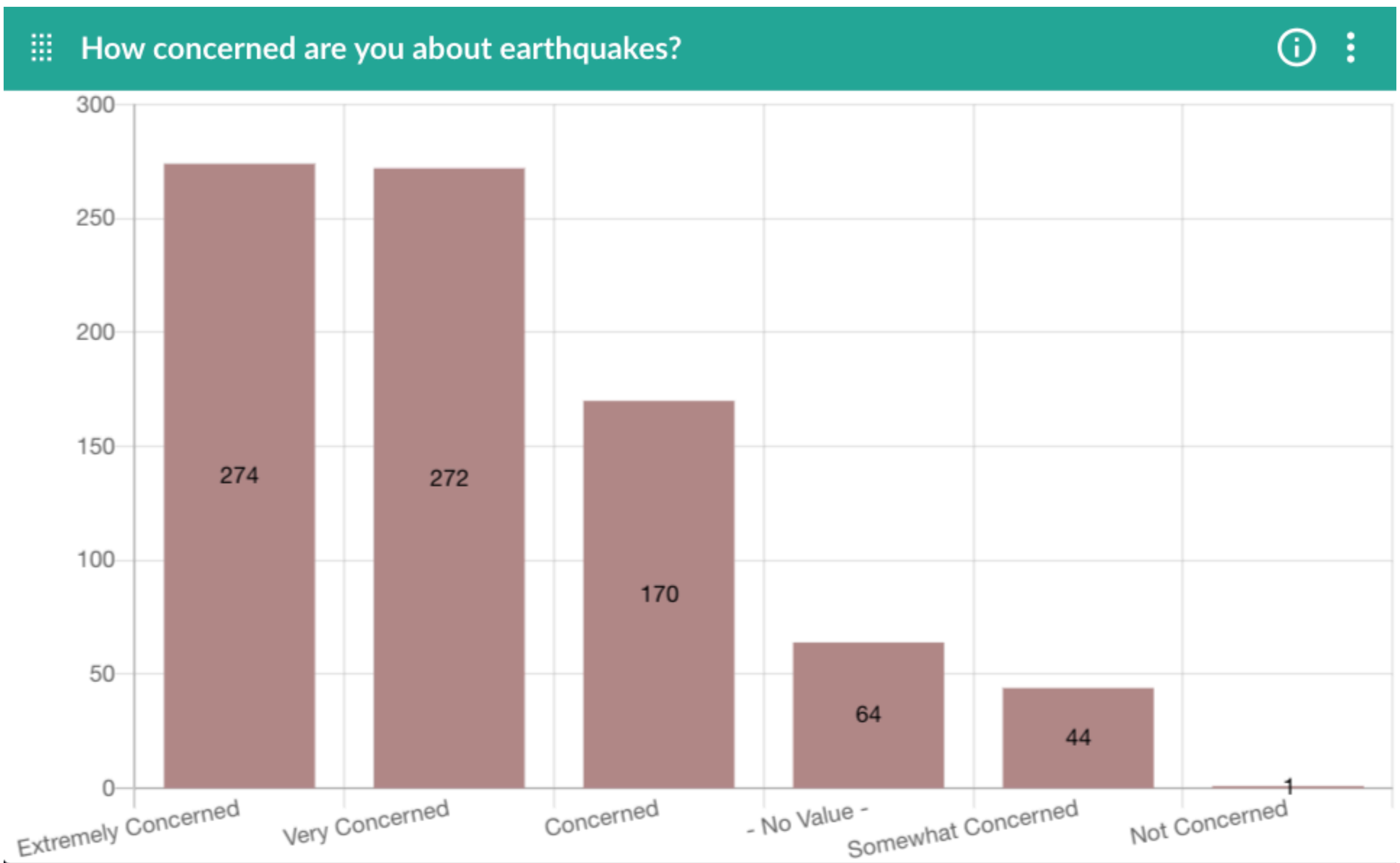
Dam Failure


How concerned are you about dam failure?
600
500
400
300
200
100
0
566
144
63
35
10
7
Not Concerned
Somewhat Concerned
Concerned
- No Value -
Very Concerned
Extremely Concered

Drought

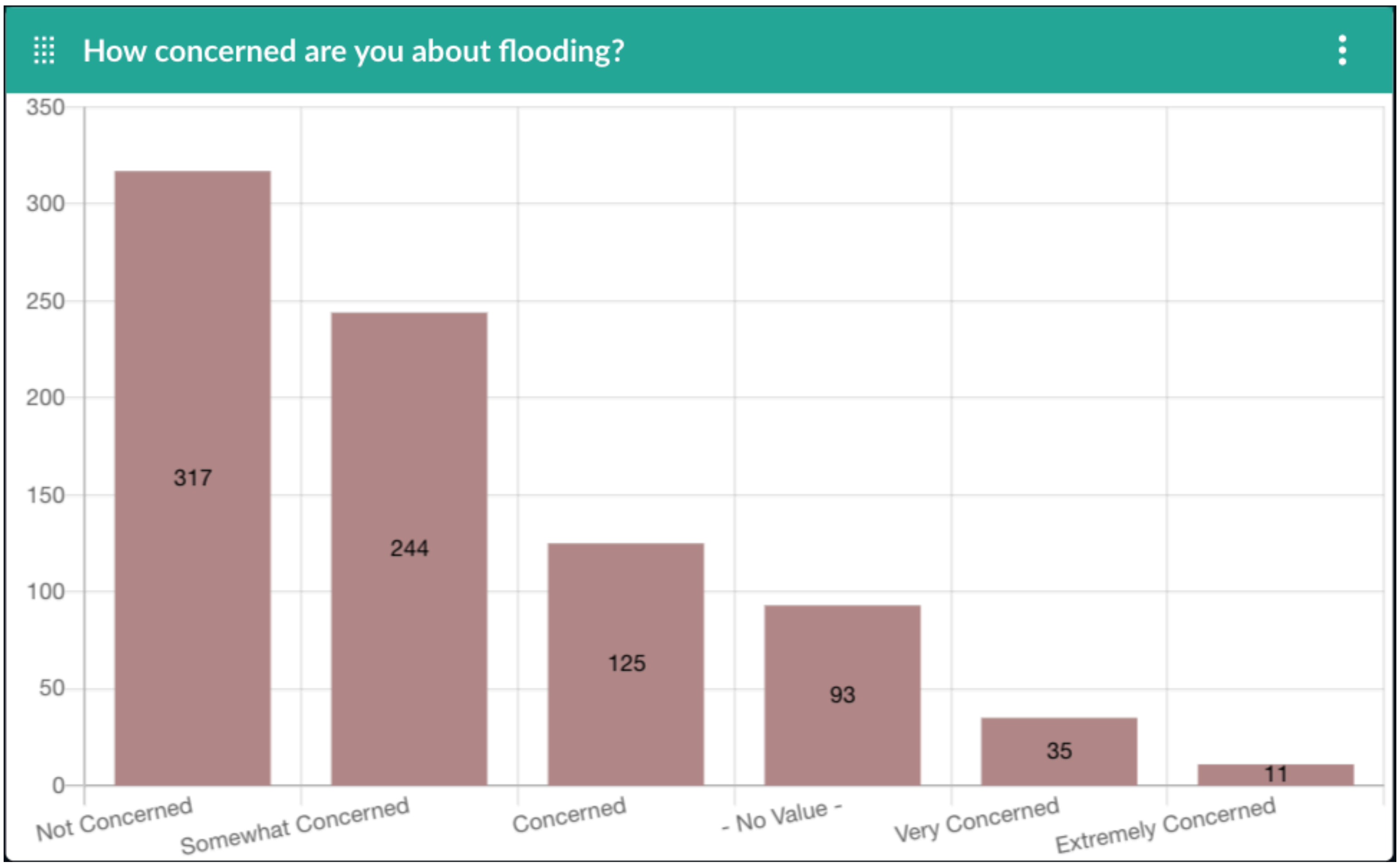

How concerned are you about drought?
300
250
200
150
100
50
0
266
187
165
127
44
36
Very Concerned
Concerned
Extremely Concered
Somewhat Concerned
- No Value -
Not Concerned

Earthquake



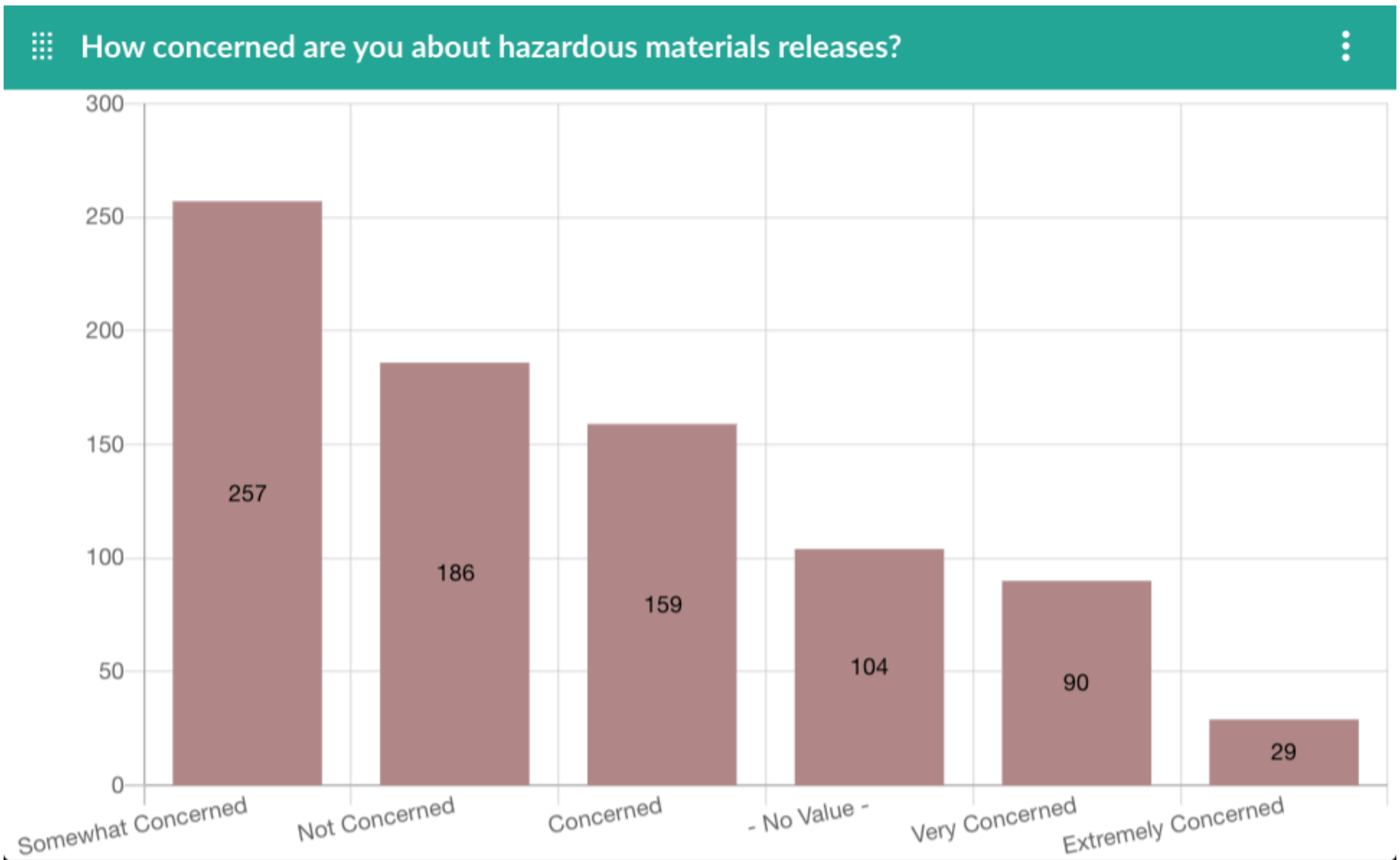
How concerned are you about earthquakes?
300
250
200
150
100
50
0
274
272
170
64
44
1
Extremely Concerned
Very Concerned
Concerned
- No Value -
Somewhat Concerned
Not Concerned

Flooding

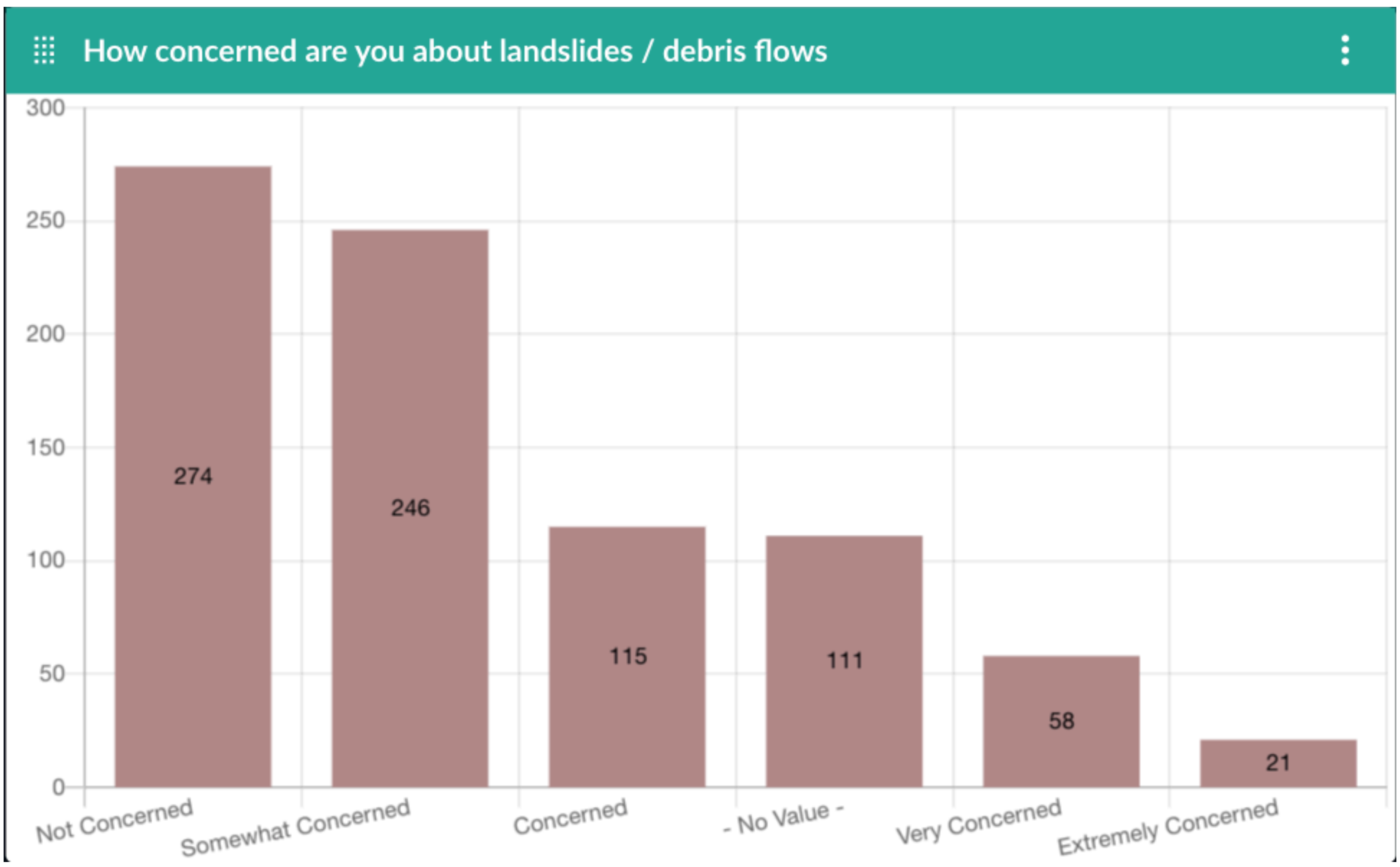


How concerned are you about flooding?
350
300
250
200
150
100
50
0
317
244
125
93
35
11
Not Concerned
Somewhat Concerned
Concerned
- No Value -
Very Concerned
Extremely Concerned

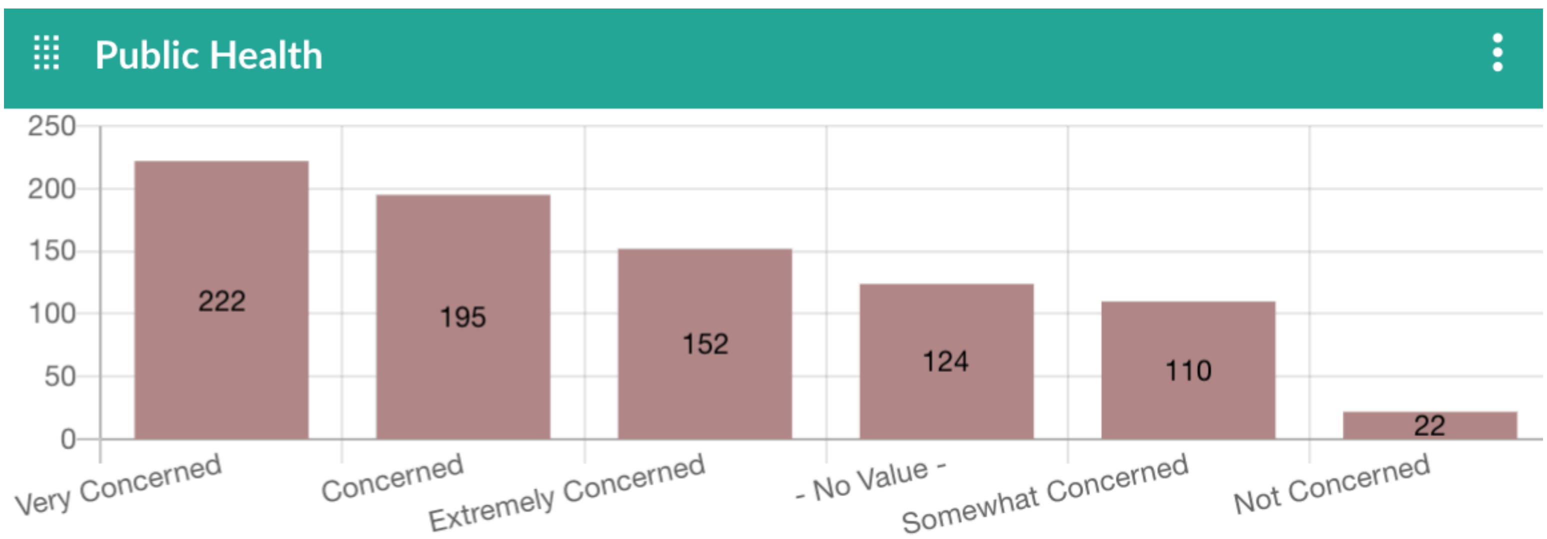
Hazardous Materials



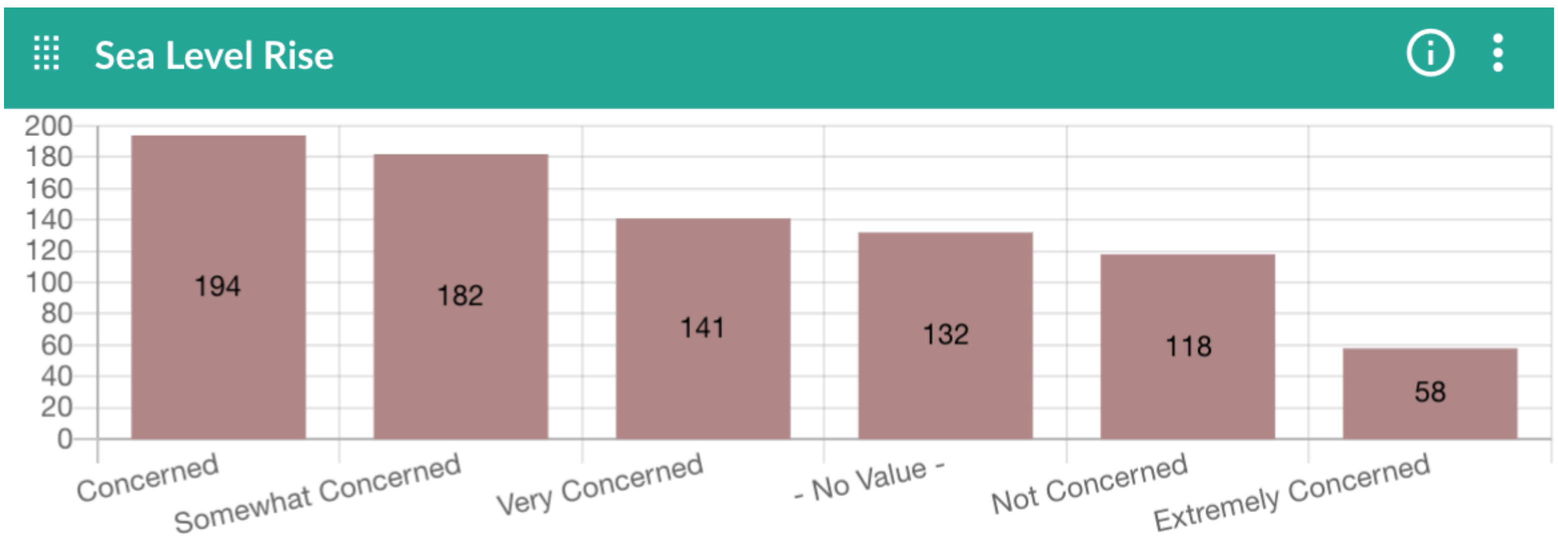
Landslide / Debris Flow



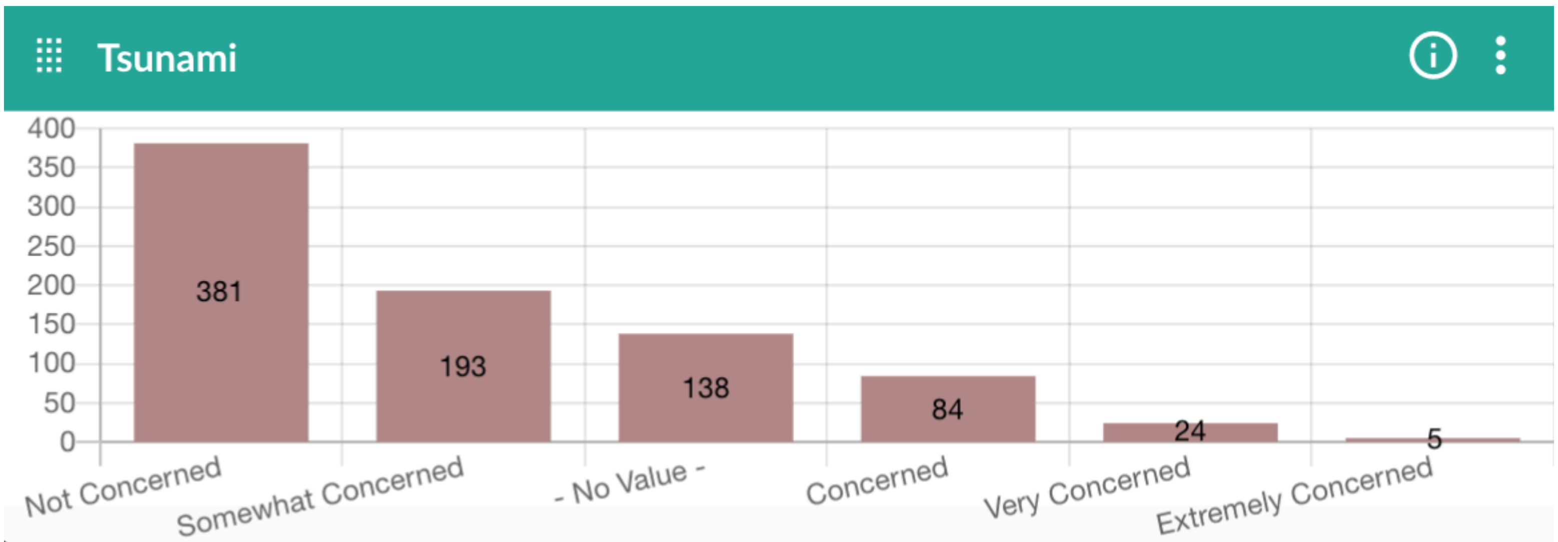
Public Health Hazards



Sea Level Rise

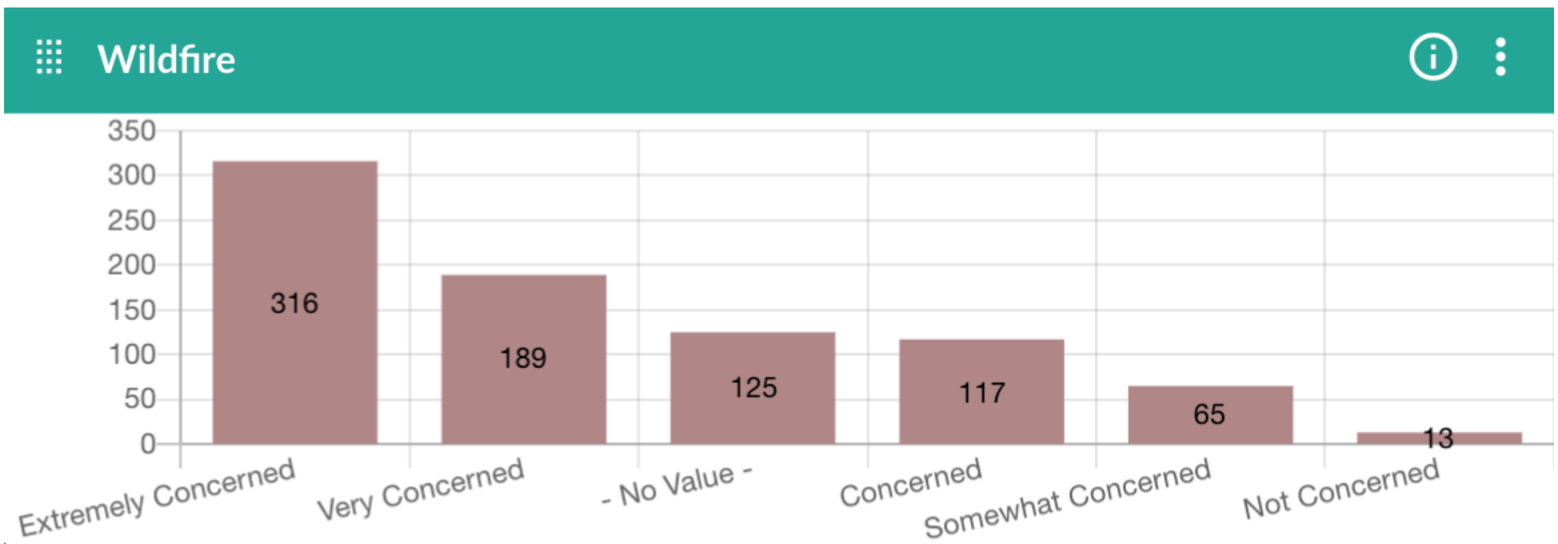


Tsunami

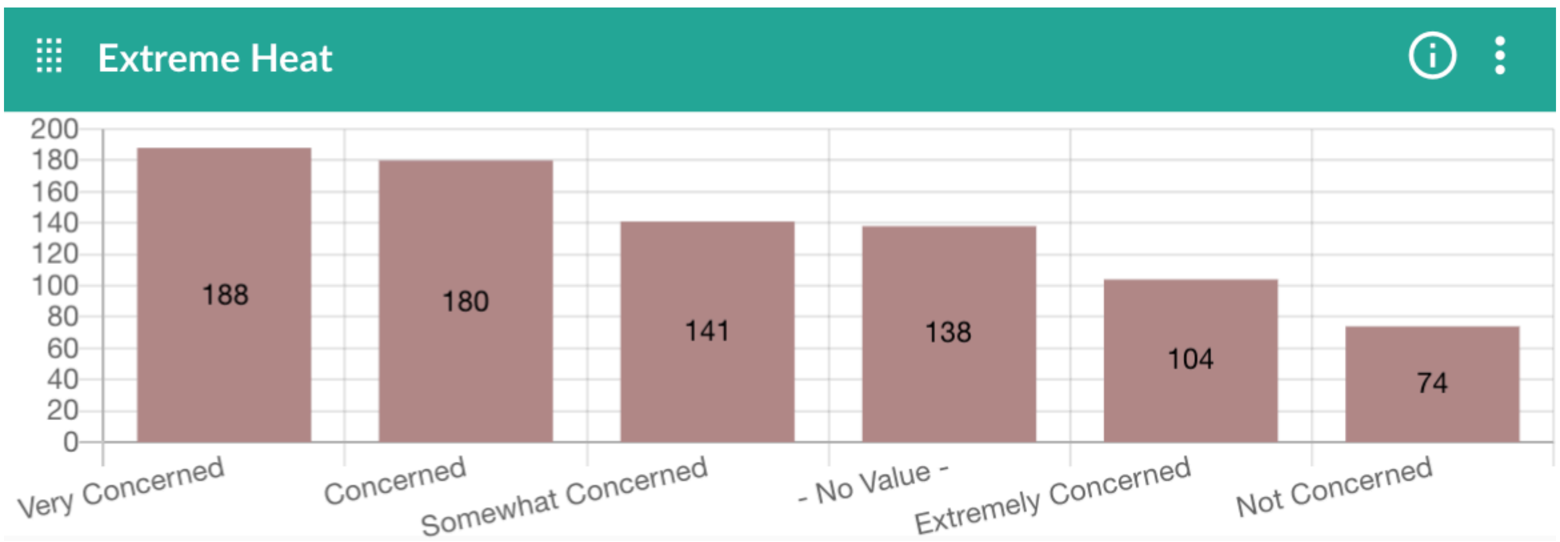


Tsunami
400
350
300
250
200
150
100
50
0
381
193
138
84
24
5
Not Concerned
Somewhat Concerned
- No Value -
Concerned
Very Concerned
Extremely Concerned

Wildfire


Wildfire
350
300
250
200
150
100
50
0
316
189
125
117
65
13
Extremely Concerned
Very Concerned
- No Value -
Concerned
Somewhat Concerned
Not Concerned

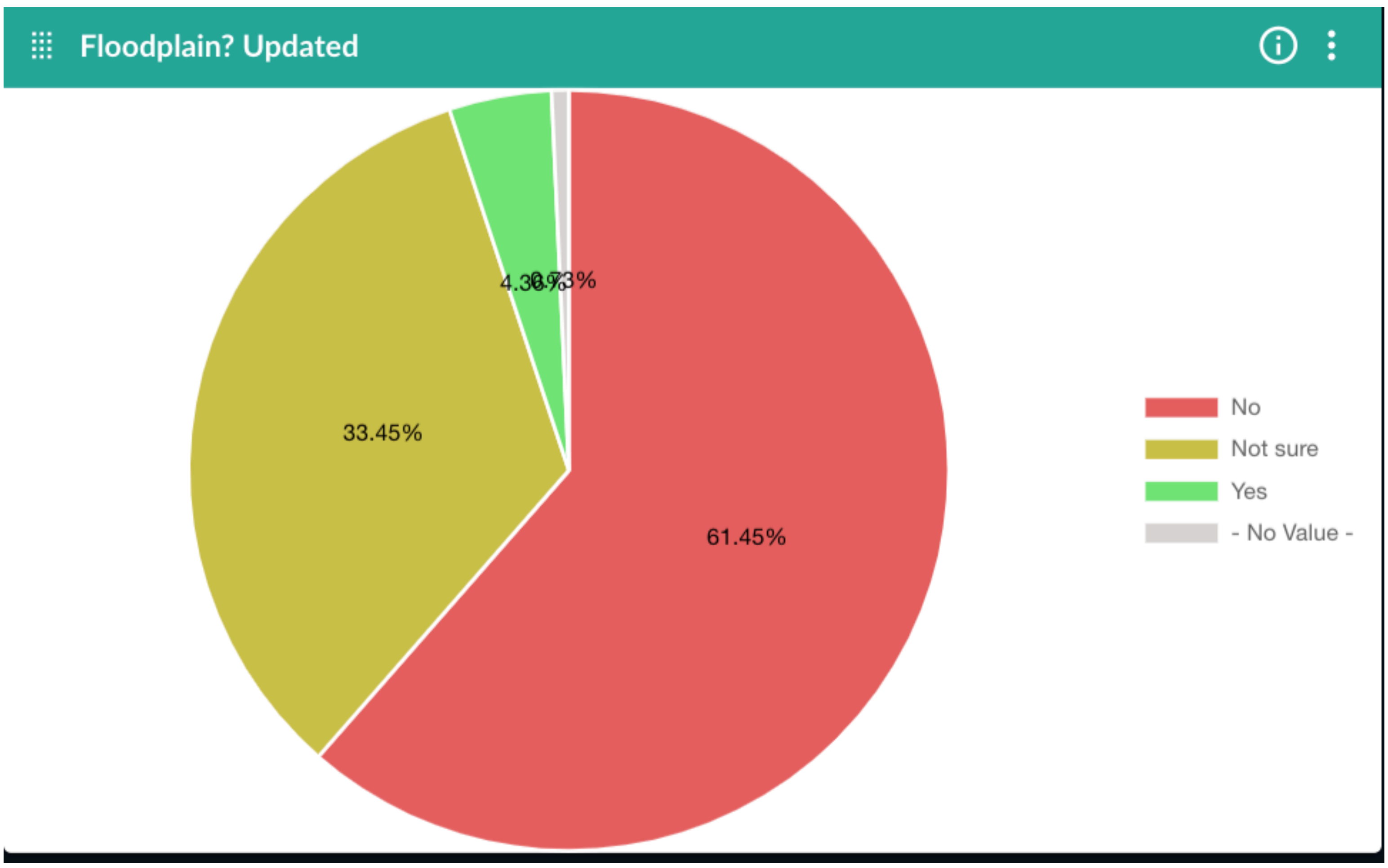
Extreme Heat



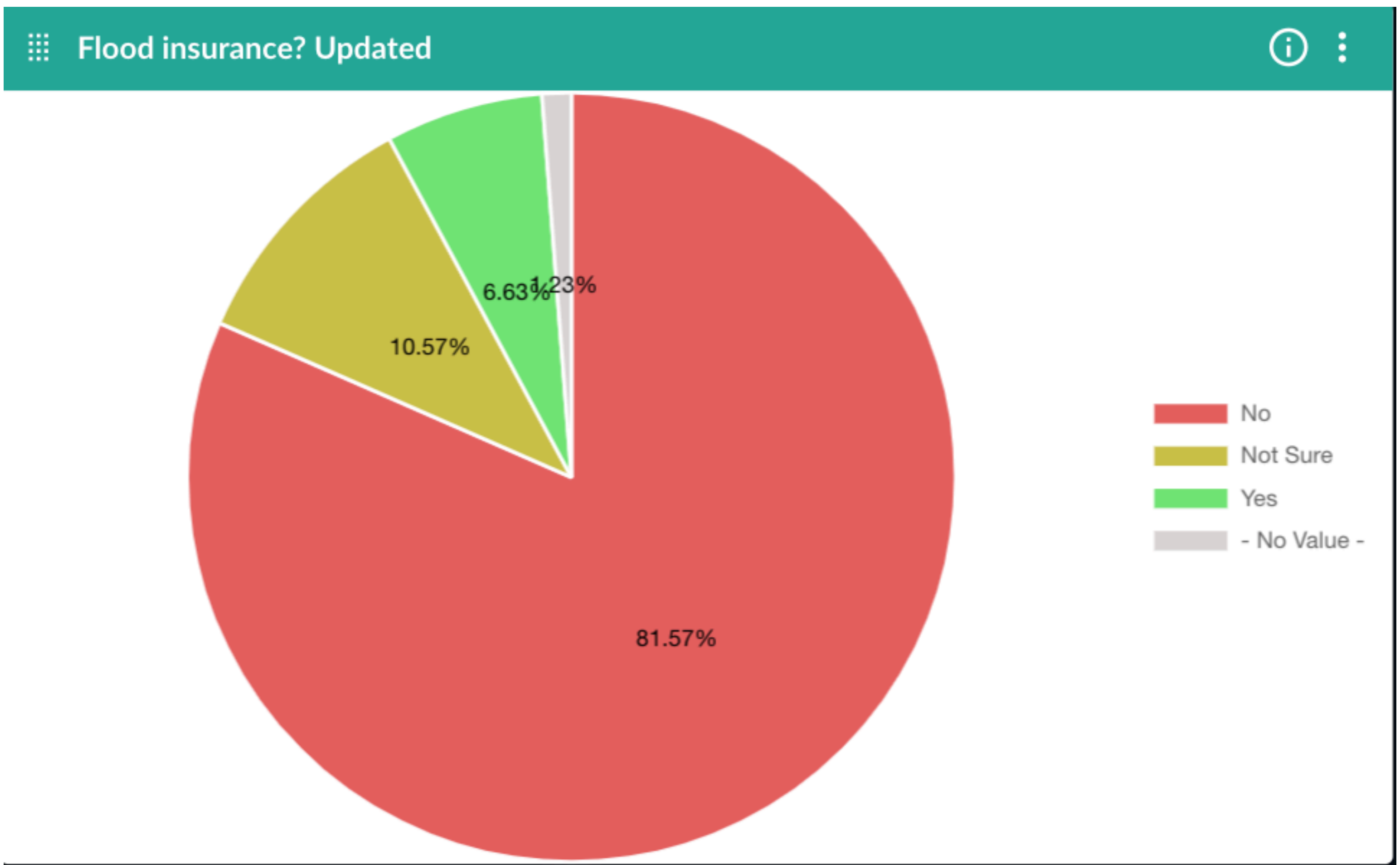
Which of the following methods do you think are most effective for providing information on emergency preparedness?

Providing Emergency Preparedness Information Update...	
Internet	607
Social Media	447
City Website	419
CORE/CERT Training	405
Public Awareness Campaign (e.g. Flood Awareness Week)	390
City Newsletters	345
American Red Cross Information	338
Fire Department/Rescue	314
TV News	305
Schools / Academic Institutions	281
Newspaper	276
Informational Brochures	269
Workshops	267
Public Meetings	259
Public Library	253
Radio News	252
Community Safety Fairs	247
Radio Ads	201
Outdoor Advertisements	193
TV Ads	187
Church or Other faith-based institution	155
Books	106
Other (please specify)	67
Chamber of Commerce	48
Telephone Book	31
- No Value -	11
Total	814

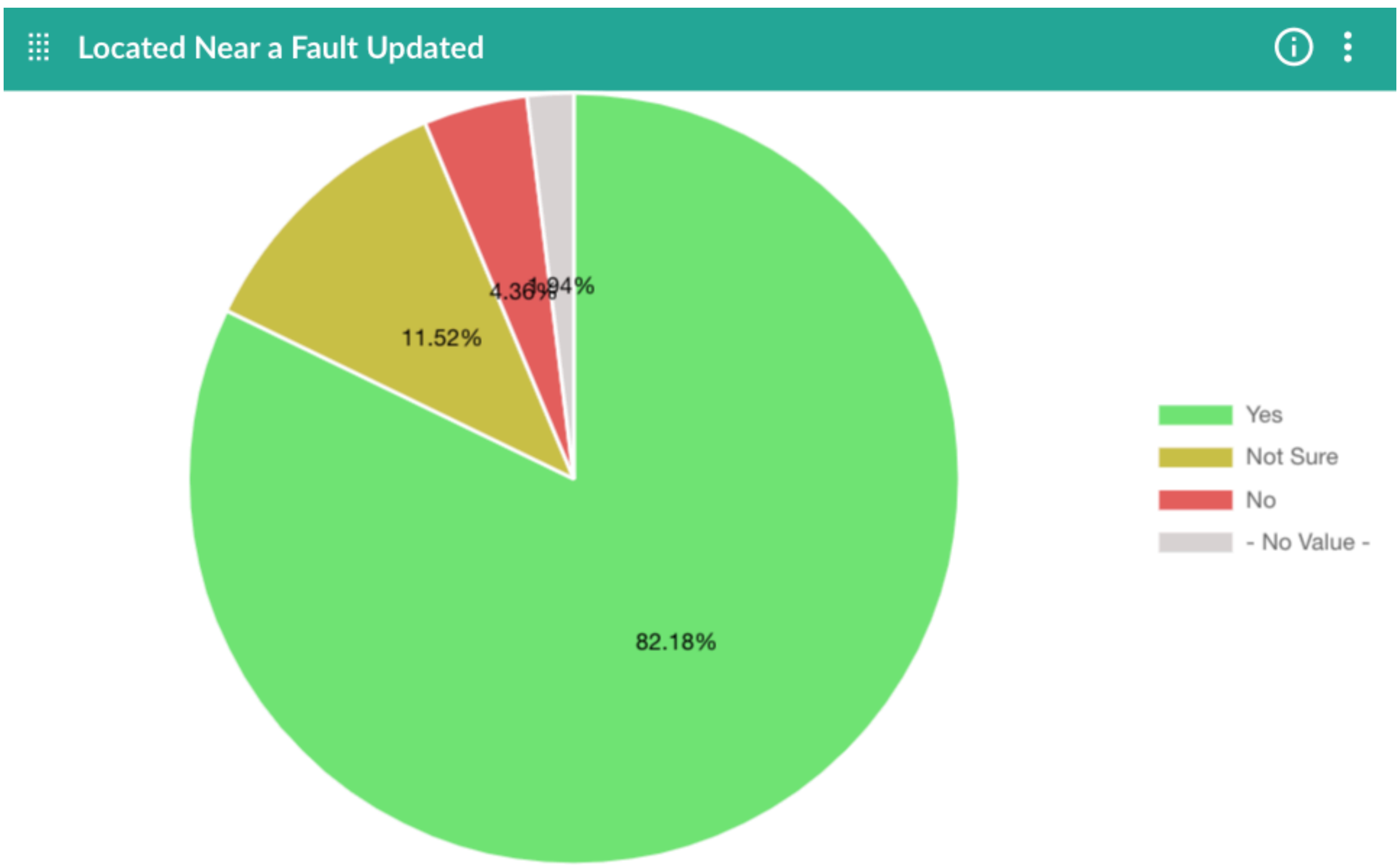
Is your home located on or near a FEMA designated floodplain?



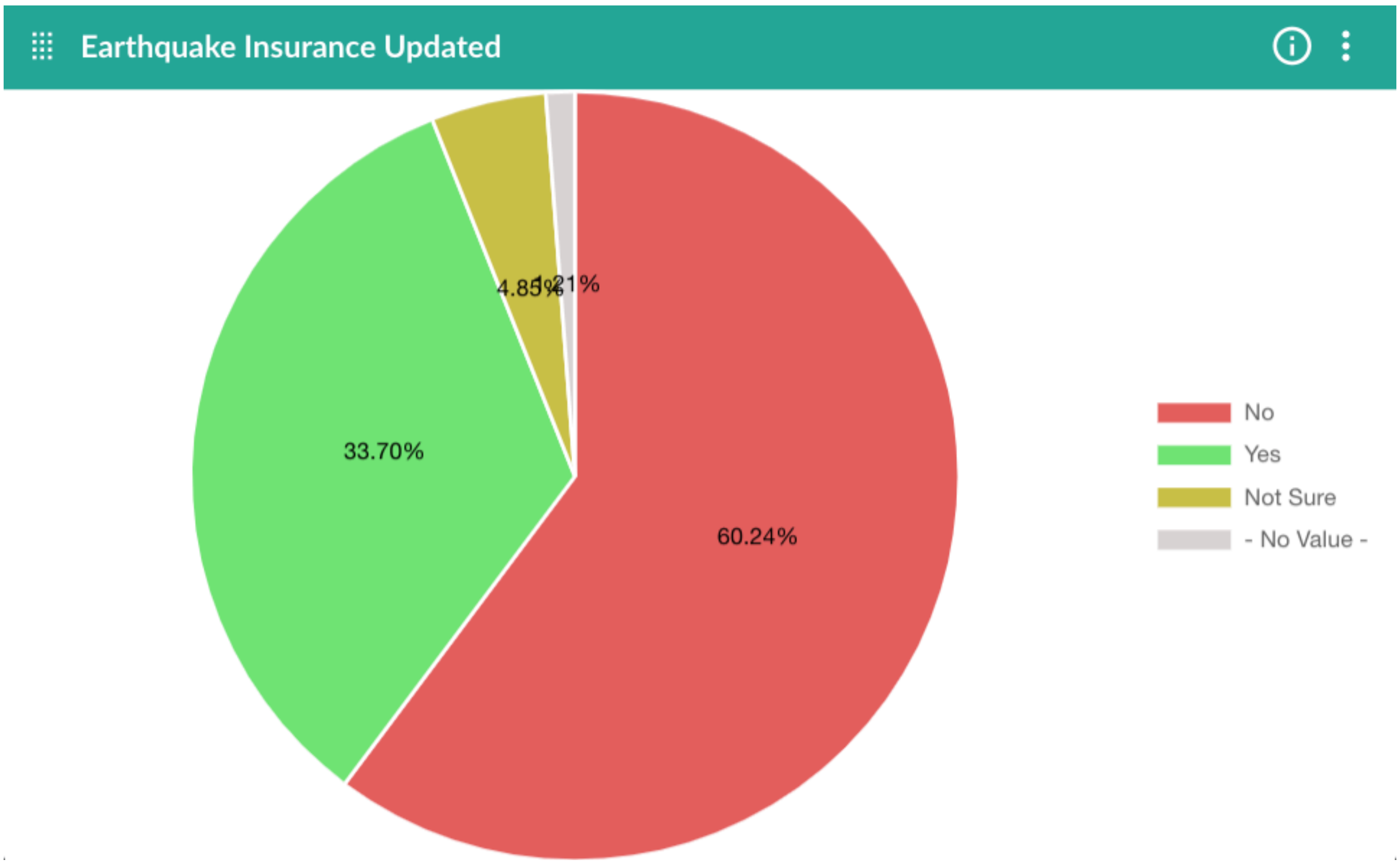
Do you have flood insurance?



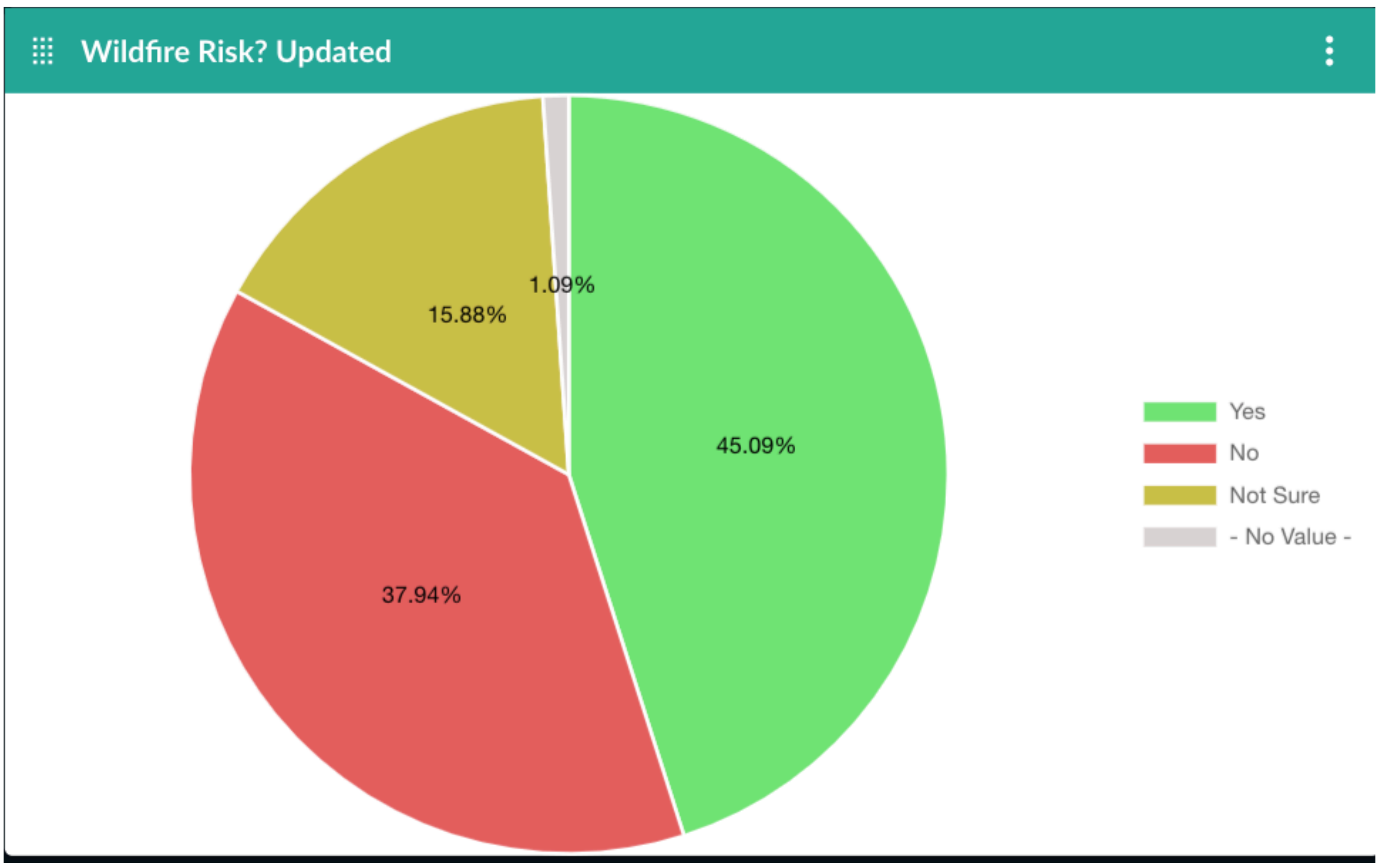
Is your home located near an earthquake fault?



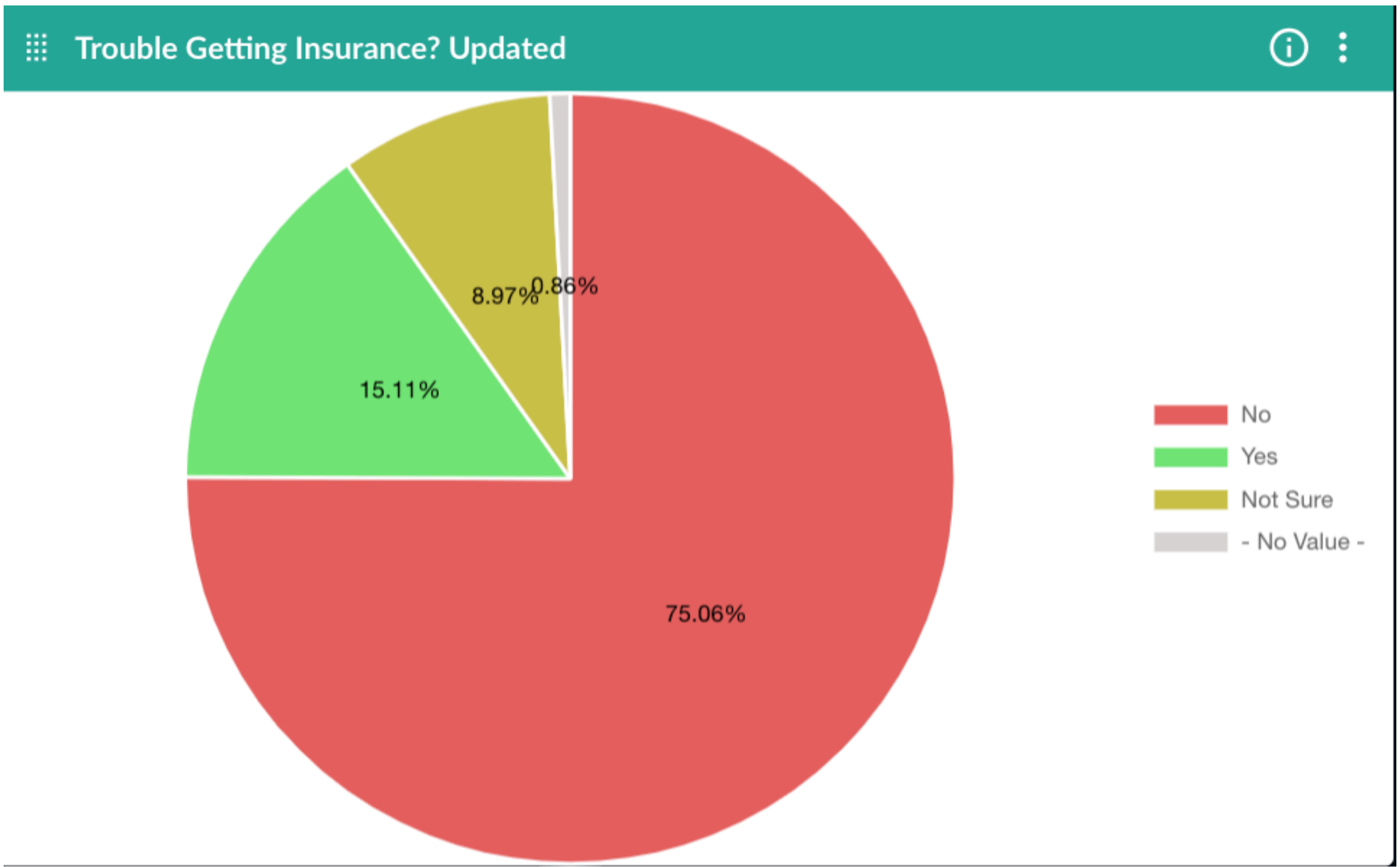
Do you have earthquake insurance?



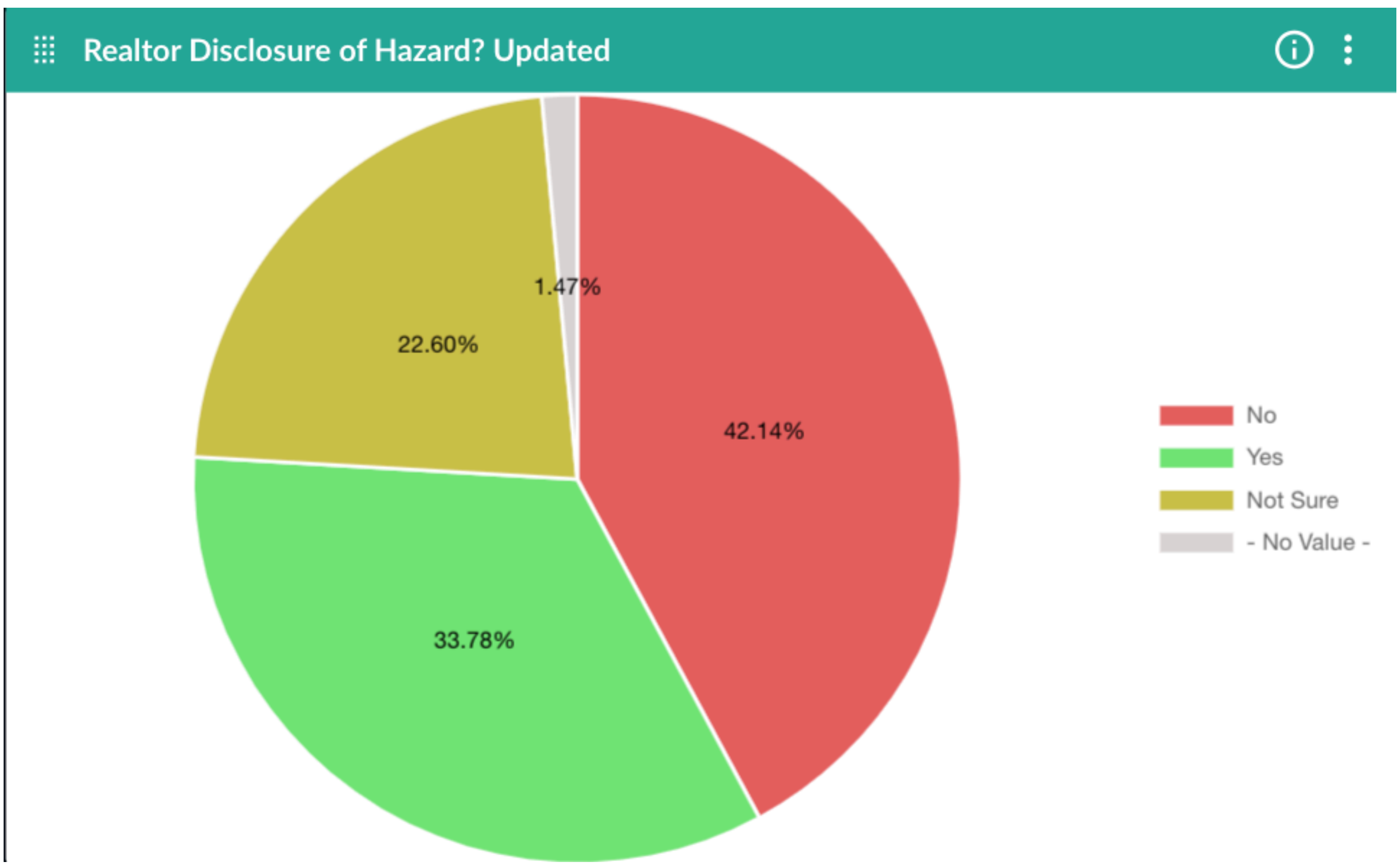
Is your home located in an area at-risk for wildfire?



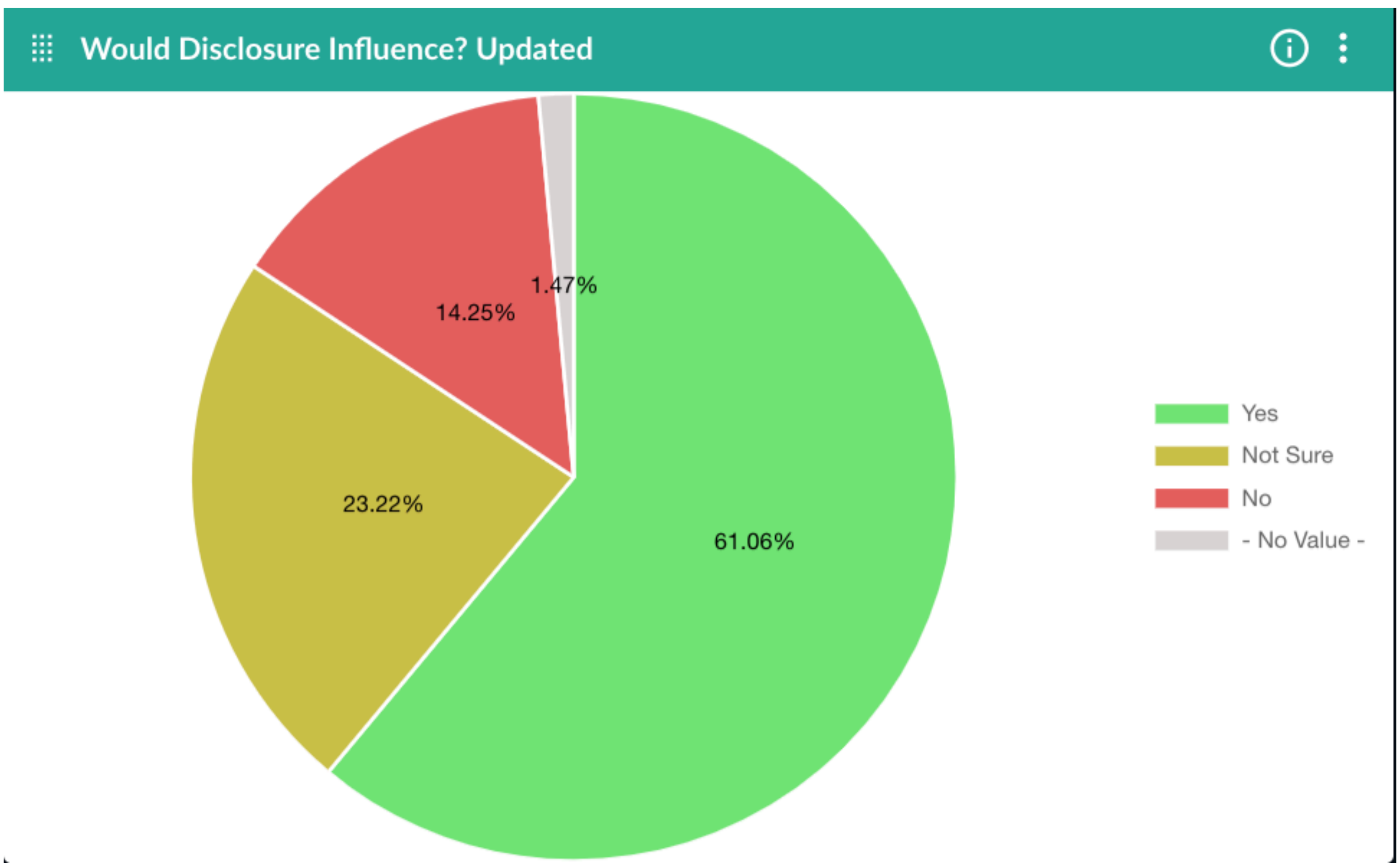
Have you ever had problems getting homeowners or renters insurance due to risks from hazards?



Was the presence of a hazard risk zone (e.g., earthquake fault zone, high fire risk area, etc.) disclosed to you by a real estate agent, seller, or landlord before you purchased or moved into your home?



Would the disclosure of this type of information influence your decision to purchase or move into a home?



Which of the following incentives would encourage you to spend money to retrofit your home or business to protect against disasters?

Incentives. Updated.

Property tax break or incentive	654
Insurance premium discount	622
Building permit fee waiver	536
Grant funding	484
Mortgage discount	425
Low interest rate loan	339
Other (please specify)	84
None	72
- No Value -	26
Total	814

Please indicate how you feel about the following statement: "I believe it is the responsibility of government (local, state, and federal) to provide education and programs that promote residents taking action to reduce their exposure and risk to natural hazards."

Responsibility of Government? Updated

Strongly agree	371
Agree	311
Strongly disagree	67
Neither agree or disagree	51
Disagree	7
- No Value -	7
Total	814

Please indicate how you feel about the following statement: "I believe it is my responsibility to educate myself about programs that reduce my exposure to natural hazards."

Personal Responsibility? Updated.

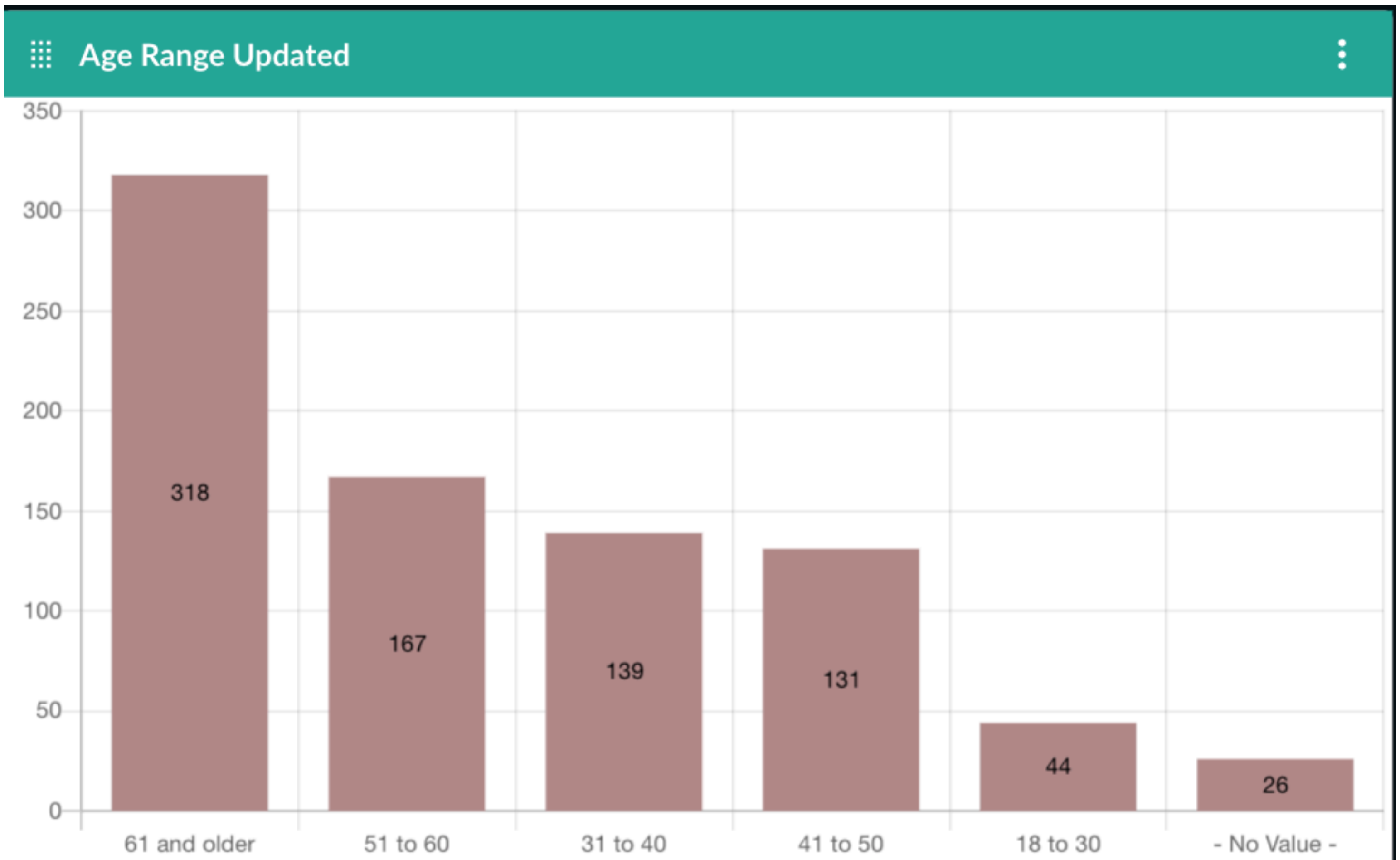
Agree	368
Strongly agree	329
Neither agree or disagree	58
Strongly disagree	44
Disagree	12
- No Value -	3
Total	814

What is your gender?

Gender? Update.

Woman	502
Man	270
- No Value -	28
Non-Binary	19
Other	4
Total	814

Please indicate your age range.



Please indicate the primary language spoken in your household.

Language Spoken at Home? Updated

English	759
- No Value -	38
Spanish	6
Other (please specify)	5
Chinese	4
Korean	1
Amharic	1
Total	814

Which of the following best describe your race/ethnicity?

Race? Updated.

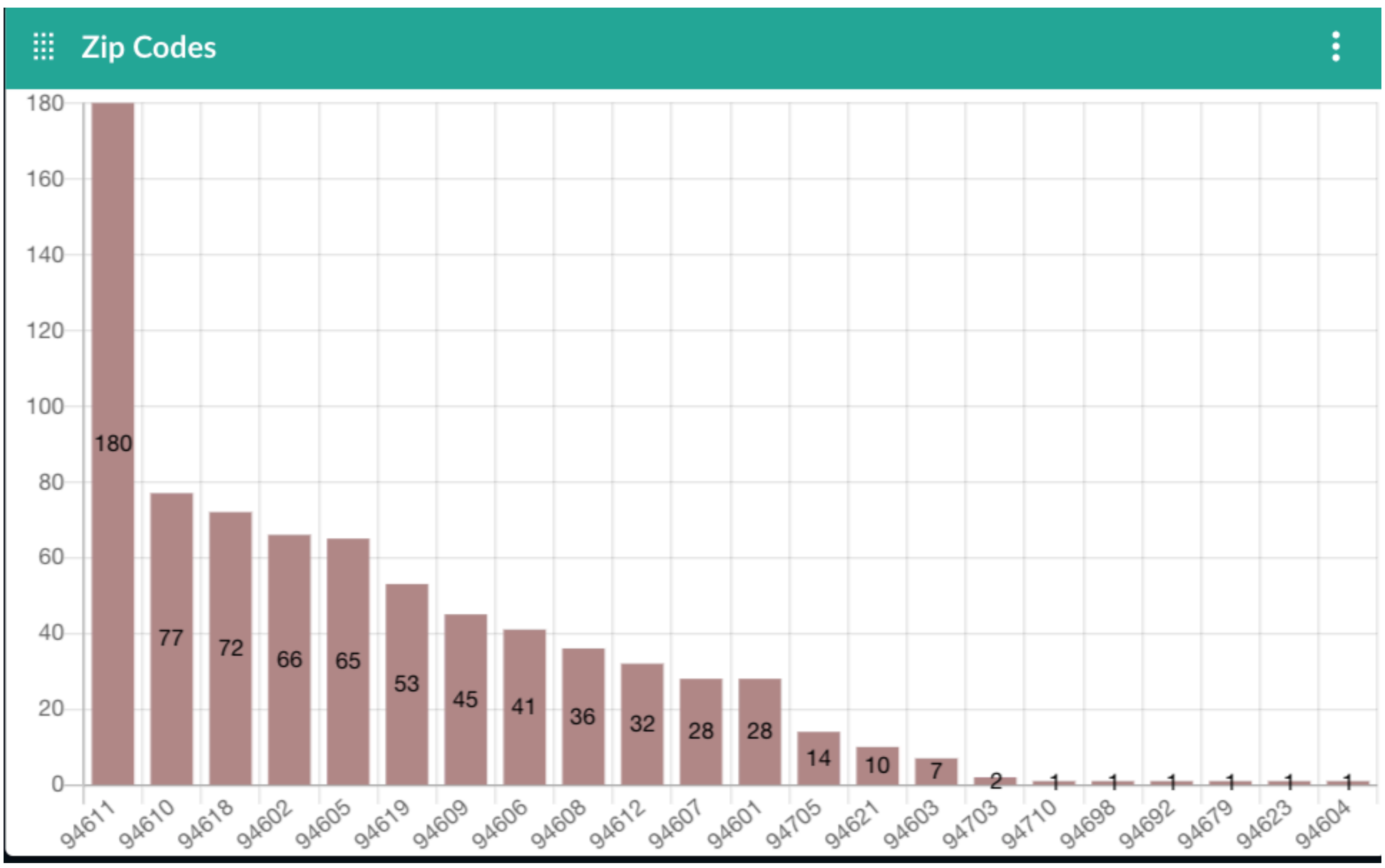
White	624
Asian	90
Black or African-American	56
Hispanic/Latinx	48
- No Value -	32
Other (please specify)	27
Native American or Alaskan Native	10
Native Hawaiian and Pacific Islander	5
Total	814

What is your household income?

Household Income? Updated.

$200,000 or more	169
$100,000 - $149,999	152
$75,000 - $99,999	113
- No Value -	105
$150,000 - $199,999	105
$50,000 - $74,999	88
$25,000 - $49,999	52
$10,000 - $24,999	19
Less than $10,000	11
Total	814

What is your zip code?

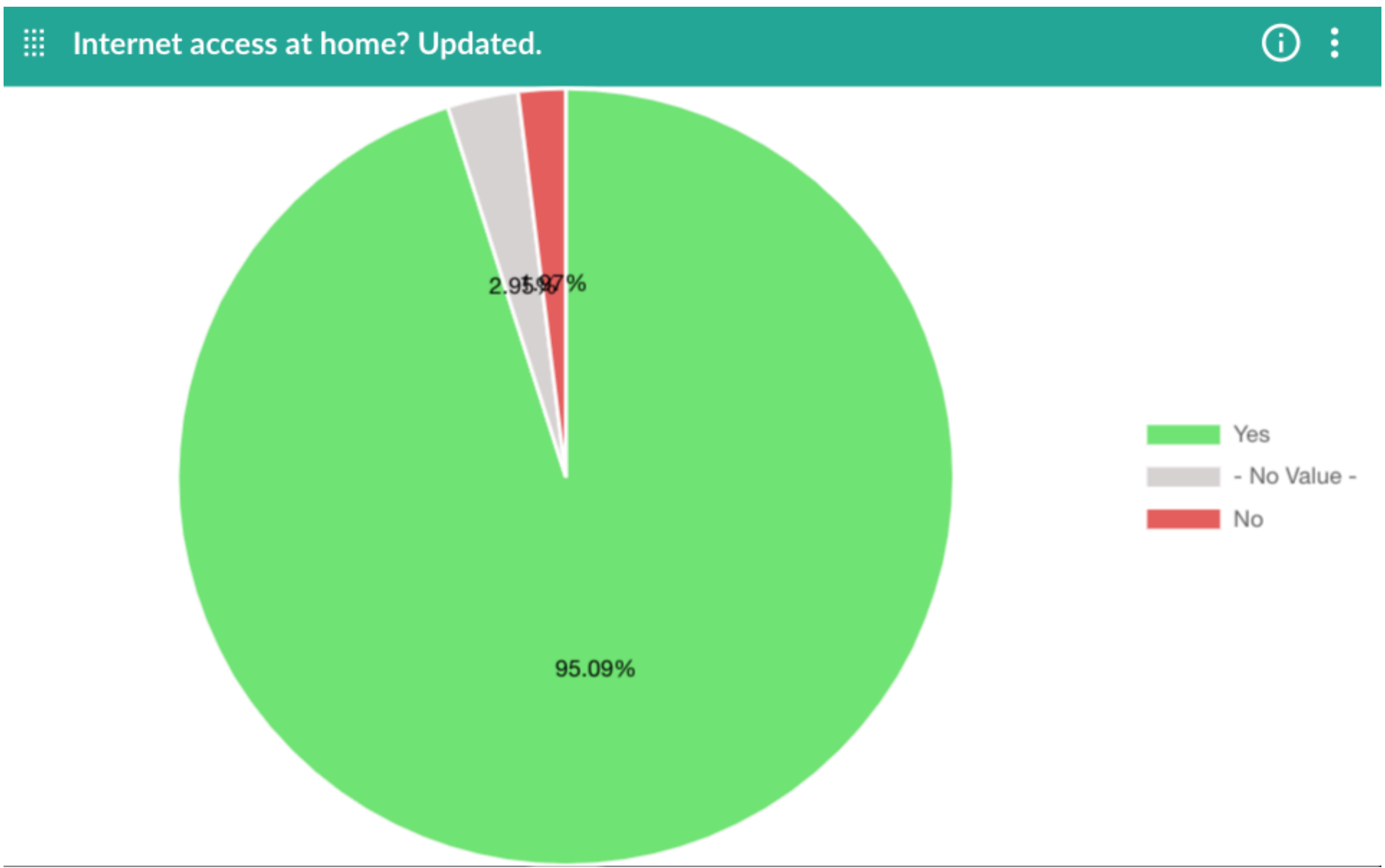


What is the name of your neighborhood?

Neighborhood? Updated.

- No Value -	74
Montclair	60
Rockridge	36
Cleveland Heights	19
Adams Point	16
Upper Rockridge	14
Piedmont Pines	14
Temescal	13
Redwood Heights	13
Maxwell Park	12
Glenview	12
Dimond	12
Crocker Highlands	12
Bushrod	11
Laurel	10
Longfellow	9
Ridgemont	8
Millsmont	8
West Oakland	7

Do you have access to reliable internet service at your home or business?



A.3 Public Review Draft Presentation

City of Oakland

2021 CITY OF OAKLAND LOCAL HAZARD MITIGATION PLAN

Feb 2021

DO YOU KNOW?

City of Oakland

- What is hazard mitigation and how it benefits the City?
- What actions the City has already taken to reduce risk?
- What the City wants to hear from you?
- Hazard Mapper

WHAT IS HAZARD MITIGATION?

- Actions to minimize risk to people, property, the environment, and natural and cultural resources
- Caused by natural, technological, or man-made disasters
- Mitigation helps create a more disaster-resilient and sustainable community

Source: *H.G. Wilshire for U.S. Geological Survey*

WHY IS HAZARD MITIGATION IMPORTANT?

City of Oakland

- Mitigation Planning allows the City to:
  - Better understand and reduce the impact of identified hazards
  - Protect people, property, and the environment
  - Remain eligible to receive federal mitigation grants
  - Strengthen relationships through planning together
  - Improve coordination of hazard mitigation with comprehensive planning and zoning
  - Develop more sustainable and disaster resistant communities
  - Save lives and money!

WE NEED YOUR HELP!

City of Oakland

Here's what you can do:

- Take the local hazard mitigation plan survey HERE
  - English (language) - https://veoci.com/v/p/form/bvddhekv2m8s
  - Chinese (language) - https://veoci.com/v/p/form/fvkxvzdsstdz
  - Spanish (language) - https://veoci.com/v/p/form/2trf6sk95q83
  - Vietnamese (language) - https://veoci.com/v/p/form/c6ttymdwpn9s
- Review and provide comment on the draft LHMP when published – Coming mid-March 2021 - https://www.oaklandca.gov/topics/2021-local-hazard-mitigation-plan#purpose-of-the-plan
- Provide comments or questions by email at OaklandLHMP@room.veoci.com

Hazard Mapper

Thank you for helping us build a more resilient Oakland

Photo: Greg Linhares, City

A.4 Comments Received on Public Review Draft

EAST BAY MUNICIPAL UTILITY DISTRICT

April 21, 2021

Jessica Feil, Emergency Services Manager
Oakland Fire Department
1605 Martin Luther King Jr. Way
Oakland, CA 94612

Re: Notice of Public Meetings/Hearings to Adopt City of Oakland 2021-2026 Local Hazard Mitigation Plan as an Amendment to the Safety Element of the Oakland General Plan, Oakland

Dear Ms. Feil:

East Bay Municipal Utility District (EBMUD) appreciates the opportunity to comment on the 2021-2026 Local Hazard Mitigation Plan (LHMP) for the City of Oakland (City). EBMUD has the following comments.

GENERAL

On page 7-2 under Planning Requirements, the LHMP discusses the Federal Energy Regulatory Commission (FERC) and on page 7-13 under Section 7.7 Issues, the first and second bullet points also reference federally regulated dams. However, none of the dams which impact the City are FERC jurisdictional dams. The California Division of Safety of Dams (DSOD) has a role in dam safety as it pertains to the dams that impact the City. Consider highlighting the State's role in dam safety planning as it pertains to the dams in Oakland.

On page 7-3 under Hazard Profile, the LHMP lists dam and reservoir failures which would result in large flooded areas in the City. Consider including Dunsmuir Reservoir, which also includes a sizable inundation area in the City. Also, under Hazard Profile, the areas which would be inundated in the case of the failure of the Upper San Leandro Reservoir Dam are listed and should be updated to include the airport itself, which would be impacted.

On page 7-5, there are several errors in Table 7-2 on high-hazard dams and should be corrected with the following information. Central Reservoir has a capacity of 472 acre-feet. The year built for the Chabot Dam is erroneously listed as 1892. Chabot Dam was originally constructed in 1875 with modifications made to the dam in 1892, 1967, 1980, and 2017. The dam type for Chabot Dam should be updated from hydraulic fill to "Earth". Chabot Dam consists of homogeneous earth fill dam with a clay core and hydraulic fill blanket on the downstream toe, which was seismically retrofitted in 2017 using Cement Deep Soil Mixing (CDSM) elements to stabilize this zone of the dam. Chabot Dam has a crest length of 500 feet, a height of 135 feet, and a storage capacity of 10,350 acre-feet.

The height of the perimeter walls of the tanks of Dunsmuir Reservoir is approximately 30 feet. But note, depths in the basin vary between 30 and 45 feet with the lowest point about 52 feet deep. Dunsmuir Reservoir has a storage capacity of 201 acre-feet. New Upper San Leandro has a crest length of 1,430 feet and a storage capacity of 38,905 acre-feet.

On page 7-6 under Inundation Mapping, the LHMP states "Digital data suitable for a quantitative assessment of dam failure risk was available for the five extremely-high hazard dams listed in Table 7-2." However, a true quantification of risk as stated is not communicated from the results on these maps. Studies for the State were performed using deterministic methods based on absolute worst-case conditions and may be very conservative to use these results in subsequent risk-based studies.

On page 8-11 under Section 8.3 Issues, consider referencing EBMUD's Water Shortage Contingency Plan which addresses water shortages, including droughts, and response actions that may be implemented. EBMUD's Urban Water Management Plan also references a diversified portfolio to help provide supplemental supplies as well as offset some demand with recycled water programs and conservation programs. The reference would tie the analysis to actions already in place.

If you have any questions concerning this response, please contact Timothy R. McGowan, Senior Civil Engineer, Major Facilities Planning Section at (510) 287-1981.

Sincerely,

David J. Rehnstrom

David J. Rehnstrom
Manager of Water Distribution Planning

DJR:JRK:djr
sb21_094.doc

Appendix B. Summary of Federal and State Agencies, Programs and Regulation

B. Summary of Federal and State Agencies, Programs and Regulation

Existing laws, ordinances, plans and programs at the federal and state level can support or impact hazard mitigation actions identified in this plan. Hazard mitigation plans are required to include a review and incorporation, if appropriate, of existing plans, studies, reports, and technical information as part of the planning process (44 CFR, Section 201.6(b)(3)). The following federal and state programs have been identified as programs that may interface with the actions identified in this plan. Each program enhances capabilities to implement mitigation actions or has a nexus with a mitigation action in this plan. Information presented in this section can be used to review local capabilities to implement the actions found in the action plan.

FEDERAL

Americans with Disabilities Act

The Americans with Disabilities Act (ADA) prohibits discrimination against people with disabilities in employment, transportation, public accommodation, communications, and government activities. Title II of the ADA deals with compliance with the Disaster Mitigation Act (DMA) in emergency management and disaster-related programs, services, and activities. The ADA applies to federal, state, and local governments as well as third parties, including religious entities and nonprofit organizations. Title III of the ADA prohibits discrimination on the basis of disability in the activities of places of public accommodations (businesses that are generally open to the public and that fall into one of 12 categories listed in the ADA, such as restaurants, movie theaters, schools, day care facilities, recreation facilities, and medical offices) and requires newly constructed or altered places of public accommodation—as well as commercial facilities (privately owned, nonresidential facilities such as factories, warehouses, or office buildings)—to comply with the ADA.

The ADA requires physical and programmatic access to be accessible to and usable by people with disabilities. This has implications for sheltering requirements, public notifications, effective communication, and reasonable accommodation. During an emergency alert, officials must use a combination of warning methods to ensure that all residents have all necessary information. Those with hearing impairments may not hear radio, television, sirens, or other audible alerts, while those with visual impairments may not see flashing lights or other visual alerts. Two technical documents for shelter operators address physical accessibility needs of people with disabilities, as well as medical needs and service animals.

The ADA intersects with disaster preparedness programs in regards to planning and preparedness for transportation, social services, temporary housing, and rebuilding. Persons with disabilities may require additional assistance in evacuation and transit (e.g., vehicles with wheelchair lifts or paratransit buses). Evacuation and other response plans should address the unique needs of residents. Local governments may be interested in implementing a special-needs registry to identify the home addresses, contact information, and needs for residents who may require more assistance.

FEMA hazard mitigation project grant applications require full compliance with applicable state and federal acts, such as the Rehabilitation Act Section 504/508 and the ADA. Any action identified in this plan that falls within the scope of this act will need to meet this requirement.

Bureau of Land Management

The U.S. Bureau of Land Management (BLM) funds and coordinates wildfire management programs and structural fire management and prevention on BLM lands. BLM works closely with the Forest Service and state and local governments to coordinate fire safety activities. The Interagency Fire Coordination Center in Boise, Idaho serves as the center for this effort.

Civil Rights Act of 1964

The Civil Rights Act of 1964 prohibits discrimination based on race, color, religion, sex or nation origin and requires equal access to public places and employment. The Act is relevant to emergency management and hazard mitigation in that it prohibits local governments from favoring the needs of one population group over another. Local government and emergency response must ensure the continued safety and well-being of all residents equally, to the extent possible. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Clean Water Act

The federal Clean Water Act (CWA) employs regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation’s surface waters so that they can support “the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water.”

Evolution of CWA programs over the last decade has included a shift from a program-by-program, source-by-source, and pollutant-by-pollutant approach to more holistic watershed-based strategies. Under the watershed approach, equal emphasis is placed on protecting healthy waters and restoring impaired ones. Numerous issues are addressed, not just those subject to CWA regulatory authority. Involvement of stakeholder groups in the development and implementation of strategies for achieving and maintaining water quality and other environmental goals is a hallmark of this approach.

The CWA is important to hazard mitigation in several ways. There are often permitting requirements for any construction within 200 feet of water of the United States, which may have implications for mitigation projects identified by a local jurisdiction. Additionally, CWA requirements apply to wetlands, which serve important functions related to preserving and protecting the natural and beneficial functions of floodplains and are linked with a community’s floodplain management program. Finally, the National Pollutant Discharge Elimination System is part of the CWA and addresses local stormwater management programs. Stormwater management plays a critical role in hazard mitigation by addressing urban drainage or localized flooding issues within jurisdictions.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Community Development Block Grant Disaster Resilience Program

In response to disasters, Congress may appropriate additional funding for the U.S. Department of Housing and Urban Development Community Development Block Grant programs to be distributed as Disaster Recovery grants (CDBG-DR). These grants can be used to rebuild affected areas and provide seed money to start the recovery process. CDBG-DR assistance may fund a broad range of recovery activities, helping communities and neighborhoods that otherwise might not recover due to limited resources. CDBG-DR grants often supplement disaster programs of FEMA, the Small Business Administration, and the U.S. Army Corps of Engineers. Housing and Urban Development generally awards noncompetitive, nonrecurring CDBG-DR grants by a formula that considers disaster recovery needs unmet by other federal disaster assistance programs. To be eligible for CDBG-DR funds, projects must meet the following criteria:

- Address a disaster-related impact (direct or indirect) in a presidentially declared county for the covered disaster
- Be a CDBG-eligible activity (according to regulations and waivers)
- Meet a national objective.

Incorporating preparedness and mitigation into these actions is encouraged, as the goal is to rebuild in ways that are safer and stronger. CDBG-DR funding is a potential alternative source of funding for actions identified in this plan.

Community Rating System

The CRS is a voluntary program within the NFIP that encourages floodplain management activities that exceed the minimum NFIP requirements. Flood insurance premiums are discounted to reflect the reduced flood risk resulting from community actions meeting the following three goals of the CRS:

- Reduce flood losses.
- Facilitate accurate insurance rating.
- Promote awareness of flood insurance.

For participating communities, flood insurance premium rates are discounted in increments of 5 percent. For example, a Class 1 community would receive a 45 percent premium discount, and a Class 9 community would receive a 5 percent discount. (Class 10 communities are those that do not participate in the CRS; they receive no discount.) The discount partially depends on location of the property. Properties outside the special flood hazard area receive smaller discounts: a 10-percent discount if the community is at Class 1 to 6 and a 5-percent discount if the community is at Class 7 to 9. The CRS classes for local communities are based on 18 creditable activities in the following categories:

- Public information
- Mapping and regulations
- Flood damage reduction
- Flood preparedness.

CRS activities can help to save lives and reduce property damage. Communities participating in the CRS represent a significant portion of the nation's flood risk; over 66 percent of the NFIP's policy base is located in these communities. Communities receiving premium discounts through the CRS range from small to large and represent a broad mixture of flood risks, including both coastal and riverine flood risks.

Disaster Mitigation Act

The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Assistance grant funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.

Emergency Relief for Federally Owned Roads Program

The U.S. Forest Service's Emergency Relief for Federally Owned Roads Program was established to assist federal agencies with repair or reconstruction of tribal transportation facilities, federal lands transportation facilities, and other federally owned roads that are open to public travel and have suffered serious damage by a natural disaster over a wide area or by a catastrophic failure. The program funds both emergency and permanent repairs. Eligible activities under this program meet some of the goals and objectives for this plan and the program is a possible funding source for actions identified in this plan.

Emergency Watershed Program

The U. S. Department of Agriculture Natural Resources Conservation Service administers the Emergency Watershed Protection Program, which responds to emergencies created by natural disasters. Eligibility for assistance is not dependent on a national emergency declaration. The program is designed to help people and conserve natural resources by relieving imminent hazards to life and property caused by floods, fires, windstorms, and other natural occurrences. Emergency Watershed Protection is an emergency recovery program. Financial and technical assistance are available for the following activities (Natural Resources Conservation Service, 2016):

- Remove debris from stream channels, road culverts, and bridges
- Reshape and protect eroded banks
- Correct damaged drainage facilities
- Establish cover on critically eroding lands
- Repair levees and structures
- Repair conservation practices.

This federal program could be a possible funding source for actions identified in this plan.

Endangered Species Act

The federal Endangered Species Act (ESA) was enacted in 1973 to conserve species facing depletion or extinction and the ecosystems that support them. The act sets forth a process for determining which species are threatened and endangered and requires the conservation of the critical habitat in which those species live. The ESA provides broad protection for species of fish, wildlife and plants that are listed as threatened or endangered. Provisions are made for listing species, as well as for recovery plans and the designation of critical habitat for listed species. The ESA outlines procedures for federal agencies to follow when taking actions that may jeopardize listed species and contains exceptions and exemptions. It is the enabling legislation for the Convention on International Trade in Endangered Species of Wild Fauna and Flora. Criminal and civil penalties are provided for violations of the ESA and the Convention.

Federal agencies must seek to conserve endangered and threatened species and use their authorities in furtherance of the ESA's purposes. The ESA defines three fundamental terms:

- Endangered means that a species of fish, animal or plant is "in danger of extinction throughout all or a significant portion of its range." (For salmon and other vertebrate species, this may include subspecies and distinct population segments.)
- Threatened means that a species "is likely to become endangered within the foreseeable future." Regulations may be less restrictive for threatened species than for endangered species.
- Critical habitat means "specific geographical areas that are…essential for the conservation and management of a listed species, whether occupied by the species or not."

Five sections of the ESA are of critical importance to understanding it:

- Section 4: Listing of a Species—The National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) is responsible for listing marine species; the U.S. Fish and Wildlife Service is responsible for listing terrestrial and freshwater aquatic species. The agencies may initiate reviews for listings, or citizens may petition for them. A listing must be made "solely on the basis of the best scientific and commercial data available." After a listing has been proposed, agencies receive comment and conduct further scientific reviews for 12 to 18 months, after which they must decide if the listing is warranted. Economic impacts cannot be considered in this decision, but it may include an evaluation of the adequacy of local and state protections. Critical habitat for the species may be designated at the time of listing.
- Section 7: Consultation—Federal agencies must ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of a listed or proposed species or adversely modify its critical habitat. This includes private and public actions that require a federal permit. Once a final listing is made, non-federal actions are subject to the same review, termed a "consultation." If the listing agency finds that an action will "take" a species, it must propose mitigations or "reasonable and prudent" alternatives to the action; if the proponent rejects these, the action cannot proceed.
- Section 9: Prohibition of Take—It is unlawful to "take" an endangered species, including killing or injuring it or modifying its habitat in a way that interferes with essential behavioral patterns, including breeding, feeding or sheltering.
- Section 10: Permitted Take—Through voluntary agreements with the federal government that provide protections to an endangered species, a non-federal applicant may commit a take that would otherwise be prohibited as long as it is incidental to an otherwise lawful activity (such as developing land or building a road). These agreements often take the form of a "Habitat Conservation Plan."
- Section 11: Citizen Lawsuits—Civil actions initiated by any citizen can require the listing agency to enforce the ESA's prohibition of taking or to meet the requirements of the consultation process.

FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) cooperates with a large number of federal and state agencies to ensure and promote dam safety. More than 3,000 dams are part of regulated hydroelectric projects in the FERC program. Two-thirds of these are more than 50 years old. As dams age, concern about their safety and integrity grows, so oversight and regular inspection are important. FERC inspects hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with the terms and conditions of a license.

Every five years, an independent engineer approved by the FERC must inspect and evaluate projects with dams higher than 32.8 feet (10 meters), or with a total storage capacity of more than 2,000 acre-feet.

FERC monitors seismic research and applies it in performing structural analyses of hydroelectric projects. FERC also evaluates the effects of potential and actual large floods on the safety of dams. During and following floods, FERC visits dams and licensed projects, determines the extent of damage, if any, and directs any necessary studies or remedial measures the licensee must undertake. The FERC publication Engineering Guidelines for the Evaluation of Hydropower Projects guides the FERC engineering staff and licensees in evaluating dam safety. The publication is frequently revised to reflect current information and methodologies.

FERC requires licensees to prepare emergency action plans and conducts training sessions on how to develop and test these plans. The plans outline an early warning system if there is an actual or potential sudden release of water from a dam due to failure. The plans include operational procedures that may be used, such as reducing reservoir levels and reducing downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that everyone knows what to do in emergency situations.

Federal Wildfire Management Policy and Healthy Forests Restoration Act

Federal Wildfire Management Policy and Healthy Forests Restoration Act (2003). These documents call for a single comprehensive federal fire policy for the Interior and Agriculture Departments (the agencies using federal fire management resources). They mandate community-based collaboration to reduce risks from wildfire.

National Dam Safety Act

Potential for catastrophic flooding due to dam failures led to passage of the National Dam Inspection Act in 1972, creation of the National Dam Safety Program in 1996, and reauthorization of the program through the Dam Safety Act in 2006. National Dam Safety Program, administered by FEMA requires a periodic engineering analysis of the majority of dams in the country; exceptions include the following:

- Dams under jurisdiction of the Bureau of Reclamation, Tennessee Valley Authority, or International Boundary and Water Commission
- Dams constructed pursuant to licenses issued under the Federal Power Act

- Dams that the Secretary of the Army determines do not pose any threat to human life or property.

The goal of this FEMA-monitored effort is to identify and mitigate the risk of dam failure so as to protect lives and property of the public. The National Dam Safety Program is a partnership among the states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under FEMA's leadership, state assistance funds have allowed all participating states to improve their programs through increased inspections, emergency action planning, and purchases of needed equipment. FEMA has also expanded existing and initiated new training programs. Grant assistance from FEMA provides support for improvement of dam safety programs that regulate most of the dams in the United States.

National Environmental Policy Act

The National Environmental Policy Act requires federal agencies to consider the environmental impacts of proposed actions and reasonable alternatives to those actions, alongside technical and economic considerations. The National Environmental Policy Act established the Council on Environmental Quality, whose regulations (40 CFR Parts 1500-1508) set standards for compliance. Consideration and decision-making regarding environmental impacts must be documented in an environmental impact statement or environmental assessment. Environmental impact assessment requires the evaluation of reasonable alternatives to a proposed action, solicitation of input from organizations and individuals that could be affected, and an unbiased presentation of direct, indirect, and cumulative environmental impacts. FEMA hazard mitigation project grant applications require full compliance with applicable federal acts. Any action identified in this plan that falls within the scope of this act will need to meet its requirements.

National Fire Plan

The 2001 National Fire Plan was developed based on the National Fire Policy. A major aspect of the National Fire Plan is joint risk reduction planning and implementation carried out by federal, state and local agencies and communities. The National Fire Plan presented a comprehensive strategy in five key initiatives:

- Firefighting—Be adequately prepared to fight fires each fire season.
- Rehabilitation and Restoration—Restore landscapes and rebuild communities damaged by wildfires.
- Hazardous Fuel Reduction—Invest in projects to reduce fire risk.
- Community Assistance—Work directly with communities to ensure adequate protection.
- Accountability—Be accountable and establish adequate oversight, coordination, program development, and monitoring for performance.

National Flood Insurance Program

The National Flood Insurance Program (NFIP) makes federally backed flood insurance available to homeowners, renters, and business owners in participating communities that enact floodplain regulations. Participation and good standing under NFIP are prerequisites to grant funding eligibility under the Robert T. Stafford Act. NFIP participation is limited to local governments that possess permit authority and have the ability to adopt and enforce regulations that govern land use.

For most participating communities, FEMA has prepared a detailed Flood Insurance Study. The study presents water surface elevations for floods of various magnitudes, including the 1-percent-annual-chance flood and the

0.2-percent-annual-chance flood. Base flood elevations and the boundaries of the flood hazard areas are shown on Flood Insurance Rate Maps, which are the principle tool for identifying the extent and location of the flood hazard. Flood Insurance Rate Maps are the most detailed and consistent data source available, and for many communities they represent the minimum area of oversight under the local floodplain management program. In recent years, Flood Insurance Rate Maps have been digitized as Digital Flood Insurance Rate Maps, which are more accessible to residents, local governments and stakeholders.

NFIP participants must, at a minimum, regulate development in floodplain areas in accordance with NFIP criteria. Before issuing a permit to build in a floodplain, participating jurisdictions must ensure that three criteria are met:

- New buildings and those undergoing substantial improvements must, at a minimum, be elevated to protect against damage by the 1-percent-annual-chance flood.
- New floodplain development must not aggravate existing flood problems or increase damage to other properties.
- New floodplain development must exercise a reasonable and prudent effort to reduce its adverse impacts on threatened salmonid species.

In California, the Department of Water Resources (DWR) is the coordinating agency for floodplain management. DWR works with FEMA and local governments by providing grants and technical assistance, evaluating community floodplain management programs, reviewing local floodplain ordinances, participating in statewide flood hazard mitigation planning, and facilitating annual statewide workshops. Compliance is monitored by FEMA regional staff and by DWR.

National Incident Management System

The National Incident Management System (NIMS) is a systematic approach for government, nongovernmental organizations, and the private sector to work together to manage incidents involving hazards. The NIMS provides a flexible but standardized set of incident management practices. Incidents typically begin and end locally, and they are managed at the lowest possible geographical, organizational, and jurisdictional level. In some cases, success depends on the involvement of multiple jurisdictions, levels of government, functional agencies, and emergency responder disciplines. These cases necessitate coordination across a spectrum of organizations. Communities using NIMS follow a comprehensive national approach that improves the effectiveness of emergency management and response personnel across the full spectrum of potential hazards (including natural hazards, technological hazards, and human-caused hazards) regardless of size or complexity.

Although participation is voluntary, federal departments and agencies are required to make adoption of NIMS by local and state jurisdictions a condition to receive federal preparedness grants and awards. The content of this plan is considered to be a viable support tool for any phase of emergency management. The NIMS program is considered as a response function, and information in this hazard mitigation plan can support the implementation and update of all NIMS-compliant plans within the planning area.

National Landslide Preparedness Act

The 2021 National Landslide Preparedness Act authorized a national landslide hazards reduction program and a 3D elevation program within the USGS. This broadened the existing Landslide Hazards Program (under the Natural Hazards Mission Area) and the 3D Elevation Program (under the National Geospatial Program). The act required coordination among federal agencies through an Interagency Coordinating Committee on Landslide

Hazards representing USGS and other agencies. The act calls for development of a national strategy for landslide loss reduction and a publicly accessible national landslide database of landslide hazard and risk.

Presidential Executive Order 11988, Floodplain Management

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. It requires federal agencies to provide leadership and take action to reduce the risk of flood loss, minimize the impact of floods on human safety, health, and welfare, and restore and preserve the natural and beneficial values of floodplains. The requirements apply to the following activities (FEMA, 1977):

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

Presidential Executive Order 11990, Protection of Wetlands

Executive Order 11990 requires federal agencies to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The requirements apply to the following activities:

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing.

All actions identified in this plan will seek full compliance with all applicable presidential executive orders.

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers operates and maintains approximately 700 dams nationwide. It is also responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. The Corps has inventoried dams; surveyed each state and federal agency's capabilities, practices and regulations regarding design, construction, operation, and maintenance of the dams; and developed guidelines for inspection and evaluation of dam safety. The Corps maintains the National Inventory of Dams, which contains information about a dam's location, size, purpose, type, last inspection and regulatory status (U.S. Army Corps of Engineers, 2017).

U.S. Army Corps of Engineers Flood Hazard Management

The following U.S. Army Corps of Engineers authorities and programs related to flood hazard management:

- The Floodplain Management Services program offers 100-percent federally funded technical services such as development and interpretation of site-specific data related to the extent, duration and frequency of flooding. Special studies may be conducted to help a community understand and respond to flood risk. These may include flood hazard evaluation, flood warning and preparedness, or flood modeling.

- For more extensive studies, the Corps of Engineers offers a cost-shared program called Planning Assistance to States and Tribes. Studies under this program generally range from $25,000 to $100,000 with the local jurisdiction providing 50 percent of the cost.
- The Corps of Engineers has several cost-shared programs (typically 65 percent federal and 35 percent non-federal) aimed at developing, evaluating and implementing structural and non-structural capital projects to address flood risks at specific locations or within a specific watershed:
    - The Continuing Authorities Program for smaller-scale projects includes Section 205 for Flood Control, with a $7 million federal limit and Section 14 for Emergency Streambank Protection with a $1.5 million federal limit. These can be implemented without specific authorization from Congress.
    - Larger scale studies, referred to as General Investigations, and projects for flood risk management, for ecosystem restoration or to address other water resource issues, can be pursued through a specific authorization from Congress and are cost-shared, typically at 65 percent federal and 35 percent non-federal.
    - Watershed management planning studies can be specifically authorized and are cost-shared at 50 percent federal and 50 percent non-federal.
- The Corps of Engineers provides emergency response assistance during and following natural disasters. Public Law 84-99 enables the Corps to assist state and local authorities in flood fight activities and cost share in the repair of flood protective structures. Assistance is provided in the flowing categories:
    - Preparedness—The Flood Control and Coastal Emergency Act establishes an emergency fund for preparedness for emergency response to natural disasters; for flood fighting and rescue operations; for rehabilitation of flood control and hurricane protection structures. Funding for Corps of Engineers emergency response under this authority is provided by Congress through the annual Energy and Water Development Appropriation Act. Disaster preparedness activities include coordination, planning, training and conduct of response exercises with local, state and federal agencies.
    - Response Activities—Public Law 84-99 allows the Corps of Engineers to supplement state and local entities in flood fighting urban and other non-agricultural areas under certain conditions (Engineering Regulation 500-1-1 provides specific details). All flood fight efforts require a project cooperation agreement signed by the public sponsor and the sponsor must remove all flood fight material after the flood has receded. Public Law 84-99 also authorizes emergency water support and drought assistance in certain situations and allows for “advance measures” assistance to prevent or reduce flood damage conditions of imminent threat of unusual flooding.
    - Rehabilitation—Under Public Law 84-99, an eligible flood protection system can be rehabilitated if damaged by a flood event. The flood system would be restored to its pre-disaster status at no cost to the federal system owner, and at 20-percent cost to the eligible non-federal system owner. All systems considered eligible for Public Law 84-99 rehabilitation assistance have to be in the Rehabilitation and Inspection Program prior to the flood event. Acceptable operation and maintenance by the public levee sponsor are verified by levee inspections conducted by the Corps on a regular basis. The Corps has the responsibility to coordinate levee repair issues with interested federal, state, and local agencies following natural disaster events where flood control works are damaged.

These authorities and programs are all available to support any related mitigation actions.

U.S. Fire Administration

There are federal agencies that provide technical support to fire agencies/organizations. For example, the U.S. Fire Administration, which is a part of FEMA, provides leadership, advocacy, coordination, and support for fire agencies and organizations.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service fire management strategy uses prescribed fire to maintain early successional fire-adapted grasslands and other ecological communities throughout the National Wildlife Refuge system.

STATE

AB 32: The California Global Warming Solutions Act

This bill identifies the following potential adverse impacts of global warming:

> "… the exacerbation of air quality problems, a reduction in the quality and supply of water to the state from the Sierra snowpack, a rise in sea levels resulting in the displacement of thousands of coastal businesses and residences, damage to marine ecosystems and the natural environment, and an increase in the incidences of infectious diseases, asthma, and other human health-related problems."

AB 32 establishes a state goal of reducing greenhouse gas emissions to 1990 levels by 2020 (a reduction of approximately 25 percent from forecast emission levels), with further reductions to follow. The law requires the state Air Resources Board to do the following:

- Establish a program to track and report greenhouse gas emissions.
- Approve a scoping plan for achieving the maximum technologically feasible and cost-effective reductions from sources of greenhouse gas emissions.
- Adopt early reduction measures to begin moving forward.
- Adopt, implement, and enforce regulations—including market mechanisms such as "cap and-trade" programs—to ensure that the required reductions occur.

The Air Resources Board has adopted a statewide greenhouse gas emissions limit and an emissions inventory, along with requirements to measure, track, and report greenhouse gas emissions by the industries it determined to be significant sources of greenhouse gas emissions.

AB 70: Flood Liability

This bill provides that a city or county may be required to contribute a fair and reasonable share to compensate for property damage caused by a flood to the extent that it has increased the state's exposure to liability for property damage by unreasonably approving new development in a previously undeveloped area that is protected by a state flood control project, unless the city or county meets specified requirements.

AB 162: Flood Planning

This California State Assembly Bill passed in 2007 requires cities and counties to address flood-related matters in the land use, conservation, and safety and housing elements of their general plans. The land use element must identify and annually review the areas covered by the general plan that are subject to flooding as identified in floodplain mapping by either FEMA or the state Department of Water Resources (DWR). During the next revision of the housing element on or after January 1, 2009, the conservation element of the general plan must identify rivers, creeks, streams, flood corridors, riparian habitat, and land that may accommodate floodwater for the purpose of groundwater recharge and stormwater management. The safety element must identify information regarding flood hazards, including:

- Flood hazard zones
- Maps published by FEMA, DWR, the U.S. Army Corps of Engineers, the Central Valley Flood Protection Board, and the Governor's Office of Emergency Services (Cal OES)
- Historical data on flooding
- Existing and planned development in flood hazard zones.

The general plan must establish goals, policies and objectives related to flooding risks, including:

- Avoiding or minimizing the risks of flooding new development
- Evaluating whether new development should be located in flood hazard zones
- Identifying construction methods to minimize damage.

AB 162 establishes goals, policies and objectives related to flooding risks. It establishes procedures for the determination of available land suitable for urban development, which may exclude lands where FEMA or DWR has concluded that the flood management infrastructure is not adequate to avoid the risk of flooding.

AB 747: Required Information for General Plan Safety Elements

This bill requires California communities with general plans to address evacuation routes in the safety element of the general plan. Information on the evacuation routes and their capacity, safety and viability under a range of emergency scenarios must be provided. For communities that have not adopted a local hazard mitigation plan, the safety element must be updated with this information by January 1, 2022. For those with a local hazard mitigation plan, the requirement applies upon the next revision of the hazard mitigation plan on or after January 1, 2022. Communities that have adopted a local hazard mitigation plan, emergency operations plan, or other document that fulfills the goals and objectives of this law may comply with this requirement by summarizing and incorporating by reference the other plan or document in the safety element.

In subsequent revisions to the safety element, communities also will be required to identify new information relating to flood and fire hazards and climate adaptation and resiliency strategies applicable to the city or county that was not available during the previous revision of the safety element. These subsequent updates must occur upon each revision of the general plan housing element or local hazard mitigation plan and not less than once every eight years.

AB 2140: General Plans—Safety Element

This bill provides that the state may allow for more than 75 percent of public assistance funding under the California Disaster Assistance Act only if the local agency is in a jurisdiction that has adopted a local hazard mitigation plan as part of the safety element of its general plan. The local hazard mitigation plan needs to include elements specified in this legislation. In addition, this bill requires Cal OES to give preference for federal mitigation funding to cities and counties that have adopted local hazard mitigation plans. The intent of the bill is to encourage cities and counties to create and adopt hazard mitigation plans.

AB 2800: Climate Change—Infrastructure Planning

This California State Assembly bill passed in 2016 and until July 1, 2020, requires state agencies to take into account the current and future impacts of climate change when planning, designing, building, operating, maintaining, and investing in state infrastructure. The bill, by July 1, 2017, and until July 1, 2020, requires an agency to establish a Climate-Safe Infrastructure Working Group to examine how to integrate scientific data concerning projected climate change impacts into state infrastructure engineering.

Alquist-Priolo Earthquake Fault Zoning Act

The Alquist-Priolo Earthquake Fault Zoning Act was enacted in 1972 to mitigate the hazard of surface faulting to structures for human occupancy. The Alquist-Priolo Earthquake Fault Zoning Act’s main purpose is to prevent construction of buildings used for human occupancy on the surface trace of active faults. Before a new project is permitted, cities and counties require a geologic investigation to demonstrate that proposed buildings will not be constructed on active faults. The act addresses only the hazard of surface fault rupture and is not directed toward other earthquake hazards, such as liquefaction or seismically induced landslides. The law requires the State of California Geologist to establish regulatory zones around the surface traces of active faults and to issue appropriate maps. The maps are distributed to all affected cities, counties, and state agencies for their use in planning and controlling new or renewed construction. Local agencies must regulate most development projects within the zones. Projects include all land divisions and most structures for human occupancy. All seismic hazard mitigation actions identified in this plan will seek full compliance with the Alquist-Priolo Earthquake Fault Zoning Act.

California Coastal Management Program

The California Coastal Management Program under the California Coastal Act requires each city or county lying wholly or partly within the coastal zone to prepare a local coastal plan. The specific contents of such plans are not specified by state law, but they must be certified by the Coastal Commission as consistent with policies of the Coastal Act (Public Resources Code, Division 20). The Coastal Act has provisions relating to geologic hazards, but does not mention tsunamis specifically. Section 30253(1) of the Coastal Act states that new development shall minimize risks to life and property in areas of high geologic, flood, and fire hazard. Development should be prevented or limited in high hazard areas whenever possible. However, where development cannot be prevented or limited, land use density, building value, and occupancy should be kept at a minimum. Any mitigation project identified in this plan that intersects the mapped coastal zone will be consistent with the recommendations of the local coastal plan.

California Department of Forestry and Fire Protection

CAL FIRE has responsibility for wildfires in areas of the county that are not under the jurisdiction of the Forest Service or a local fire organization, including lands designated as State Responsibility Areas. CAL FIRE also has fire protection responsibilities by contract and mutual aid agreements. For example, CAL FIRE provides year-round fire protection under Amador Plan agreements with certain local government agencies (Public Resources Code §4144). Through these agreements, CAL FIRE provides local structural and wildfire protection or dispatch services to a community and maintains a staffing level that otherwise would be available only during the fire season. The local entity pays the additional cost of the service.

California Department of Parks and Recreation (State Parks)

State Parks manages portions of the California coastline including coastal wetlands, estuaries, beaches, and dune systems. The State Parks Resources Management Division has limited wildfire protection resources available to suppress fires on State Park lands.

California Department of Water Resources

In California, the DWR is the coordinating agency for floodplain management. The DWR works with FEMA and local governments by providing grants and technical assistance, evaluating community floodplain management programs, reviewing local floodplain ordinances, participating in statewide flood hazard mitigation planning, and facilitating annual statewide workshops. Compliance is monitored by FEMA regional staff and by the DWR.

California Division of Safety of Dams

California's Division of Safety of Dams (a division of the DWR) monitors the dam safety program at the state level and maintains a working list of dams in the state. When a new dam is proposed, Division engineers and geologists inspect the site and the subsurface. Upon submittal of an application, the Division reviews the plans and specifications prepared by the owner to ensure that the dam is designed to meet minimum requirements and that the design is appropriate for the known geologic conditions. After approval of the application, the Division inspects all aspects of the construction to ensure that the work is done in accordance with the approved plans and specifications. After construction, the Division inspects each dam to ensure that it is performing as intended and is not developing problems. The Division periodically reviews the stability of dams and their major appurtenances in light of improved design approaches and requirements, as well as new findings regarding earthquake hazards and hydrologic estimates in California. Over 1,200 dams are inspected by Division engineers on a yearly schedule to ensure performance and maintenance of dams (California Division of Safety of Dams, 2017).

California Environmental Quality Act

The California Environmental Quality Act (CEQA) was passed in 1970, shortly after the federal government enacted the National Environmental Policy Act, to institute a statewide policy of environmental protection. CEQA requires state and local agencies in California to follow a protocol of analysis and public disclosure of the potential environmental impacts of development projects. CEQA makes environmental protection a mandatory part of every California state and local agency's decision-making process.

CEQA establishes a statewide environmental policy and mandates actions all state and local agencies must take to advance the policy. Jurisdictions conduct analysis of the project to determine if there are potentially significant environmental impacts, identify mitigation measures, and possible project alternatives by preparing environmental reports for projects that requires CEQA review. This environmental review is required before an agency takes action on any policy, program, or project. Any project action identified in this plan will seek full CEQA compliance upon implementation.

California Fire Alliance

The California Fire Alliance (CFA) was established in response to directives from the 2001 National Fire Plan. The CFA pursues four strategies to deal with the National Fire Plan's community assistance initiative:

- Work with communities at risk from wildfires to develop community-based planning leadership and facilitate the development of community fire loss mitigation plans, which transcend jurisdiction and ownership boundaries.
- Assist communities in development of fire loss mitigation planning, education and projects to reduce the threat of wildfire losses on public and private lands.
- Develop an information and education outreach plan to increase awareness of wildfire protection program opportunities available to communities at risk.
- Work collaboratively to develop, modify and maintain a comprehensive list of communities at risk.

California Fire Plan

The State Board of Forestry and CAL FIRE have prepared a comprehensive update of the California Fire Plan for wildfire protection. The planning process included defining a level of service measurement; considering assets at risk; incorporating the cooperative interdependent relationships of wildfire protection providers; providing for public stakeholder involvement; and creating a fiscal framework for policy analysis. The California Fire Plan's overall goal is to reduce costs and losses from wildfire in the state by protecting assets at risk through pre-fire management and by reducing the spread of fire through more successful initial response.

California Fire Safe Council

In 1993, the statewide Fire Safe Council, consisting of private and public membership, was formed to educate and encourage Californians to plan and prepare for wildfires by reducing the risk of fire to property, communities, and natural/structural resources. In 2002, this group created a nonprofit organization and board of directors, called the California Fire Safe Council. The Council works with the California Fire Alliance to facilitate the distribution of National Fire Plan grants for wildfire risk reduction and education (www.grants.firesafecouncil.org). The Council also provides assistance to local Fire Safe Councils through its website (www.firesafecouncil.org), the distribution of educational materials, and technical assistance, primarily through regional representatives. More than 130 local Fire Safe Councils have formed in California to plan, coordinate, and implement fire prevention activities.

California Fire Service and Rescue Emergency Mutual Aid Plan

The Governor's Office of Emergency Services Fire and Rescue Branch administers the California Fire Service and Rescue Emergency Mutual Aid Plan. The agency provides guidance and procedures for agencies developing emergency operations plans, as well as training and technical support, primarily to overall emergency service organizations and urban search and rescue teams.

California General Planning Law

California state law requires that every county and city prepare and adopt a comprehensive long-range plan to serve as a guide for community development. The general plan expresses the community's goals, visions, and policies relative to future land uses, both public and private. The general plan is mandated and prescribed by state law (Cal. Gov. Code §65300 et seq.), and forms the basis for most local government land use decision-making.

The plan must consist of an integrated, internally consistent set of goals, policies, and implementation measures. In addition, the plan must focus on issues of the greatest concern to the community and be written in a clear and concise manner. City and county actions, such as those relating to land use allocations, annexations, zoning, subdivision and design review, redevelopment, and capital improvements, must be consistent with the plan.

California Multi-Hazard Mitigation Plan

Under the DMA, California must adopt a federally approved state multi-hazard mitigation plan to be eligible for certain disaster assistance and mitigation funding. The intent of the State of California Multi-Hazard Mitigation Plan is to reduce or prevent injury and damage from hazards in the state through the following:

- Documenting statewide hazard mitigation planning in California
- Describing strategies and priorities for future mitigation activities
- Facilitating the integration of local and tribal hazard mitigation planning activities into statewide efforts
- Meeting state and federal statutory and regulatory requirements.

The plan is an annex to the State Emergency Plan, and it identifies past and present mitigation activities, current policies and programs, and mitigation strategies for the future. It also establishes hazard mitigation goals and objectives. The plan will be reviewed and updated annually to reflect changing conditions and new information, especially information on local planning activities.

Under 44 CFR Section 201.6, local hazard mitigation plans must be consistent with their state's hazard mitigation plan. In updating this plan, the Steering Committee reviewed the California State Hazard Mitigation Plan to identify key relevant state plan elements (see Section 3.7).

California Residential Mitigation Program

The California Residential Mitigation Program was established in 2011 to help Californians strengthen their homes against damage from earthquakes. The program is a joint powers authority created by Cal OES and the California Earthquake Authority, which is a not-for-profit, publicly managed, privately funded provider of home earthquake insurance to California homeowners and renters.

Earthquake Brace + Bolt was developed to help homeowners lessen the potential for damage to their houses during an earthquake. A residential seismic retrofit strengthens an existing older house, making it more resistant to earthquake activity such as ground shaking and soil failure. The seismic retrofitting involves bolting the house to its foundation and adding bracing around the perimeter of the crawl space. Most homeowners hire a contractor to do the retrofit work, and owners of houses in ZIP Codes with house characteristics suitable for this type of retrofit are eligible for up to $3,000 toward the cost. A typical retrofit by a contractor may cost between $3,000 and $7,000, depending on the location and size of the house, contractor fees, and the amount of materials and work involved. If the homeowner is an experienced do-it-yourselfer, a retrofit can cost less than $3,000.

California State Building Code

California Code of Regulations Title 24 (CCR Title 24), also known as the California Building Standards Code, is a compilation of building standards from three sources:

- Building standards that have been adopted by state agencies without change from building standards contained in national model codes
- Building standards that have been adopted and adapted from the national model code standards to meet California conditions
- Building standards authorized by the California legislature that constitute extensive additions not covered by the model codes adopted to address particular California concerns.

The state Building Standards Commission is authorized by California Building Standards Law (Health and Safety Code Sections 18901 through 18949.6) to administer the processes related to the adoption, approval, publication, and implementation of California's building codes. These building codes serve as the basis for the design and construction of buildings in California. The national model code standards adopted into Title 24 apply to all occupancies in California, except for modifications adopted by state agencies and local governing bodies. Since 1989, the Building Standards Commission has published new editions of Title 24 every three years.

On January 1, 2014, California Building Code Accessibility Standards found in Chapter 11B incorporated the 2010 Americans with Disabilities Act (ADA) Standards as the model accessibility code for California. The purpose was to ensure consistency with federal guidelines. As a result of this incorporation, the California standards will fully implement and include 2010 ADA Standards within the California Building Code while maintaining enhanced levels of accessibility already provided by existing California accessibility regulations.

Disadvantaged and Low-income Communities Investments

Senate Bill (SB) 535 directs state and local agencies to make investments that benefit California's disadvantaged communities. It also directs the California Environmental Protection Agency to identify disadvantaged communities for the purposes of these investments based on geographic, socio-economic, public health, and environmental hazard criteria. Assembly Bill (AB) 1550 increased the percent of funds for projects located in disadvantaged communities from 10 to 25 percent and added a focus on investments in low-income communities and households. This program is a potential alternative source of funding for actions identified in this plan.

Division of the State Architect's AB 300 List of Seismically At-Risk Schools

In 2002, California's Division of the State Architect completed an inventory of public school buildings built before 1978 that identifies buildings with characteristics that might make them unsafe in future earthquakes. This inventory provides a list of potentially at-risk schools known as the AB 300 list (the inventory was authorized by Assembly Bill 300 in 1999). Using available information on school buildings' dates of construction, seismic retrofits, and structural systems (wood-frame, concrete shear wall, or steel moment frame, etc.), the inventory categorized California public school buildings into one of two categories: those expected to perform well in future earthquakes; and those that are not expected to perform well and require more detailed seismic evaluation.

The Division of the State Architect recommends that public schools on this list undergo detailed seismic evaluations to determine if they pose life safety risks, but the state has neither required nor funded school districts to do this.

Governor’s Executive Order S-13-08

Governor’s Executive Order S-13-08 enhances the state’s management of climate impacts from sea-level rise, increased temperatures, shifting precipitation and extreme weather events. There are four key actions in the executive order:

- Initiate California’s first statewide climate change adaptation strategy to assess expected climate change impacts, identify where California is most vulnerable, and recommend adaptation policies. This effort will improve coordination within state government so that better planning can more effectively address climate impacts on human health, the environment, the state’s water supply and the economy.
- Request that the National Academy of Science establish an expert panel to report on sea-level rise impacts in California, to inform state planning and development efforts.
- Issue interim guidance to state agencies for how to plan for sea-level rise in designated coastal and floodplain areas for new projects.
- Initiate a report on critical infrastructure projects vulnerable to sea-level rise.

Office of the State Fire Marshal

The Office of the State Fire Marshal is a division of CAL FIRE that has a wide variety of fire safety and training responsibilities and provides technical support to fire agencies/organizations.

Senate Bill 92: Public Resources Portion of Biennial Budget Bill

The State of California updated its requirements regarding emergency action plans (EAPs) via Senate Bill 92, which became effective in June 2017 as part of the state Legislature’s biennial budget process. The bill required dam owners to submit EAPs to Cal OES and the Department of Water Resources for approval by January 1, 2018 (for extremely high hazard dams), January 1, 2019 (for high-hazard dams), and January 1, 2021 (for significant hazard dams). The EAPs were to include the following (California Government Code Section 8589.5; Cal OES, 2018):

- Emergency notification flow charts
- Information on a four-step response process
- Description of agencies’ roles and actions in response to an emergency incident
- Description of actions to be taken in advance of an emergency
- Inundation maps
- Additional information such as revision records and distribution lists.

After the EAPs are approved by the state, the law requires dam owners to send the approved EAPs to relevant stakeholders. Local public agencies can then adopt emergency procedures that incorporate the information in the EAP in a manner that conforms to local needs and includes methods and procedures for alerting and warning the public and other response and preparedness related items (State of California, 2018).

SB 92 also requires dams other than low-risk dams to have current inundation mapping, which must be updated every 10 years, or sooner if specific circumstances change. EAPs also must be updated every 10 years. It provides DWR with enforcement tools, including fines and operational restrictions for failure to comply. Cal OES is required by the law to work with state and federal agencies, dam owners, planners, and the public to make dam inundation maps available to citizens interested in learning their dam failure inundation risk.

Senate Bill 97: Guidelines for Greenhouse Gas Emissions

Senate Bill 97, enacted in 2007, amends CEQA to clearly establish that greenhouse gas emissions and the effects of greenhouse gas emissions are appropriate subjects for CEQA analysis. It directs the Governor's Office of Planning and Research to develop draft CEQA guidelines for the mitigation of greenhouse gas emissions or their effects by July 1, 2009 and directs the California Natural Resources Agency to certify and adopt the CEQA Guidelines by January 1, 2010.

Senate Bill 99: Evacuation Route Planning

Senate Bill 99, enacted in 2019, requires that cities' and counties' general plans address evacuation routes from any hazard area identified in the safety element. Under this law, the safety element must include information to identify residential developments in hazard areas that do not have at least two emergency evacuation routes. Each city or county must update its safety element with the new information upon the next revision of its housing element on or after January 1, 2020.

Senate Bill 182 Local Government: Planning and Zoning: Wildfires

California Senate Bill 182 made a number of changes to state law regarding planning for and permitting development in areas designated as very high fire risk areas. The bill requires a local jurisdiction to do the following:

- Include a comprehensive retrofit strategy in its safety element to reduce the risk of property loss and damage during wildfires.
- Amend its land use element to identify all very high fire risk areas and to establish measures to protect lives and property from unreasonable risk of wildfire.
- Adopt a very high fire risk overlay zone for its zoning ordinance.
- Allocate a lower portion of projected future housing to very high fire hazard severity zones

This bill prohibits local governments from entering into a development agreement for property in a very high fire risk area, approving a permit for a project in a very high fire risk area, or approving a tentative map for a subdivision in a very high fire risk area, unless the jurisdiction makes specified findings based on substantial evidence.

Senate Bill 379: General Plans: Safety Element—Climate Adaptation

Senate Bill 379 builds upon the flood planning inclusions into the safety and housing elements and the hazard mitigation planning safety element inclusions in general plans outlined in AB 162 and AB 2140, respectively. SB 379 focuses on a new requirement that cities and counties include climate adaptation and resiliency strategies in the safety element of their general plans beginning January 1, 2017. In addition, this bill requires general plans to include a set of goals, policies and objectives, and specified implementation measures based on the conclusions drawn from climate adaptation research and recommendations.

Senate Bill 1000: General Plan Amendments—Safety and Environmental Justice Elements

In 2016, Senate Bill 1000 amended California's Planning and Zoning Law in two ways:

- The original law established requirements for initial revisions of general plan safety elements to address flooding, fire, and climate adaptation and resilience. It also required subsequent review and revision as necessary based on new information. Senate Bill 1000 specifies that the subsequent reviews and revision based on new information are required to address only flooding and fires (not climate adaptation and resilience).
- Senate Bill 1000 adds a requirement that, upon adoption or revision of any two other general plan elements on or after January 1, 2018, an environmental justice element be adopted for the general plan or environmental justice goals, policies and objectives be incorporated into other elements of the plan.

Senate Bill 1035: Fire, Flood, and Adaptation Safety Element Updates

Senate Bill 1035 clarifies that revisions to a community's General Plan Safety Element—to address fire hazards, flood hazards, and climate adaptation and resilience strategies—must occur upon each revision to a Housing Element or Local Hazard Mitigation Program.

Senate Bill 1241: General Plans: Safety Element—Fire Hazard Impacts

In 2012, Senate Bill 1241 passed requiring that the safety elements of all future general plans address fire risk in state responsibility areas and very high fire hazard severity zones. The bill requires cities and counties to make findings regarding available fire protection and suppression services before approving a tentative map or parcel map.

Standardized Emergency Management System

CCR Title 19 establishes the Standardized Emergency Management System (SEMS) to standardize the response to emergencies involving multiple jurisdictions. SEMS is intended to be flexible and adaptable to the needs of all emergency responders in California. It requires emergency response agencies to use basic principles and components of emergency management. Local governments must use SEMS by December 1, 1996, to be eligible for state funding of response-related personnel costs under CCR Title 19 (Sections 2920, 2925 and 2930). The roles and responsibilities of Individual agencies contained in existing laws or the state emergency plan are not superseded by these regulations. This hazard mitigation plan is considered to be a support document for all phases of emergency management, including those associated with SEMS.

Western Governors Association Ten-Year Comprehensive Strategy

The *Western Governors Association Ten-Year Comprehensive Strategy: A Collaborative Approach for Reducing Wildfire Risks to Communities and the Environment* (August 2001) is strategy implementation plan prepared by federal and Western state agencies that outlines measures to restore fire-adapted ecosystems and reduce hazardous fuels.

City of Oakland 2021 – 2026 Hazard Mitigation Plan

Appendix C. Data Sources and Methods Used for Mapping

C. DATA SOURCES AND METHODS USED FOR MAPPING

DAM FAILURE INUNDATION MAPPING

Dam breach inundation maps, including inundation boundaries and depth grids, were downloaded from the California Department of Water Resources' (DWR) website - https://fmds.water.ca.gov/maps/damim/. As required by California Water Code section 6161, the Division of Safety of Dams (DSOD) at DWR reviews and approves inundation maps prepared by licensed civil engineers and submitted by dam owners for extremely high, high, and significant hazard dams and their critical appurtenant structures. Inundation maps are based on a hypothetical failure of a dam or critical appurtenant structure and the information depicted on the maps is approximate. The dams and failure scenarios are as follows:

- Central (National Inventory of Dams (NID) ID CA00162) - Scenario shows an inundation extent for a sunny day breach of the main embankment at Central Dam. File downloaded from DSOD website generated on 8/12/2020.
- Central (NID CA00162) - Scenario shows an inundation extent for a sunny day failure of the auxiliary dam at Central Dam. File downloaded from DSOD website generated on 8/12/2020.
- Chabot (NID CA00165) - Scenario shows an inundation extent for a sunny day failure of Main Dam. File downloaded from DSOD website generated on 12/27/2019.
- Dunsmuir Reservoir (NID CA00174) - Scenario shows an inundation extent for an east breach sunny day failure of Dunsmuir Dam. File downloaded from DSOD website generated on 8/11/2020.
- Dunsmuir Reservoir (NID CA00174) - Scenario shows an inundation extent for an west breach sunny day failure of Dunsmuir Dam. File downloaded from DSOD website generated on 8/11/2020.
- Lake Temescal (NID CA00160) - Scenario shows an inundation extent for a sunny day failure of Main Dam. File downloaded from DSOD website generated on 12/20/2018.
- New Upper San Leandro (NID CA01082) - Scenario shows an inundation extent for a sunny day failure of Main Dam. File downloaded from DSOD website generated on 9/3/2020.
- New Upper San Leandro (NID CA01082) - Scenario shows an inundation extent for a sunny day failure of Spillway. File downloaded from DSOD website generated on 9/3/2020.

EARTHQUAKE MAPPING

Liquefaction Susceptibility

Liquefaction susceptibility data represents the entire San Francisco Bay Area by combining both U.S. Geological Survey (USGS) Open-File Report 00-444 and USGS Open-File Report 2006-1037. Much of the land adjacent to

San Francisco Bay and the major rivers and streams is underlain by unconsolidated deposits that are particularly vulnerable to earthquake shaking and liquefaction of water-saturated granular sediment. The mapping uses geomorphic expression, pedogenic soils, inferred depositional environments, and geologic age to define and distinguish the map units. The report is the product of cooperative work by the National Earthquake Hazards Reduction Program (NEHRP) and National Cooperative Geologic Mapping Program of the U.S. Geological Survey, William Lettis and Associates, Inc., and the California Geological Survey. The mapping has been carried out by William Lettis and Associates geologists under contract to the NEHRP Earthquake Program (Grant 99-HQ-GR-0095) and by the California Geological Survey (USGS, 2006).

National Earthquake Hazard Reduction Program (NEHRP) Soils

NEHRP soils information is derived from a shear wave velocity (Vs30) data produced by the California Geological Survey in 2015. The Vs30 data represents simplified geologic units that have been correlated to the time-averaged shear-wave velocity in the upper 30 meters of the earth's surface. The geologic units were compiled from published maps that range in scale from 1:250,000 to 1:24,000. (Wills, et. al., 2015)

Probabilistic Peak Ground Acceleration Maps

Probabilistic peak ground acceleration data, by Census tract, are generated by Hazus 4.2 SP03. In Hazus' probabilistic analysis procedure, the ground shaking demand is characterized by spectral contour maps developed by the U.S. Geological Survey (USGS) as part of a 2018 update of the National Seismic Hazard Maps. USGS probabilistic seismic hazard maps are revised about every six years to reflect newly published or thoroughly reviewed earthquake science and to keep pace with regular updates of the building code. Hazus includes maps for eight probabilistic hazard levels: ranging from ground shaking with a 39 percent probability of being exceeded in 50 years (100-year return period) to the ground shaking with a 2 percent probability of being exceeded in 50 years (2,500-year return period).

Shake Maps

A shake map is designed as a rapid response tool to portray the extent and variation of ground shaking throughout the affected region immediately following significant earthquakes. Ground motion and intensity maps are derived from peak ground motion amplitudes recorded on seismic sensors (accelerometers), with interpolation based on estimated amplitudes where data are lacking, and site amplification corrections. Color-coded instrumental intensity maps are derived from empirical relations between peak ground motions and Modified Mercalli intensity. For this plan, shake maps were prepared by the USGS for two earthquake scenarios:

- An earthquake on the Calaveras fault with the following characteristics:
  - Magnitude: 6.86
  - Epicenter: N 37.65 W 121.93
  - Depth: 10.4 km
- An earthquake on the Hayward fault with the following characteristics:
  - Magnitude: 7.05
  - Epicenter: N 37.80 W 122.18
  - Depth: 8.0 km
- An earthquake on the San Andreas fault with the following characteristics:

- Magnitude: 7.38
- Epicenter: N 37.52 W 122.36
- Depth: 7.8 km

FLOOD MAPPING

Flood hazard areas are from the countywide effective FEMA Digital Flood Insurance Rate Map (DFIRM) dated December 21, 2018 with latest incorporated letter of map revision effective March 16, 2020.

LANDSLIDE MAPPING

Susceptibility to Deep-Seated Landslides data provided by the California Geological Survey. The map, and associated data, show the relative likelihood of deep-seated landsliding based on regional estimates of rock strength and steepness of slopes. On the most basic level, weak rocks and steep slopes are most likely to generate landslides. The map uses detailed information on the location of past landslides, the location and relative strength of rock units, and steepness of slope to estimate susceptibility to deep-seated landsliding (0 to X, low to high). The USGS 2009 National Elevation Dataset with 10-m grid size was used as the base map. This landslide susceptibility map is intended to provide infrastructure owners, emergency planners and the public with a general overview of where landslides are more likely to occur. (Wills, et al., 2011)

SEA LEVEL RISE MAPPING

The Adapting to Rising Tides, Bay Area Sea Level Rise Analysis and Mapping Project, produces consistent inundation data and mapping products for all nine San Francisco Bay Area counties. The sea-level rise inundation mapping products capture permanent inundation and temporary flooding impacts from sea-level rise scenarios from 0 to 66 inches and extreme high tide events from the 1-year to the 100-year extreme tide. (San Francisco Bay Conservation and Development Commission, 2017)

TSUNAMI MAPPING

Tsunami hazard area data are produced collectively by tsunami modelers, geologic hazard mapping scientists, and emergency planning specialists from the California Geological Survey, the California Governor’s Office of Emergency Services, the Tsunami Research Center at the University of Southern California, and AECOM Technical Services. The Tsunami Hazard areas are developed for all populated areas at risk to tsunamis in California and represent a combination of the maximum considered tsunamis for each area. Local agencies, organizations, and other stakeholders assisted the State in the development of the hazard area as they will be used for evacuation planning at the community level.

The modeling used 10-m resolution data and are part of a probabilistic tsunami hazard analysis. The tsunami sources selected for inclusion in development of the new maps represent large, realistic events primarily from the Alaska and Cascadia subduction zones, equivalent to a baseline of the 975-year average return period (ARP). (State of California, 2021)

WILDFIRE MAPPING

Wildland Urban Interface, Wildland Urban Intermix, and Wildfire Influence Zones developed for the FRAP 2015 Assessment. It is derived from several data sources, including housing density (input_lsn_HousingDensity12_2), Fire Hazard Severity Zones (FHSZ_Assessment11_1), Unimproved Parcels (input_UnimprovedParcels16_1), and Vegetation Cover (input_FVEG15_2).

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Appendix D. Oakland Conditions of Approval Related to Natural Hazards

D. Oakland Conditions of Approval Related to Natural Hazards

To address a number of issues related to natural hazards, the City of Oakland applies the standard conditions of approval described below for development projects.

DROUGHT-RELATED STANDARDS

Standard Condition of Approval 18(a), Landscape Plan Required

Applicability

Applicable to all projects that establish one or more new residential units, that add 500 square feet of floor area to an existing residential facility, that establish new nonresidential facilities, or add 1,000 square feet of floor area to an existing nonresidential facility.

Requirement

The project applicant shall submit a final Landscape Plan for City review and approval that is consistent with the approved Landscape Plan. The Landscape Plan shall be included with the set of drawings submitted for the construction-related permit and shall comply with the landscape requirements of chapter 17.124 of the Planning Code. Proposed plants shall be predominantly drought-tolerant. Specification of any street trees shall comply with the Master Street Tree List and Tree Planting Guidelines

Standard Condition of Approval 89, Recycled Water

Applicability

Applicable to all projects involving a tentative map approval for a land subdivision or condominium subdivision located in the EBMUD Recycled Water Project area (generally portions of West Oakland, Downtown, and Jack London Square).

Requirement

Pursuant to section 16.08.030 of the Oakland Municipal Code, the project applicant shall provide for the use of recycled water in the project for feasible recycled water uses unless the City determines that there is a higher and better use for the recycled water, the use of recycled water is not economically justified for the project, or the use of recycled water is not financially or technically feasible for the project. Feasible recycled water uses may include, but are not limited to, landscape irrigation, commercial and industrial process use, and toilet and urinal flushing in non-residential buildings. The project applicant shall contact the New Business Office of the East Bay Municipal Utility District (EBMUD) for a recycled water feasibility assessment by the Office of Water Recycling. If recycled water is to be provided in the project, the project drawings submitted for construction-related permits shall include the proposed recycled water system and the project applicant shall install the recycled water system during construction.

Standard Condition of Approval 90, Water Efficient Landscape Ordinance

Applicability

Applicable to all projects involving (a) new construction with an aggregate landscape area equal to or greater than 500 square feet, (b) rehabilitated landscape projects with an aggregate landscape area equal to or greater than 2,500 square feet, (c) existing landscapes, and (d) cemeteries.

Requirement

The project applicant shall comply with California's Water Efficient Landscape Ordinance in order to reduce landscape water usage.

For any landscape project with an aggregate (total noncontiguous) landscape area equal to 2,500 sq. ft. or less, the project applicant may implement either the Prescriptive Measures or the Performance Measures, of, and in accordance with the California's Model Water Efficient Landscape Ordinance. For any landscape project with an aggregate (total noncontiguous) landscape area over 2,500 sq. ft., the project applicant shall implement the Performance Measures in accordance with the Water Efficient Landscape Ordinance.

Prescriptive Measures

Prior to construction, the project applicant shall submit the Project Information (detailed below) and documentation showing compliance with Appendix D of California's Model Water Efficient Landscape Ordinance.

Performance Measures

Prior to construction, the project applicant shall prepare and submit a Landscape Documentation Package for review and approval, which includes the following

- Project Information:
    - Date
    - Applicant and property owner name
    - Project address
    - Total landscape area
    - Project type (new, rehabilitated, cemetery, or home owner installed)
    - Water supply type and water purveyor
    - Checklist of documents in the package
    - Project contacts
    - Applicant signature and date with the statement: "I agree to comply with the requirements of the water efficient landscape ordinance and submit a complete Landscape Documentation Package."

- Water Efficient Landscape Worksheet
  - Hydrozone Information Table
  - Water Budget Calculations with Maximum Applied Water Allowance and Estimated Total Water Use
- Soil Management Report
- Landscape Design Plan
- Irrigation Design Plan, and
- Grading Plan

Upon installation of the landscaping and irrigation systems, and prior to the final of a construction-related permit, the Project applicant shall submit a Certificate of Completion and landscape and irrigation maintenance schedule for review and approval by the City. The Certificate of Completion shall also be submitted to the local water purveyor and property owner or his or her designee.

EARTHQUAKE-RELATED STANDARDS

Standard Condition of Approval 38, Earthquake Fault Zone

Applicability

To further address earthquake hazards, and pursuant to Oakland Municipal Code Chapter 15.20, the City of Oakland applies Standard Condition of Approval 38 to all projects that involve new structures, major additions, and subdivisions located in an Earthquake Fault Zone per the State Alquist-Priolo Fault Zoning Act.

Requirement

The project applicant shall submit a site-specific fault location investigation, as defined in California Geological Survey Note 49 (as amended), prepared by a certified engineering geologist for City review and approval containing at a minimum the results of subsurface investigations, locations of hazardous faults adjacent to the project site, recommended setback distances of proposed structures from hazardous faults, and additional recommended measures to accommodate warping and distributive deformation associated with faulting (e.g., strengthened foundations, engineering design, flexible utility connections). The project applicant shall implement the recommendations contained in the approved report during project design and construction.

Standard Condition of Approval 39, Seismic Hazard Zone (Landslide/Liquefaction)

Applicability

To further address earthquake hazards, and pursuant to Oakland Municipal Code Chapter 15.20, the City of Oakland applies Standard Condition of Approval 39 to all projects that involve new structures, major additions, and subdivisions located in a Seismic Hazard Zone per the State Seismic Hazards Mapping Act.

Requirement

The project applicant shall submit a site-specific geotechnical report, consistent with California Geological Survey Special Publication 117 (as amended), prepared by a registered geotechnical engineer for City review and approval containing at a minimum a description of the geological and geotechnical conditions at the site, an evaluation of site-specific seismic hazards based on geological and geotechnical conditions, and recommended measures to reduce potential impacts related to liquefaction and/or slope stability hazards. The project applicant shall implement the recommendations contained in the approved report during project design and construction.

FLOOD-RELATED STANDARDS

Standard Condition of Approval 60, Structures in a Flood Zone

Applicability

To further address flooding hazards, the City of Oakland applies a Standard Conditions of Approval to all projects that involve new construction within the 100-year flood zone as mapped on a Federal Hazard Boundary map, Flood Insurance Rate map, or other floor hazard delineation map.

Requirement

The project shall be designed to ensure that new structures within a 100-year flood zone do not interfere with the flow of water or increase flooding. The project applicant shall submit plans and hydrological calculations for City review and approval with the construction-related drawings that show finished site grades and floor elevations elevated above the Base Flood Elevation.

Standard Condition of Approval 88. Storm Drain Systems.

The City of Oakland applies this Standard Conditions of Approval to further reduce urban drainage flooding caused by increased water runoff due to urban development and drainage systems.

Applicability

Applicable to all major development projects, specifically those involving any of the following: (a) construction of 50 or more residential dwelling units; (b) construction of 50,000 square feet or more nonresidential floor area; (c) any development project requiring CEQA review.

Requirement

The project storm drainage system shall be designed in accordance with the City of Oakland's Storm Drainage Design Guidelines. To the maximum extent practicable, peak stormwater runoff from the project site shall be reduced by at least 25 percent compared to the pre-project condition.

LANDSLIDE-RELATED STANDARDS

Standard Condition of Approval 40, Oakland Area Geologic Hazard Abatement District

Applicability

To further address landslide hazards, the City of Oakland applies this Standard Condition of Approval to all proposals for newly constructed land use facilities where a geologic hazard is present, including an actual or threatened landslide, land subsidence, or soil erosion, earthquake, fault movement, or any other natural or unnatural movement of land or earth, and where a technical report pertaining to the actual or threatened geologic hazard specifies the need for a Geologic Hazards Abatement District (GHAD) or a substantial degree of construction attention, site monitoring, or maintenance of project improvements.

Requirement

Prior to approval of the final map or issuance of a building permit (whichever occurs first), the project applicant shall provide to the City 1) all required resolutions from the GHAD and City Council showing that the project property has been annexed into the GHAD, and 2) a statement from the GHAD Manager stating that an adequate funding mechanism is in place to fund the GHAD operations for the annexed property. To begin the annexation process, the project applicant shall submit a petition for annexation to the GHAD Manager which shall include but is not limited to a proposed Plan of Control as defined in Public Resource Code Section 26509, specifying all anticipated operations and maintenance responsibilities of the GHAD for the annexed property. The project applicant will be required to pay to the GHAD costs and fees associated with the annexation request, which includes the preparation and review of all necessary documents and resolutions by the GHAD Manager and/or GHAD Attorney. The GHAD Manager may require the project applicant to provide initial funding to allow the GHAD to operate with respect to the annexed property during the time a secure and stable financing source is obtained to ultimately fund the long term operations of the GHAD for the annexed property. If a real property assessment is proposed as a financing mechanism, the project applicant shall prepare an engineer's report identifying the projected costs and budget for GHAD operations for the annexed property and comply with all assessment voting requirements and other requirements in Proposition 218. If annexation is not approved by the GHAD and/or City Council, the project applicant shall demonstrate to the City's satisfaction that 1) another entity will and has assumed the responsibilities proposed for the GHAD ("Other Responsible Entity") and 2) there is an adequate financing mechanism in place to carry out those responsibilities.

The project applicant shall defend, hold harmless, and indemnify the GHAD, its officers, and agents against any and all liability, damages, claims, demands, judgments, losses, or other forms of legal or equitable relief relating to the GHAD annexation process and the securing/approval of funding sources by the GHAD and in the case of the City Council members, actions taken by said members while acting as the GHAD Board of Directors.

The project applicant shall request the GHAD or Other Responsible Entity to defend, hold harmless, and indemnify the Indemnified Parties (as defined in these Conditions of Approval) and their insurers against any and all liability, damages, claims, demands, judgments, losses, or other forms of legal or equitable relief related to the responsibilities and operation of the GHAD or Other Responsible Entity (including, without limitation, maintenance of GHAD/Other Responsibility Entity owned property) relating to the annexed property ("Indemnified Geologic Claims") and in the case of the City Council members, actions taken by said members while acting as the GHAD Board of Directors. This indemnity shall include, without limitation, payment of litigation expenses relating to the qualified Indemnified Geologic Claims. The Indemnified Parties shall take all reasonable steps to promptly notify the GHAD/Other Responsible Entity of any claim, demand, or legal actions that may create a claim for indemnification under this condition of approval. Within 90 days of the annexation to the GHAD or acceptance by the Other Responsible Entity, the applicant shall request the GHAD or Other Responsible Entity to enter into an Indemnification Agreement to establish in more specific detail the terms and conditions of the indemnification obligations set forth herein. The parties acknowledge that the GHAD can only provide indemnification as allowed by law. Any failure of any party to timely execute such Indemnification Agreement shall not be construed to limit any right or obligation otherwise specified in these Conditions of Approval.

SEVERE-WEATHER-RELATED STANDARDS

Standard Condition of Approval 83, Underground Utilities

Applicability

To further address severe weather hazards, the City of Oakland applies this Standard Condition of Approval to all construction projects.

Requirement

The project applicant shall place underground all new utilities serving the project and under the control of the project applicant and the City, including all new gas, electric, cable, and telephone facilities, fire alarm conduits, street light wiring, and other wiring, conduits, and similar facilities. The new facilities shall be placed underground along the project's street frontage and from the project structures to the point of service. Utilities under the control of other agencies, such as PG&E, shall be placed underground if feasible. All utilities shall be installed in accordance with standard specifications of the serving utilities.

WILDFIRE-RELATED STANDARDS

Standard Condition of Approval 47, Designated Very High Fire Severity Zone – Vegetation Management

Applicability

To further address wildfire hazards the City of Oakland applies this Standard Condition of Approval to all projects involving construction of new facilities located in the designated Very High Fire Severity Zone.

Requirement

a. Vegetation Management Plan Required

The project applicant shall submit a Vegetation Management Plan for City review and approval, and shall implement the approved Plan prior to, during, and after construction of the project. The Vegetation Management Plan may be combined with the Landscape Plan otherwise required by the Conditions of Approval. The Vegetation Management Plan shall include, at a minimum, the following measures:

- Removal of all tree branches and vegetation that overhang the horizontal building roof line and chimney areas within 10 feet vertically;
- Removal of leaves and needles from roofs and rain gutters;
- Planting and placement of fire-resistant plants around the house and phasing out flammable vegetation, however, ornamental vegetation shall not be planted within 5 feet of the foundation of the residential structure;
- Trimming back vegetation around windows;
- Removal of flammable vegetation on hillside slopes greater than 20%; Defensible space requirements shall clear all hillsides of non-ornamental vegetation within 30 feet of the residential structure on slopes of 5% or less, within 50 feet on slopes of 5 to 20% and within 100 feet or to the property line on slopes greater than 20%.
- All trees shall be pruned up at least ¼ the height of the tree from the ground at the base of the trunk;
- Clearing out ground-level brush and debris; and All non-ornamental plants, seasonal weeds & grasses, brush, leaf litter and debris within 30 feet of the residential structure shall be cut, raked and removed from the parcel.
- Stacking woodpiles away from structures at least 20 feet from residential structures.
- If a biological report, prepared by a qualified biologist and reviewed by the Bureau of Planning, identifies threatened or endangered species on the parcel, the Vegetation Management Plan shall include islands of habitat refuge for the species noted on a site plan and appropriate fencing for the species shall be installed. Clearing of vegetation within these islands of refuge shall occur solely for the purpose of fire suppression within a designated Very High Fire Severity Zone and only upon the Fire Code Official approving specific methods and timeframes for clearing that take into account the specific flora and fauna species.

b. Fire Safety Prior to Construction

The project plans shall specify that prior to construction, the project applicant shall ensure that the project contractor cuts, rakes and removes all combustible ground level vegetation project to a height of 6” or less from the construction, access and staging areas to reduce the threat of fire ignition per Sections 304.1.1 and 304.1.2 of the California Fire Code.

c. Fire Safety During Construction

The project applicant shall require the construction contractor to implement spark arrestors on all construction vehicles and equipment to minimize accidental ignition of dry construction debris and surrounding dry vegetation. Per section 906 of the California Fire Code, during construction, the contractor shall have at minimum three type 2A10BC fire extinguishers present on the job site, with current state fire marshal service tags attached and these extinguishers shall be deployed in the immediate presence of workers for use in the event of an ignition.

d. Smoking Prohibition

The project applicant shall require the construction contractor to implement a no smoking policy on the site and surrounding area during construction per Section 310.8 of the California Fire Code.

City of Oakland 2021 – 2026 Hazard Mitigation Plan

Appendix E. Detailed Risk Assessment Results

E.1 Detailed Risk Assessment Results—Exposure and Impacts on People and Properties

Sub-Area	Estimated Population (1)	Total Number of Buildings (2)	Total Number of Residential Buildings (2)	Total Building Value (Structure and contents in $) (2)
Central East Oakland	99,586	22,119	20,615	$20,183,735,157
Coliseum/Airport	3,775	1,269	946	$5,530,628,942
Downtown	20,470	1,637	432	$17,897,460,530
East Oakland Hills	32,073	10,296	10,110	$5,833,677,350
Eastlake/Fruitvale	99,218	16,048	14,611	$17,525,433,126
Glenview/ Redwood Heights	31,915	10,831	10,572	$6,085,453,758
North Oakland Hills	23,973	9,617	9,442	$6,429,810,236
North Oakland/Adams Point	80,439	16,458	14,966	$26,393,885,776
West Oakland	25,993	5,090	4,078	$11,690,676,559
Total	**417,442**	**93,365**	**85,772**	**$117,570,761,434**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.

(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Detailed Risk Assessment Exposure Vulnerability Results Dam Failure Combined

Sub-Area	Estimated Building Exposure						
	Buildings Exposed (2)	Population Exposed (3)	% of Population Exposed	Value Structure in $ Exposed (2)	Value Contents in $ Exposed (2)	Value (Structure and contents in $) Exposed (2)	% of Total Value Exposed
Central East Oakland	8,598	38,255	38.4%	$5,081,331,330	$4,571,536,230	$9,652,867,560	47.8%
Coliseum/Airport	1,244	3,751	99.4%	$2,338,924,473	$2,342,653,846	$4,681,578,319	84.6%
Downtown	0	0	0.0%	$0	$0	$0	0.0%
East Oakland Hills	353	1,088	3.4%	$117,508,864	$74,708,166	$192,217,030	3.3%
Eastlake/Fruitvale	1,600	9,154	9.2%	$1,260,051,205	$1,059,749,177	$2,319,800,382	13.2%
Glenview/ Redwood Heights	1	0	0.0%	$18,707,260	$18,707,260	$37,414,520	0.6%
North Oakland Hills	0	0	0.0%	$0	$0	$0	0.0%
North Oakland/Adams Point	2,714	13,286	16.5%	$1,722,294,351	$1,430,992,121	$3,153,286,472	11.9%
West Oakland	122	402	1.5%	$101,333,523	$101,250,917	$202,584,440	1.7%
Total	**14,632**	**65,936**	**15.8%**	**$10,640,151,005**	**$9,599,597,717**	**$20,239,748,722**	**17.2%**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.

(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Detailed Risk Assessment Exposure Vulnerability Results Dam Failure Combined

Sub-Area	Economic Impact							
	Structure Debris (Tons) (4)	Displaced Population (5)	People Requiring Short-Term Shelter (5)	Buildings Impacted (6)	Value Structure in $ Damaged (6)	Value Contents in $ Damaged (6)	Total Value (Structure and Contents in $)	% of Total Value Damaged
Central East Oakland	199,798	33,005	3,232	8,586	$1,518,521,104	$2,731,720,732	$4,250,241,836	21.1%
Coliseum/Airport	34,299	3,713	309	1,244	$526,399,297	$1,232,478,010	$1,758,877,306	31.8%
Downtown	0	0	0	0	$0	$0	$0	0.0%
East Oakland Hills	22,713	501	33	353	$72,158,439	$53,718,669	$125,877,108	2.2%
Eastlake/Fruitvale	20,927	3,210	294	210	$19,697,376	$40,251,830	$59,949,206	0.3%
Glenview/ Redwood Heights	413	0	0	1	$3,683,277	$14,300,789	$17,984,067	0.3%
North Oakland Hills	0	0	0	0	$0	$0	$0	0.0%
North Oakland/Adams Point	6,659	5,631	397	2,006	$33,928,654	$59,339,787	$93,268,441	0.4%
West Oakland	13	59	2	76	$119,018	$228,338	$347,356	0.0%
Total	**284,822**	**46,119**	**4,268**	**12,476**	**$2,174,507,164**	**$4,132,038,155**	**$6,306,545,319**	**5.4%**

(1) Population estimates from Oakland DOT Planning Area Layer.
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(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.

(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Sub-Area	Acres of Inundation Area	Number of Structures in Inundation Area (2)							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central East Oakland	3,965	7,919	393	177	1	44	34	30	8598
Coliseum/Airport	5,648	940	181	75	0	9	36	3	1244
Downtown	0	0	0	0	0	0	0	0	0
East Oakland Hills	271	343	8	0	0	1	1	0	353
Eastlake/Fruitvale	635	1,348	204	16	0	12	13	7	1600
Glenview/ Redwood Heights	3	0	1	0	0	0	0	0	1
North Oakland Hills	0	0	0	0	0	0	0	0	0
North Oakland/Adams Point	684	2,472	204	10	0	15	6	7	2714
West Oakland	142	63	15	41	0	1	1	1	122
Total	**11,347**	**13,085**	**1006**	**319**	**1**	**82**	**91**	**48**	**14632**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.

(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Sub-Area	Estimated Population (1)	Total Number of Buildings (2)	Total Number of Residential Buildings (2)	Total Building Value (Structure and contents in $) (2)
Central East Oakland	99,586	22,119	20,615	$20,183,735,157
Coliseum/Airport	3,775	1,269	946	$5,530,628,942
Downtown	20,470	1,637	432	$17,897,460,530
East Oakland Hills	32,073	10,296	10,110	$5,833,677,350
Eastlake/Fruitvale	99,218	16,048	14,611	$17,525,433,126
Glenview/ Redwood Heights	31,915	10,831	10,572	$6,085,453,758
North Oakland Hills	23,973	9,617	9,442	$6,429,810,236
North Oakland/Adams Point	80,439	16,458	14,966	$26,393,885,776
West Oakland	25,993	5,090	4,078	$11,690,676,559
Total	**417,442**	**93,365**	**85,772**	**$117,570,761,434**

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(3) Percent of residential buildings exposed multiplied by the Estimated Population.
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(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Detailed Risk Assessment Exposure Vulnerability Results Flood 100-yr

Sub-Area	Estimated Building Exposure						
	Buildings Exposed (2)	Population Exposed (3)	% of Population Exposed	Value Structure in $ Exposed (2)	Value Contents in $ Exposed (2)	Value (Structure and contents in $) Exposed (2)	% of Total Value Exposed
Central East Oakland	79	348	0.3%	$33,717,012	$23,225,926	$56,942,938	0.3%
Coliseum/Airport	13	8	0.2%	$348,122,595	$340,057,960	$688,180,555	12.4%
Downtown	13	47	0.2%	$62,689,204	$62,393,739	$125,082,944	0.7%
East Oakland Hills	10	32	0.1%	$11,894,810	$5,947,405	$17,842,215	0.3%
Eastlake/Fruitvale	54	333	0.3%	$16,386,176	$11,822,385	$28,208,561	0.2%
Glenview/ Redwood Heights	18	51	0.2%	$4,684,707	$2,633,072	$7,317,780	0.1%
North Oakland Hills	54	137	0.6%	$12,598,404	$6,299,202	$18,897,606	0.3%
North Oakland/Adams Point	64	285	0.4%	$86,129,071	$78,865,474	$164,994,546	0.6%
West Oakland	2	0	0.0%	$520,493	$520,493	$1,040,985	0.0%
Total	**307**	**1,241**	**0.3%**	**$576,742,473**	**$531,765,656**	**$1,108,508,129**	**0.9%**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.

(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Detailed Risk Assessment Exposure Vulnerability Results Flood 100-yr

Sub-Area	Economic Impact							
	Structure Debris (Tons) (4)	Displaced Population (5)	People Requiring Short-Term Shelter (5)	Buildings Impacted (6)	Value Structure in $ Damaged (6)	Value Contents in $ Damaged (6)	Total Value (Structure and Contents in $)	% of Total Value Damaged
Central East Oakland	1,424	29	1	12	$460,433	$537,430	$997,864	0.0%
Coliseum/Airport	435	1	0	12	$8,647,284	$21,291,835	$29,939,119	0.5%
Downtown	217	15	1	11	$1,172,081	$3,464,233	$4,636,315	0.0%
East Oakland Hills	181	4	0	4	$52,500	$32,053	$84,553	0.0%
Eastlake/Fruitvale	446	17	0	10	$151,509	$216,725	$368,234	0.0%
Glenview/ Redwood Heights	11	3	0	3	$20,648	$20,402	$41,050	0.0%
North Oakland Hills	27	23	1	20	$228,243	$138,970	$367,213	0.0%
North Oakland/Adams Point	1,078	27	1	20	$1,124,638	$1,153,972	$2,278,610	0.0%
West Oakland	0	0	0	2	$68,468	$392,438	$460,906	0.0%
Total	**3,818**	**119**	**5**	**94**	**$11,925,804**	**$27,248,058**	**$39,173,862**	**0.0%**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.

(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Sub-Area	Acres of Floodplain	Number of Structures in Floodplain (2)							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central East Oakland	104	72	4	0	0	0	2	1	79
Coliseum/Airport	1,899	2	6	2	0	0	3	0	13
Downtown	279	1	9	0	0	0	3	0	13
East Oakland Hills	15	10	0	0	0	0	0	0	10
Eastlake/Fruitvale	196	49	2	1	0	0	1	1	54
Glenview/ Redwood Heights	8	17	1	0	0	0	0	0	18
North Oakland Hills	14	54	0	0	0	0	0	0	54
North Oakland/Adams Point	55	53	6	0	0	1	2	2	64
West Oakland	828	0	0	0	0	0	2	0	2
Total	**3,398**	**258**	**28**	**3**	**0**	**1**	**13**	**4**	**307**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.

(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Detailed Risk Assessment Exposure Vulnerability Results Flood 500-yr

Sub-Area	Estimated Population (1)	Total Number of Buildings (2)	Total Number of Residential Buildings (2)	Total Building Value (Structure and contents in $) (2)
Central East Oakland	99,586	22,119	20,615	$20,183,735,157
Coliseum/Airport	3,775	1,269	946	$5,530,628,942
Downtown	20,470	1,637	432	$17,897,460,530
East Oakland Hills	32,073	10,296	10,110	$5,833,677,350
Eastlake/Fruitvale	99,218	16,048	14,611	$17,525,433,126
Glenview/ Redwood Heights	31,915	10,831	10,572	$6,085,453,758
North Oakland Hills	23,973	9,617	9,442	$6,429,810,236
North Oakland/Adams Point	80,439	16,458	14,966	$26,393,885,776
West Oakland	25,993	5,090	4,078	$11,690,676,559
Total	**417,442**	**93,365**	**85,772**	**$117,570,761,434**

(1) Population estimates from Oakland DOT Planning Area Layer.

(2) Values based off of 2020 tax assessor data from Alameda County.

(3) Percent of residential buildings exposed multiplied by the Estimated Population.

(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.

(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.

(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Detailed Risk Assessment Exposure Vulnerability Results Flood 500-yr

Sub-Area	Estimated Building Exposure						
	Buildings Exposed (2)	Population Exposed (3)	% of Population Exposed	Value Structure in $ Exposed (2)	Value Contents in $ Exposed (2)	Value (Structure and contents in $) Exposed (2)	% of Total Value Exposed
Central East Oakland	2,633	10,739	10.8%	$2,597,337,275	$2,484,084,080	$5,081,421,355	25.2%
Coliseum/Airport	304	670	17.8%	$1,387,755,782	$1,421,261,809	$2,809,017,592	50.8%
Downtown	36	142	0.7%	$184,209,684	$170,046,913	$354,256,597	2.0%
East Oakland Hills	12	35	0.1%	$15,019,561	$7,927,123	$22,946,684	0.4%
Eastlake/Fruitvale	1,567	8,936	9.0%	$1,162,782,415	$977,489,316	$2,140,271,731	12.2%
Glenview/ Redwood Heights	63	112	0.3%	$79,736,420	$69,115,341	$148,851,761	2.4%
North Oakland Hills	58	142	0.6%	$14,041,930	$7,398,125	$21,440,055	0.3%
North Oakland/Adams Point	397	2,005	2.5%	$303,896,721	$222,848,491	$526,745,212	2.0%
West Oakland	325	854	3.3%	$1,080,537,456	$1,163,422,636	$2,243,960,092	19.2%
Total	**5,395**	**23,635**	**5.7%**	**$6,825,317,244**	**$6,523,593,834**	**$13,348,911,078**	**11.4%**

(1) Population estimates from Oakland DOT Planning Area Layer.

(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.
(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Detailed Risk Assessment Exposure Vulnerability Results Flood 500-yr

Sub-Area	Economic Impact							
	Structure Debris (Tons) (4)	Displaced Population (5)	People Requiring Short-Term Shelter (5)	Buildings Impacted (6)	Value Structure in $ Damaged (6)	Value Contents in $ Damaged (6)	Total Value (Structure and Contents in $) Damaged	% of Total Value Damaged
Central East Oakland	24,364	6,137	750	1,248	$192,596,755	$404,586,534	$597,183,289	3.0%
Coliseum/Airport	858	310	22	212	$81,421,763	$123,321,068	$204,742,831	3.7%
Downtown	265	96	9	15	$3,311,480	$4,591,131	$7,902,610	0.0%
East Oakland Hills	199	4	1	6	$323,927	$260,861	$584,788	0.0%
Eastlake/Fruitvale	18,762	4,244	474	688	$59,577,451	$76,249,625	$135,827,077	0.8%
Glenview/ Redwood Heights	1,595	15	1	46	$16,581,297	$41,999,532	$58,580,828	1.0%
North Oakland Hills	49	17	0	23	$417,511	$258,710	$676,221	0.0%
North Oakland/Adams Point	1,817	444	43	170	$7,268,286	$6,235,017	$13,503,303	0.1%
West Oakland	513	245	11	201	$12,286,782	$32,341,691	$44,628,472	0.4%
Total	**48,422**	**11,513**	**1,311**	**2,609**	**$373,785,252**	**$689,844,169**	**$1,063,629,420**	**0.9%**

(1) Population estimates from Oakland DOT Planning Area Layer.

(2) Values based off of 2020 tax assessor data from Alameda County.

(3) Percent of residential buildings exposed multiplied by the Estimated Population.

(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.

(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.

(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Sub-Area	Acres of Floodplain	Number of Structures in Floodplain (2)							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central East Oakland	1,108	2,223	261	100	0	17	22	10	2633
Coliseum/Airport	2,714	168	91	23	0	5	17	0	304
Downtown	309	3	30	0	0	0	3	0	36
East Oakland Hills	16	11	1	0	0	0	0	0	12
Eastlake/Fruitvale	601	1,316	195	20	0	8	13	15	1567
Glenview/ Redwood Heights	24	37	26	0	0	0	0	0	63
North Oakland Hills	16	56	1	0	0	0	0	1	58
North Oakland/Adams Point	121	373	15	1	0	2	3	3	397
West Oakland	1,509	134	93	86	0	0	12	0	325
Total	**6,417**	**4,321**	**713**	**230**	**0**	**32**	**70**	**29**	**5395**

(1) Population estimates from Oakland DOT Planning Area Layer.

(2) Values based off of 2020 tax assessor data from Alameda County.

(3) Percent of residential buildings exposed multiplied by the Estimated Population.

(4) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03.

(5) Calculated using a Census block level, general building stock (GBS) analysis in Hazus 4.2 SP03, and adjusted to reflect the estimated population.

(6) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Sub-Area	Estimated Population (1)	Total Number of Buildings (2)	Total Number of Residential Buildings (2)	Total Building Value (Structure and contents in $) (2)
Central East Oakland	99,586	22,119	20,615	$20,183,735,157
Coliseum/Airport	3,775	1,269	946	$5,530,628,942
Downtown	20,470	1,637	432	$17,897,460,530
East Oakland Hills	32,073	10,296	10,110	$5,833,677,350
Eastlake/Fruitvale	99,218	16,048	14,611	$17,525,433,126
Glenview/ Redwood Heights	31,915	10,831	10,572	$6,085,453,758
North Oakland Hills	23,973	9,617	9,442	$6,429,810,236
North Oakland/Adams Point	80,439	16,458	14,966	$26,393,885,776
West Oakland	25,993	5,090	4,078	$11,690,676,559
Total	**417,442**	**93,365**	**85,772**	**117,570,761,434**

Sub-Area	Estimated Population (1)	Total Number of Buildings (2)	Total Number of Residential Buildings (2)	Total Building Value (Structure and contents in $) (2)
Central East Oakland	99,586	22,119	20,615	$20,183,735,157
Coliseum/Airport	3,775	1,269	946	$5,530,628,942
Downtown	20,470	1,637	432	$17,897,460,530
East Oakland Hills	32,073	10,296	10,110	$5,833,677,350
Eastlake/Fruitvale	99,218	16,048	14,611	$17,525,433,126
Glenview/ Redwood Heights	31,915	10,831	10,572	$6,085,453,758
North Oakland Hills	23,973	9,617	9,442	$6,429,810,236
North Oakland/Adams Point	80,439	16,458	14,966	$26,393,885,776
West Oakland	25,993	5,090	4,078	$11,690,676,559
Total	**417,442**	**93,365**	**85,772**	**117,570,761,434**

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Coliseum/Airport	3,775	1,269	946	$5,530,628,942
Downtown	20,470	1,637	432	$17,897,460,530
East Oakland Hills	32,073	10,296	10,110	$5,833,677,350
Eastlake/Fruitvale	99,218	16,048	14,611	$17,525,433,126
Glenview/ Redwood Heights	31,915	10,831	10,572	$6,085,453,758
North Oakland Hills	23,973	9,617	9,442	$6,429,810,236
North Oakland/Adams Point	80,439	16,458	14,966	$26,393,885,776
West Oakland	25,993	5,090	4,078	$11,690,676,559
Total	**417,442**	**93,365**	**85,772**	**117,570,761,434**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Susceptibility to Deep-Seated Landslides in California (CGS Map Sheet 58) provided by the CA Geological Survey. Susceptibility classes categorized as follows: Very High (class 10), High (class 7, 8, and 9), Moderate (class 5 and 6).
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Sub-Area	Landslide Susceptibility - Very High (3)						
	Estimated Exposure						
	Estimated Buildings Exposed (2)	Population Exposed (4)	% of Population Exposed	Value Structure in $ Exposed (2)	Value Contents in $ Exposed (2)	Value (Structure and contents in $) Exposed (2)	% of Total Value
Central East Oakland	48	227	0.2%	$12,152,257	$6,773,794	$18,926,051	0.1%
Coliseum/Airport	0	0	0.0%	$0	$0	$0	0.0%
Downtown	0	0	0.0%	$0	$0	$0	0.0%
East Oakland Hills	455	1,418	4.4%	$132,713,431	$71,293,502	$204,006,933	3.5%
Eastlake/Fruitvale	128	849	0.9%	$135,877,769	$106,063,734	$241,941,503	1.4%
Glenview/ Redwood Heights	439	1,316	4.1%	$117,191,339	$60,173,522	$177,364,861	2.9%
North Oakland Hills	691	1,744	7.3%	$233,126,163	$120,778,877	$353,905,039	5.5%
North Oakland/Adams Point	101	527	0.7%	$84,891,136	$51,175,397	$136,066,532	0.5%
West Oakland	0	0	0.0%	$0	$0	$0	0.0%
Total	**1,862**	**6,081**	**1.5%**	**$715,952,094**	**$416,258,825**	**$1,132,210,919**	**1.0%**

Sub-Area	Landslide Susceptibility - High (3)						
	Estimated Exposure						
	Estimated Buildings Exposed (2)	Population Exposed (4)	% of Population Exposed	Value Structure in $ Exposed (2)	Value Contents in $ Exposed (2)	Value (Structure and contents in $) Exposed (2)	% of Total Value
Central East Oakland	2,590	12,231	12.3%	$634,546,981	$387,700,132	$1,022,247,113	5.1%
Coliseum/Airport	1	0	0.0%	$101,484	$101,484	$202,968	0.0%
Downtown	39	616	3.0%	$163,170,578	$105,895,456	$269,066,034	1.5%
East Oakland Hills	3,095	9,625	30.0%	$1,054,076,288	$669,916,320	$1,723,992,608	29.6%
Eastlake/Fruitvale	5,800	37,824	38.1%	$2,464,598,042	$1,564,908,036	$4,029,506,077	23.0%
Glenview/ Redwood Heights	5,893	17,530	54.9%	$1,812,810,988	$1,073,746,523	$2,886,557,511	47.4%
North Oakland Hills	4,624	11,494	47.9%	$1,881,881,122	$1,128,167,869	$3,010,048,991	46.8%
North Oakland/Adams Point	3,578	17,946	22.3%	$3,462,078,086	$2,450,157,288	$5,912,235,374	22.4%
West Oakland	0	0	0.0%	$0	$0	$0	0.0%
Total	**25,620**	**107,267**	**25.7%**	**$11,473,263,568**	**$7,380,593,109**	**$18,853,856,677**	**16.0%**

Sub-Area	Landslide Susceptibility - Moderate (3)						
	Estimated Exposure						
	Estimated Buildings Exposed (2)	Population Exposed (4)	% of Population Exposed	Value Structure in $ Exposed (2)	Value Contents in $ Exposed (2)	Value (Structure and contents in $) Exposed (2)	% of Total Value
Central East Oakland	0	0	0.0%	$0	$0	$0	0.0%
Coliseum/Airport	0	0	0.0%	$0	$0	$0	0.0%
Downtown	0	0	0.0%	$0	$0	$0	0.0%
East Oakland Hills	1,226	3,848	12.0%	$408,380,378	$233,457,717	$641,838,096	11.0%
Eastlake/Fruitvale	0	0	0.0%	$0	$0	$0	0.0%
Glenview/ Redwood Heights	1,614	4,827	15.1%	$491,279,930	$301,091,717	$792,371,647	13.0%
North Oakland Hills	2,250	5,649	23.6%	$909,723,964	$498,767,639	$1,408,491,602	21.9%
North Oakland/Adams Point	698	3,719	4.6%	$268,483,130	$146,145,778	$414,628,907	1.6%
West Oakland	0	0	0.0%	$0	$0	$0	0.0%
Total	**5,788**	**18,044**	**4.3%**	**$2,077,867,402**	**$1,179,462,851**	**$3,257,330,253**	**2.8%**

(1) Population estimates from Oakland DOT Planning Area Layer.
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(3) Susceptibility to Deep-Seated Landslides in California (CGS Map Sheet 58) provided by the CA Geological Survey. Susceptibility classes categorized as follows: Very High (class 10), High (class 7, 8, and 9), Moderate (class 5 and 6).
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Sub-Area	Number of Structures in Very High Category (2)							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central East Oakland	47	0	0	0	1	0	0	48
Coliseum/Airport	0	0	0	0	0	0	0	0
Downtown	0	0	0	0	0	0	0	0
East Oakland Hills	447	2	0	0	3	3	0	455
Eastlake/Fruitvale	125	3	0	0	0	0	0	128
Glenview/ Redwood Heights	436	2	0	0	0	1	0	439
North Oakland Hills	687	2	0	0	0	2	0	691
North Oakland/Adams Point	98	0	0	0	0	1	2	101
West Oakland	0	0	0	0	0	0	0	0
Total	**1,840**	**9**	**0**	**0**	**4**	**7**	**2**	**1,862**

Sub-Area	Number of Structures in High Category (2)							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central East Oakland	2,532	35	0	1	8	7	7	2,590
Coliseum/Airport	0	0	0	0	0	1	0	1
Downtown	13	24	1	0	0	1	0	39
East Oakland Hills	3,034	35	0	0	7	8	11	3,095
Eastlake/Fruitvale	5,570	153	20	0	26	11	20	5,800
Glenview/ Redwood Heights	5,807	50	0	0	16	6	14	5,893
North Oakland Hills	4,527	73	0	1	4	15	4	4,624
North Oakland/Adams Point	3,339	207	1	0	15	5	11	3,578
West Oakland	0	0	0	0	0	0	0	0
Total	**24,822**	**577**	**22**	**2**	**76**	**54**	**67**	**25,620**

Sub-Area	Number of Structures in Moderate Category (2)							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central East Oakland	0	0			0	0	0	0
Coliseum/Airport	0	0			0	0	0	0
Downtown	0	0			0	0	0	0
East Oakland Hills	1,213	6			5	1	1	1,226
Eastlake/Fruitvale	0	0			0	0	0	0
Glenview/ Redwood Heights	1,599	8			3	0	4	1,614
North Oakland Hills	2,225	15			2	5	3	2,250
North Oakland/Adams Point	692	5			1	0	0	698
West Oakland	0	0			0	0	0	0
Total	**5,729**	**34**	**0**	**0**	**11**	**6**	**8**	**5,788**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Susceptibility to Deep-Seated Landslides in California (CGS Map Sheet 58) provided by the CA Geological Survey. Susceptibility classes categorized as follows: Very High (class 10), High (class 7, 8, and 9), Moderate (class 5 and 6).
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Sub-Area	Estimated Population (1)	Total Number of Buildings (2)	Total Number of Residential Buildings (2)	Total Building Value (Structure and contents in $) (2)
Central East Oakland	99,586	22,119	20,615	$20,183,735,157
Coliseum/Airport	3,775	1,269	946	$5,530,628,942
Downtown	20,470	1,637	432	$17,897,460,530
East Oakland Hills	32,073	10,296	10,110	$5,833,677,350
Eastlake/Fruitvale	99,218	16,048	14,611	$17,525,433,126
Glenview/ Redwood Heights	31,915	10,831	10,572	$6,085,453,758
North Oakland Hills	23,973	9,617	9,442	$6,429,810,236
North Oakland/Adams Point	80,439	16,458	14,966	$26,393,885,776
West Oakland	25,993	5,090	4,078	$11,690,676,559
Total	**417,442**	**93,365**	**85,772**	**$117,570,761,434**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Sub-Area	Estimated Building Exposure						
	Buildings Exposed (2)	Population Exposed (3)	% of Population Exposed	Value Structure in $ Exposed (2)	Value Contents in $ Exposed (2)	Value (Structure and contents in $) Exposed (2)	% of Total Value Exposed
Central East Oakland	121	39	0.0%	$584,749,541	$642,064,845	$1,226,814,386	6.1%
Coliseum/Airport	520	1,245	33.0%	$1,977,952,715	$2,004,179,652	$3,982,132,367	72.0%
Downtown	244	1,516	7.4%	$1,148,895,940	$896,435,363	$2,045,331,303	11.4%
East Oakland Hills	0	0	0.0%	$0	$0	$0	0.0%
Eastlake/Fruitvale	310	917	0.9%	$1,247,624,757	$1,334,003,425	$2,581,628,182	14.7%
Glenview/ Redwood Heights	0	0	0.0%	$0	$0	$0	0.0%
North Oakland Hills	0	0	0.0%	$0	$0	$0	0.0%
North Oakland/Adams Point	0	0	0.0%	$0	$0	$0	0.0%
West Oakland	1,823	8,337	32.1%	$3,160,020,402	$3,166,636,801	$6,326,657,203	54.1%
Total	**3,018**	**12,054**	**2.9%**	**$8,119,243,355**	**$8,043,320,086**	**$16,162,563,441**	**13.7%**

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(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Sub-Area	Economic Impact				
	Buildings Impacted (4)	Value Structure in $ Damaged (4)	Value Contents in $ Damaged (4)	Total Value (Structure and Contents in $) Damaged	% of Total Value Damaged
Central East Oakland	0	$0	$0	$0	0.0%
Coliseum/Airport	7	$560,870	$44,663,479	$45,224,350	0.8%
Downtown	126	$2,321,900,803	$2,346,901,657	$4,668,802,460	26.1%
East Oakland Hills	0	$0	$0	$0	0.0%
Eastlake/Fruitvale	56	$130,523,890	$569,183,553	$699,707,442	4.0%
Glenview/ Redwood Heights	0	$0	$0	$0	0.0%
North Oakland Hills	0	$0	$0	$0	0.0%
North Oakland/Adams Point	0	$0	$0	$0	0.0%
West Oakland	681	$1,508,252,981	$1,716,559,445	$3,224,812,426	27.6%
Total	**870**	**$3,961,238,544**	**$4,677,308,133**	**$8,638,546,677**	**7.3%**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Detailed Risk Assessment Exposure Vulnerability Results Tsunami

Sub-Area	Acres of Hazard Area	Number of Structures in Hazard Area (2)							
		Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central East Oakland	366	8	76	33	0	0	4	0	121
Coliseum/Airport	4,867	312	119	47	0	5	35	2	520
Downtown	470	32	179	16	0	2	14	1	244
East Oakland Hills	0	0	0	0	0	0	0	0	0
Eastlake/Fruitvale	622	135	92	53	0	0	23	7	310
Glenview/ Redwood Heights	0	0	0	0	0	0	0	0	0
North Oakland Hills	0	0	0	0	0	0	0	0	0
North Oakland/Adams Point	0	0	0	0	0	0	0	0	0
West Oakland	4,822	1,308	261	181	0	18	48	7	1823
Total	**11,147**	**1,795**	**727**	**330**	**0**	**25**	**124**	**17**	**3018**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Percent of residential buildings exposed multiplied by the Estimated Population.
(4) Calculated using a user-defined (UDF) analysis in Hazus 4.2 SP03.

Detailed Risk Assessment Exposure Vulnerability Results Sea Level Rise 48"

Sub-Area	Estimated Population (1)	Total Number of Buildings (2)	Total Number of Residential Buildings (2)	Total Building Value (Structure and contents in $) (2)
Central East Oakland	99,586	22,119	20,615	$20,183,735,157
Coliseum/Airport	3,775	1,269	946	$5,530,628,942
Downtown	20,470	1,637	432	$17,897,460,530
East Oakland Hills	32,073	10,296	10,110	$5,833,677,350
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North Oakland/Adams Point	80,439	16,458	14,966	$26,393,885,776
West Oakland	25,993	5,090	4,078	$11,690,676,559
Total	**417,442**	**93,365**	**85,772**	**117,570,761,434**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Adapting to Rising Tides sea level rise data provided by BCDC.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Detailed Risk Assessment Exposure Vulnerability Results   Sea Level Rise 48"

Sub-Area	Sea Level Rise 48" (3)						
	Estimated Exposure						
	Estimated Buildings Exposed (2)	Population Exposed (4)	% of Population Exposed	Value Structure in $ Exposed (2)	Value Contents in $ Exposed (2)	Value (Structure and contents in $) Exposed (2)	% of Total Value
Central East Oakland	26	39	0.04%	92,956,266	104,662,970	197,619,236	0.98%
Coliseum/Airport	109	295	7.82%	616,128,126	614,562,827	1,230,690,953	22.25%
Downtown	13	95	0.46%	86,566,110	75,806,218	162,372,328	0.91%
East Oakland Hills	0	0	0.00%	0	0	0	0.00%
Eastlake/Fruitvale	6	0	0.00%	9,335,380	10,219,675	19,555,056	0.11%
Glenview/ Redwood Heights	0	0	0.00%	0	0	0	0.00%
North Oakland Hills	0	0	0.00%	0	0	0	0.00%
North Oakland/Adams Point	0	0	0.00%	0	0	0	0.00%
West Oakland	3	0	0.00%	5,911,736	5,911,736	11,823,473	0.10%
Total	**157**	**429**	**0.10%**	**810,897,619**	**811,163,426**	**1,622,061,045**	**1.38%**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Adapting to Rising Tides sea level rise data provided by BCDC.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

1.00%	**$16,220,610**	0.01%
10.00%	$162,206,105	0.14%
30.00%	$486,618,314	0.41%
50.00%	$811,030,523	0.69%

Detailed Risk Assessment Exposure Vulnerability Results Sea Level Rise 48"

Sub-Area	Number of Structures in Hazard Area (2)							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central East Oakland	8	16	2	0	0	0	0	26
Coliseum/Airport	74	16	9	0	1	9	0	109
Downtown	2	9	0	0	0	2	0	13
East Oakland Hills	0	0	0	0	0	0	0	0
Eastlake/Fruitvale	0	2	1	0	0	3	0	6
Glenview/ Redwood Heights	0	0	0	0	0	0	0	0
North Oakland Hills	0	0	0	0	0	0	0	0
North Oakland/Adams Point	0	0	0	0	0	0	0	0
West Oakland	0	0	0	0	0	3	0	3
Total	**84**	**43**	**12**	**0**	**1**	**17**	**0**	**157**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Adapting to Rising Tides sea level rise data provided by BCDC.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Detailed Risk Assessment Exposure Vulnerability Results Sea Level Rise 108"

Sub-Area	Estimated Population (1)	Total Number of Buildings (2)	Total Number of Residential Buildings (2)	Total Building Value (Structure and contents in $) (2)
Central East Oakland	99,586	22,119	20,615	$20,183,735,157
Coliseum/Airport	3,775	1,269	946	$5,530,628,942
Downtown	20,470	1,637	432	$17,897,460,530
East Oakland Hills	32,073	10,296	10,110	$5,833,677,350
Eastlake/Fruitvale	99,218	16,048	14,611	$17,525,433,126
Glenview/ Redwood Heights	31,915	10,831	10,572	$6,085,453,758
North Oakland Hills	23,973	9,617	9,442	$6,429,810,236
North Oakland/Adams Point	80,439	16,458	14,966	$26,393,885,776
West Oakland	25,993	5,090	4,078	$11,690,676,559
Total	**417,442**	**93,365**	**85,772**	**117,570,761,434**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Adapting to Rising Tides sea level rise data provided by BCDC.

(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Detailed Risk Assessment Exposure Vulnerability Results Sea Level Rise 108"

Sub-Area	Sea Level Rise 108" (3)						
	Estimated Exposure						
	Estimated Buildings Exposed (2)	Population Exposed (4)	% of Population Exposed	Value Structure in $ Exposed (2)	Value Contents in $ Exposed (2)	Value (Structure and contents in $) Exposed (2)	% of Total Value
Central East Oakland	869	2,913	2.93%	1,615,940,027	1,685,171,180	3,301,111,208	16.36%
Coliseum/Airport	772	1,907	50.53%	2,539,204,778	2,577,589,844	5,116,794,622	92.52%
Downtown	134	806	3.94%	915,220,289	736,653,058	1,651,873,347	9.23%
East Oakland Hills	0	0	0.00%	0	0	0	0.00%
Eastlake/Fruitvale	164	421	0.42%	851,439,391	763,691,552	1,615,130,943	9.22%
Glenview/ Redwood Heights	6	0	0.00%	5,268,815	5,268,815	10,537,629	0.17%
North Oakland Hills	0	0	0.00%	0	0	0	0.00%
North Oakland/Adams Point	70	97	0.12%	368,702,975	318,105,977	686,808,952	2.60%
West Oakland	1,184	4,634	17.83%	2,571,376,191	2,685,949,874	5,257,326,065	44.97%
Total	**3,199**	**10,778**	**2.58%**	**8,867,152,465**	**8,772,430,300**	**17,639,582,766**	**15.00%**

(1) Population estimates from Oakland DOT Planning Area Layer.	**1.00%**	**$176,395,828**	0.15%
(2) Values based off of 2020 tax assessor data from Alameda County.	10.00%	$1,763,958,277	1.50%
(3) Adapting to Rising Tides sea level rise data provided by BCDC.	30.00%	$5,291,874,830	4.50%
(4) Percent of residential buildings exposed multiplied by the Estimated Population.	50.00%	$8,819,791,383	7.50%

Detailed Risk Assessment Exposure Vulnerability Results Sea Level Rise 108"

Sub-Area	Number of Structures in Hazard Area (2)							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central East Oakland	603	152	97	0	3	12	2	869
Coliseum/Airport	478	176	72	0	7	37	2	772
Downtown	17	96	6	0	2	13	0	134
East Oakland Hills	0	0	0	0	0	0	0	0
Eastlake/Fruitvale	62	60	21	0	1	17	3	164
Glenview/ Redwood Heights	0	6	0	0	0	0	0	6
North Oakland Hills	0	0	0	0	0	0	0	0
North Oakland/Adams Point	18	49	0	0	0	3	0	70
West Oakland	727	222	183	0	10	41	1	1,184
Total	**1,905**	**761**	**379**	**0**	**23**	**123**	**8**	**3,199**

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Adapting to Rising Tides sea level rise data provided by BCDC.

(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Sub-Area	Estimated Population (1)	Total Number of Buildings (2)	Total Number of Residential Buildings (2)	Total Building Value (Structure and contents in $) (2)
Central East Oakland	99,586	22,119	20,615	$20,183,735,157
Coliseum/Airport	3,775	1,269	946	$5,530,628,942
Downtown	20,470	1,637	432	$17,897,460,530
East Oakland Hills	32,073	10,296	10,110	$5,833,677,350
Eastlake/Fruitvale	99,218	16,048	14,611	$17,525,433,126
Glenview/ Redwood Heights	31,915	10,831	10,572	$6,085,453,758
North Oakland Hills	23,973	9,617	9,442	$6,429,810,236
North Oakland/Adams Point	80,439	16,458	14,966	$26,393,885,776
West Oakland	25,993	5,090	4,078	$11,690,676,559
Total	**417,442**	**93,365**	**85,772**	**117,570,761,434**

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Coliseum/Airport	3,775	1,269	946	$5,530,628,942
Downtown	20,470	1,637	432	$17,897,460,530
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North Oakland Hills	23,973	9,617	9,442	$6,429,810,236
North Oakland/Adams Point	80,439	16,458	14,966	$26,393,885,776
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Total	**417,442**	**93,365**	**85,772**	**117,570,761,434**

(1) Population estimates from Oakland DOT Planning Area Layer.
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(3) Wildfire severity zones are within the WUI intermix and interface zones. Fire and Resource Assessment Program (FRAP) data provided by California Department of Forestry and Fire Protection.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Sub-Area	Very High Fire Severity Zone (3)						
	Estimated Exposure						
	Estimated Buildings Exposed (2)	Population Exposed (4)	% of Population Exposed	Value Structure in $ Exposed (2)	Value Contents in $ Exposed (2)	Value (Structure and contents in $) Exposed (2)	% of Total Value
Central East Oakland	1	5	0.0%	$614,517	$307,259	$921,776	0.0%
Coliseum/Airport	0	0	0.0%	$0	$0	$0	0.0%
Downtown	0	0	0.0%	$0	$0	$0	0.0%
East Oakland Hills	6,205	19,428	60.6%	$2,277,863,792	$1,452,226,644	$3,730,090,436	63.9%
Eastlake/Fruitvale	0	0	0.0%	$0	$0	$0	0.0%
Glenview/ Redwood Heights	1,845	5,482	17.2%	$607,290,255	$386,641,233	$993,931,488	16.3%
North Oakland Hills	7,218	17,996	75.1%	$2,993,513,959	$1,749,027,564	$4,742,541,523	73.8%
North Oakland/Adams Point	134	704	0.9%	$53,744,693	$30,088,179	$83,832,872	0.3%
West Oakland	0	0	0.0%	$0	$0	$0	0.0%
Total	15,403	43,615	10.4%	$5,933,027,216	$3,618,290,879	$9,551,318,096	8.1%

Sub-Area	High Fire Severity Zone (3)						
	Estimated Exposure						
	Estimated Buildings Exposed (2)	Population Exposed (4)	% of Population Exposed	Value Structure in $ Exposed (2)	Value Contents in $ Exposed (2)	Value (Structure and contents in $) Exposed (2)	% of Total Value
Central East Oakland	10	19	0.0%	$211,496,088	$296,432,193	$507,928,281	2.5%
Coliseum/Airport	0	0	0.0%	$0	$0	$0	0.0%
Downtown	0	0	0.0%	$0	$0	$0	0.0%
East Oakland Hills	1,157	3,639	11.3%	$306,134,615	$191,554,268	$497,688,882	8.5%
Eastlake/Fruitvale	0	0	0.0%	$0	$0	$0	0.0%
Glenview/ Redwood Heights	1,699	5,099	16.0%	$445,581,954	$256,693,595	$702,275,549	11.5%
North Oakland Hills	683	1,727	7.2%	$228,472,740	$124,752,474	$353,225,213	5.5%
North Oakland/Adams Point	296	1,580	2.0%	$121,176,467	$71,786,247	$192,962,714	0.7%
West Oakland	0	0	0.0%	$0	$0	$0	0.0%
Total	3,845	12,064	2.9%	$1,312,861,862	$941,218,776	$2,254,080,639	1.9%

Sub-Area	Moderate Fire Severity Zone (3)						
	Estimated Exposure						
	Estimated Buildings Exposed (2)	Population Exposed (4)	% of Population Exposed	Value Structure in $ Exposed (2)	Value Contents in $ Exposed (2)	Value (Structure and contents in $) Exposed (2)	% of Total Value
Central East Oakland	116	502	0.5%	$114,962,388	$116,907,160	$231,869,548	1.1%
Coliseum/Airport	0	0	0.0%	$0	$0	$0	0.0%
Downtown	0	0	0.0%	$0	$0	$0	0.0%
East Oakland Hills	1,079	3,350	10.4%	$295,998,207	$181,399,732	$477,397,939	8.2%
Eastlake/Fruitvale	0	0	0.0%	$0	$0	$0	0.0%
Glenview/ Redwood Heights	1,567	4,685	14.7%	$486,169,656	$304,396,325	$790,565,981	13.0%
North Oakland Hills	497	1,239	5.2%	$235,140,787	$167,621,243	$402,762,031	6.3%
North Oakland/Adams Point	304	1,634	2.0%	$108,754,594	$54,377,297	$163,131,890	0.6%
West Oakland	0	0	0.0%	$0	$0	$0	0.0%
Total	3,563	11,411	2.7%	$1,241,025,632	$824,701,758	$2,065,727,390	1.8%

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Wildfire severity zones are within the WUI intermix and interface zones. Fire and Resource Assessment Program (FRAP) data provided by California Department of Forestry and Fire Protection.
(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Sub-Area	Number of Structures in Very High Category (2)							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central East Oakland	1	0	0	0	0	0	0	1
Coliseum/Airport	0	0	0	0	0	0	0	0
Downtown	0	0	0	0	0	0	0	0
East Oakland Hills	6,124	32	1	0	16	14	18	6,205
Eastlake/Fruitvale	0	0	0	0	0	0	0	0
Glenview/ Redwood Heights	1,816	11	0	0	6	7	5	1,845
North Oakland Hills	7,088	99	0	1	6	17	7	7,218
North Oakland/Adams Point	131	1	0	0	0	1	1	134
West Oakland	0	0	0	0	0	0	0	0
Total	**15,160**	**143**	**1**	**1**	**28**	**39**	**31**	**15,403**

Sub-Area	Number of Structures in High Category (2)							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central East Oakland	4	1	0	0	1	1	3	10
Coliseum/Airport	0	0	0	0	0	0	0	0
Downtown	0	0	0	0	0	0	0	0
East Oakland Hills	1,147	3	0	0	1	4	2	1,157
Eastlake/Fruitvale	0	0	0	0	0	0	0	0
Glenview/ Redwood Heights	1,689	2	0	0	2	1	5	1,699
North Oakland Hills	680	2	0	0	0	1	0	683
North Oakland/Adams Point	294	0	0	0	0	0	2	296
West Oakland	0	0	0	0	0	0	0	0
Total	**3,814**	**8**	**0**	**0**	**4**	**7**	**12**	**3,845**

Sub-Area	Number of Structures in Moderate Category (2)							
	Residential	Commercial	Industrial	Agriculture	Religion	Government	Education	Total
Central East Oakland	104	4	0	0	2	0	6	116
Coliseum/Airport	0	0	0	0	0	0	0	0
Downtown	0	0	0	0	0	0	0	0
East Oakland Hills	1,056	15	0	0	2	5	1	1,079
Eastlake/Fruitvale	0	0	0	0	0	0	0	0
Glenview/ Redwood Heights	1,552	6	0	0	5	0	4	1,567
North Oakland Hills	488	5	0	0	2	1	1	497
North Oakland/Adams Point	304	0	0	0	0	0	0	304
West Oakland	0	0	0	0	0	0	0	0
Total	**3,504**	**30**	**0**	**0**	**11**	**6**	**12**	**3,563**

(1) Population estimates from Oakland DOT Planning Area Layer.
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(4) Percent of residential buildings exposed multiplied by the Estimated Population.

Detailed Risk Assessment Exposure Vulnerability Results EQ Calaveras M6.86

Sub-Area	Estimated Exposure				
	Estimated Population (1)	% Population Exposed	Total Number of Buildings (2)	Total Building Value (Structure and contents in $) (2)	% of Total Value Exposed
Central East Oakland	99,586	100%	22,119	$20,183,735,157	100%
Coliseum/Airport	3,775	100%	1,269	$5,530,628,942	100%
Downtown	20,470	100%	1,637	$17,897,460,530	100%
East Oakland Hills	32,073	100%	10,296	$5,833,677,350	100%
Eastlake/Fruitvale	99,218	100%	16,048	$17,525,433,126	100%
Glenview/ Redwood Heights	31,915	100%	10,831	$6,085,453,758	100%
North Oakland Hills	23,973	100%	9,617	$6,429,810,236	100%
North Oakland/Adams Point	80,439	100%	16,458	$26,393,885,776	100%
West Oakland	25,993	100%	5,090	$11,690,676,559	100%
TOTAL	**417,442**	100%	**93,365**	**$117,570,761,434**	100%

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(4) Calculated using an Advanced Engineering Building Model (AEBM) analysis in Hazus 4.2 SP03.

Sub-Area	Economic Impact						
	Structure Debris (x 1,000 Tons) (3)	Number of Displaced Households (3)	People Requiring Short-Term Shelter (3)	Value Structure in $ Damaged (4)	Value Contents in $ Damaged (4)	Total Value (Structure and Contents in $) Damaged (4)	% of Total Value Damaged
Central East Oakland	216.38	10	12	$1,315,817,439	$613,463,668	$1,929,281,107	9.6%
Coliseum/Airport	35.77	0	0	$358,505,623	$195,227,147	$553,732,769	10.0%
Downtown	136.49	199	105	$731,130,793	$332,265,025	$1,063,395,818	5.9%
East Oakland Hills	13.70	14	7	$187,267,844	$76,852,471	$264,120,314	4.5%
Eastlake/Fruitvale	106.72	54	46	$699,247,956	$315,520,076	$1,014,768,032	5.8%
Glenview/ Redwood Heights	16.44	1	0	$218,295,391	$86,167,050	$304,462,441	5.0%
North Oakland Hills	9.26	2	1	$183,971,146	$67,566,449	$251,537,595	3.9%
North Oakland/Adams Point	109.29	56	26	$943,608,240	$434,639,182	$1,378,247,422	5.2%
West Oakland	68.33	30	27	$549,798,630	$280,488,007	$830,286,637	7.1%
TOTAL	**712.38**	**367**	**225**	**$5,187,643,061**	**$2,402,189,075**	**7,589,832,136**	6.5%

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(4) Calculated using an Advanced Engineering Building Model (AEBM) analysis in Hazus 4.2 SP03.

Sub-Area	Estimated Exposure				
	Estimated Population (1)	% Population Exposed	Total Number of Buildings (2)	Total Building Value (Structure and contents in $) (2)	% of Total Value Exposed
Central East Oakland	99,586	100%	22,119	$20,183,735,157	100%
Coliseum/Airport	3,775	100%	1,269	$5,530,628,942	100%
Downtown	20,470	100%	1,637	$17,897,460,530	100%
East Oakland Hills	32,073	100%	10,296	$5,833,677,350	100%
Eastlake/Fruitvale	99,218	100%	16,048	$17,525,433,126	100%
Glenview/ Redwood Heights	31,915	100%	10,831	$6,085,453,758	100%
North Oakland Hills	23,973	100%	9,617	$6,429,810,236	100%
North Oakland/Adams Point	80,439	100%	16,458	$26,393,885,776	100%
West Oakland	25,993	100%	5,090	$11,690,676,559	100%
TOTAL	**417,442**	100%	**93,365**	**$117,570,761,434**	100%

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Sub-Area	Economic Impact						
	Structure Debris (x 1,000 Tons) (3)	Number of Displaced Households (3)	People Requiring Short-Term Shelter (3)	Value Structure in $ Damaged (4)	Value Contents in $ Damaged (4)	Total Value (Structure and Contents in $) Damaged (4)	% of Total Value Damaged
Central East Oakland	1,118.29	150	160	$3,663,533,745	$1,686,674,356	$5,350,208,102	26.5%
Coliseum/Airport	163.81	0	0	$632,808,627	$311,739,610	$944,548,237	17.1%
Downtown	667.20	1,460	778	$1,736,322,824	$704,339,301	$2,440,662,124	13.6%
East Oakland Hills	101.69	156	97	$564,551,256	$213,356,191	$777,907,447	13.3%
Eastlake/Fruitvale	572.05	574	477	$2,285,731,302	$974,967,533	$3,260,698,835	18.6%
Glenview/ Redwood Heights	178.92	58	31	$907,314,190	$366,819,498	$1,274,133,688	20.9%
North Oakland Hills	155.61	136	60	$931,518,139	$358,284,251	$1,289,802,390	20.1%
North Oakland/Adams Point	631.14	791	371	$3,142,591,147	$1,385,827,542	$4,528,418,689	17.2%
West Oakland	338.15	315	281	$1,277,741,711	$594,108,974	$1,871,850,685	16.0%
TOTAL	**3,926.86**	**3,640**	**2,254**	**$15,142,112,941**	**$6,596,117,255**	**21,738,230,196**	18.5%

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(4) Calculated using an Advanced Engineering Building Model (AEBM) analysis in Hazus 4.2 SP03.

Sub-Area	Estimated Exposure				
	Estimated Population (1)	% Population Exposed	Total Number of Buildings (2)	Total Building Value (Structure and contents in $) (2)	% of Total Value Exposed
Central East Oakland	99,586	100%	22,119	$20,183,735,157	100%
Coliseum/Airport	3,775	100%	1,269	$5,530,628,942	100%
Downtown	20,470	100%	1,637	$17,897,460,530	100%
East Oakland Hills	32,073	100%	10,296	$5,833,677,350	100%
Eastlake/Fruitvale	99,218	100%	16,048	$17,525,433,126	100%
Glenview/ Redwood Heights	31,915	100%	10,831	$6,085,453,758	100%
North Oakland Hills	23,973	100%	9,617	$6,429,810,236	100%
North Oakland/Adams Point	80,439	100%	16,458	$26,393,885,776	100%
West Oakland	25,993	100%	5,090	$11,690,676,559	100%
TOTAL	**417,442**	100%	**93,365**	**$117,570,761,434**	100%

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.

(4) Calculated using an Advanced Engineering Building Model (AEBM) analysis in Hazus 4.2 SP03.

Sub-Area	Economic Impact						
	Structure Debris (x 1,000 Tons) (3)	Number of Displaced Households (3)	People Requiring Short-Term Shelter (3)	Value Structure in $ Damaged (4)	Value Contents in $ Damaged (4)	Total Value (Structure and Contents in $) Damaged (4)	% of Total Value Damaged
Central East Oakland	76.92	2	2	$668,742,475	$344,869,826	$1,013,612,302	5.0%
Coliseum/Airport	29.85	0	0	$350,864,204	$197,083,676	$547,947,880	9.9%
Downtown	134.07	222	122	$783,921,471	$355,259,254	$1,139,180,725	6.4%
East Oakland Hills	1.65	0	0	$58,032,491	$23,510,405	$81,542,897	1.4%
Eastlake/Fruitvale	62.46	26	20	$518,437,359	$252,513,807	$770,951,165	4.4%
Glenview/ Redwood Heights	4.27	0	0	$101,291,725	$39,611,734	$140,903,459	2.3%
North Oakland Hills	1.64	0	0	$88,371,158	$32,305,267	$120,676,426	1.9%
North Oakland/Adams Point	69.45	29	15	$617,549,538	$285,645,399	$903,194,937	3.4%
West Oakland	84.79	35	31	$621,725,630	$312,987,754	$934,713,385	8.0%
TOTAL	**465.11**	**314**	**190**	**$3,808,936,052**	**$1,843,787,123**	**5,652,723,175**	4.8%

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Sub-Area	Estimated Exposure				
	Estimated Population (1)	% Population Exposed	Total Number of Buildings (2)	Total Building Value (Structure and contents in $) (2)	% of Total Value Exposed
Central East Oakland	99,586	100%	22,119	$20,183,735,157	100%
Coliseum/Airport	3,775	100%	1,269	$5,530,628,942	100%
Downtown	20,470	100%	1,637	$17,897,460,530	100%
East Oakland Hills	32,073	100%	10,296	$5,833,677,350	100%
Eastlake/Fruitvale	99,218	100%	16,048	$17,525,433,126	100%
Glenview/ Redwood Heights	31,915	100%	10,831	$6,085,453,758	100%
North Oakland Hills	23,973	100%	9,617	$6,429,810,236	100%
North Oakland/Adams Point	80,439	100%	16,458	$26,393,885,776	100%
West Oakland	25,993	100%	5,090	$11,690,676,559	100%
TOTAL	**417,442**	100%	**93,365**	**$117,570,761,434**	100%

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(4) Calculated using an Advanced Engineering Building Model (AEBM) analysis in Hazus 4.2 SP03.

Sub-Area	Economic Impact						
	Structure Debris (x 1,000 Tons) (3)	Number of Displaced Households (3)	People Requiring Short-Term Shelter (3)	Value Structure in $ Damaged (4)	Value Contents in $ Damaged (4)	Total Value (Structure and Contents in $) Damaged (4)	% of Total Value Damaged
Central East Oakland	454.38	242	256	$2,166,400,613	$1,002,758,772	$3,169,159,385	15.7%
Coliseum/Airport	112.41	2	3	$529,875,663	$274,018,331	$803,893,995	14.5%
Downtown	487.82	906	497	$1,327,405,097	$607,168,292	$1,934,573,389	10.8%
East Oakland Hills	43.14	108	67	$291,346,683	$119,901,598	$411,248,280	7.0%
Eastlake/Fruitvale	249.48	517	424	$1,198,073,803	$553,665,090	$1,751,738,894	10.0%
Glenview/ Redwood Heights	53.78	78	41	$376,330,161	$147,725,163	$524,055,324	8.6%
North Oakland Hills	30.09	38	17	$349,513,541	$129,657,305	$479,170,847	7.5%
North Oakland/Adams Point	357.93	617	305	$1,850,068,680	$854,896,442	$2,704,965,123	10.2%
West Oakland	240.69	252	223	$1,256,807,270	$600,100,804	$1,856,908,074	15.9%
TOTAL	**2,029.72**	**2,761**	**1,833**	**$9,345,821,513**	**$4,289,891,798**	**13,635,713,311**	11.6%

(1) Population estimates from Oakland DOT Planning Area Layer.
(2) Values based off of 2020 tax assessor data from Alameda County.
(3) Calculated using a Census tract level, general building stock (GBS) analysis in Hazus 4.2 SP03.
(4) Calculated using an Advanced Engineering Building Model (AEBM) analysis in Hazus 4.2 SP03.

E.2 Detailed Risk Assessment Results—Exposure of Critical Facilities

Total Critical Facilities in the Planning Area								
Planning Area	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medical	Safety & Security	Transportation	Total
Central East Oakland	55	2	0	219	1	75	33	385
Coliseum/Airport	81	2	0	129	0	14	35	261
Downtown	154	4	0	123	1	41	28	351
East Oakland Hills	50	1	0	58	0	28	16	153
Eastlake/Fruitvale	47	2	1	212	2	60	46	370
Glenview/ Redwood Heights	7	2	0	64	0	22	23	118
North Oakland Hills	60	3	0	47	0	19	16	145
North Oakland/Adams Point	49	4	2	237	7	46	99	444
West Oakland	71	9	1	190	1	27	80	379
Total	574	29	4	1,279	12	332	376	2,606

Total Critical Facilities in the Combined Dam Failure Inundation Zone								
Planning Area	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medical	Safety & Security	Transportation	Total
Central East Oakland	25	2	0	132	1	23	22	205
Coliseum/Airport	75	2	0	123	0	14	30	244
Downtown	0	0	0	0	0	0	0	0
East Oakland Hills	2	0	0	8	0	1	4	15
Eastlake/Fruitvale	9	2	0	66	1	12	11	101
Glenview/ Redwood Heights	0	0	0	0	0	0	0	0
North Oakland Hills	0	0	0	0	0	0	0	0
North Oakland/Adams Point	6	1	0	50	1	7	7	72
West Oakland	1	0	0	30	0	0	0	31
Total	118	7	0	409	3	57	74	668

Total Critical Facilities in the 1-Percent Annual Chance Flood Zone

Planning Area	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medical	Safety & Security	Transportation	Total
Central East Oakland	0	0	0	2	0	0	8	10
Coliseum/Airport	1	0	0	20	0	3	14	38
Downtown	2	0	0	2	0	1	8	13
East Oakland Hills	0	0	0	0	0	0	0	0
Eastlake/Fruitvale	0	0	0	4	0	0	3	7
Glenview/ Redwood Heights	0	0	0	1	0	0	0	1
North Oakland Hills	0	0	0	0	0	0	0	0
North Oakland/Adams Point	0	0	0	6	0	2	0	8
West Oakland	10	0	0	0	0	0	7	17
Total	**13**	**0**	**0**	**35**	**0**	**6**	**40**	**94**

Total Critical Facilities in the 0.2-Percent Annual Chance Flood Zone

Planning Area	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medical	Safety & Security	Transportation	Total
Central East Oakland	18	1	0	94	0	18	23	154
Coliseum/Airport	51	0	0	82	0	6	28	167
Downtown	18	1	0	8	0	2	8	37
East Oakland Hills	0	0	0	0	0	0	0	0
Eastlake/Fruitvale	3	0	0	40	0	9	11	63
Glenview/ Redwood Heights	0	0	0	5	0	1	0	6
North Oakland Hills	0	0	0	1	0	0	0	1
North Oakland/Adams Point	0	0	1	10	0	3	0	14
West Oakland	24	0	0	73	0	0	15	112
Total	**114**	**2**	**1**	**313**	**0**	**39**	**85**	**554**

Total Critical Facilities in the High and Very High Landslide Susceptibility Zones

Planning Area	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medical	Safety & Security	Transportation	Total
Central East Oakland	7	0	0	4	0	5	4	20
Coliseum/Airport	0	0	0	0	0	0	1	1
Downtown	0	0	0	0	0	0	7	7
East Oakland Hills	18	1	0	13	0	9	7	48
Eastlake/Fruitvale	11	0	0	27	1	15	14	68
Glenview/ Redwood Heights	1	1	0	31	0	11	12	56
North Oakland Hills	45	2	0	20	0	6	6	79
North Oakland/Adams Point	16	1	0	35	0	6	18	76
West Oakland	0	0	0	0	0	0	3	3
Total	98	5	0	130	1	52	72	358

Total Critical Facilities in the 48” Sea-Level-Rise Inundation Zone

Planning Area	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medical	Safety & Security	Transportation	Total
Central East Oakland	0	1	0	12	0	0	6	19
Coliseum/Airport	28	0	0	42	0	4	19	93
Downtown	2	0	0	2	0	1	3	8
East Oakland Hills	0	0	0	0	0	0	0	0
Eastlake/Fruitvale	0	0	0	4	0	0	2	6
Glenview/ Redwood Heights	0	0	0	0	0	0	0	0
North Oakland Hills	0	0	0	0	0	0	0	0
North Oakland/Adams Point	0	0	0	0	0	0	0	0
West Oakland	9	0	0	0	0	0	2	11
Total	39	1	0	60	0	5	32	137

Total Critical Facilities in the 108" Sea-Level-Rise Inundation Zone								
Planning Area	**Communications**	**Energy**	**Food, Water, Shelter**	**Hazardous Material**	**Health & Medical**	**Safety & Security**	**Transportation**	**Total**
Central East Oakland	9	1	0	89	0	2	17	**118**
Coliseum/Airport	81	2	0	129	0	11	29	**252**
Downtown	46	2	0	20	0	3	15	**86**
East Oakland Hills	0	0	0	0	0	0	0	**0**
Eastlake/Fruitvale	11	0	0	41	0	2	9	**63**
Glenview/ Redwood Heights	0	0	0	2	0	0	0	**2**
North Oakland Hills	0	0	0	0	0	0	0	**0**
North Oakland/Adams Point	4	0	1	10	0	3	0	**18**
West Oakland	62	9	0	124	0	6	55	**256**
Total	**213**	**14**	**1**	**415**	**0**	**27**	**125**	**795**

Total Critical Facilities in the Mapped Tsunami Inundation Zone								
Planning Area	**Communications**	**Energy**	**Food, Water, Shelter**	**Hazardous Material**	**Health & Medical**	**Safety & Security**	**Transportation**	**Total**
Central East Oakland	2	1	0	43	0	0	4	**50**
Coliseum/Airport	78	1	0	100	0	10	30	**219**
Downtown	36	2	0	22	0	2	12	**74**
East Oakland Hills	0	0	0	0	0	0	0	**0**
Eastlake/Fruitvale	9	1	0	43	0	2	10	**65**
Glenview/ Redwood Heights	0	0	0	0	0	0	0	**0**
North Oakland Hills	0	0	0	0	0	0	0	**0**
North Oakland/Adams Point	0	0	0	0	0	0	0	**0**
West Oakland	63	9	0	126	0	8	62	**268**
Total	**188**	**14**	**0**	**334**	**0**	**22**	**118**	**676**

Total Critical Facilities in the High and Very High Wildfire Risk Zones								
Planning Area	Communications	Energy	Food, Water, Shelter	Hazardous Material	Health & Medical	Safety & Security	Transportation	Total
Central East Oakland	2	0	0	0	0	1	1	4
Coliseum/Airport	0	0	0	0	0	0	0	0
Downtown	0	0	0	0	0	0	0	0
East Oakland Hills	31	1	0	38	0	21	13	104
Eastlake/Fruitvale	0	0	0	0	0	0	0	0
Glenview/ Redwood Heights	6	1	0	14	0	6	9	36
North Oakland Hills	20	0	0	36	0	10	16	82
North Oakland/Adams Point	0	0	0	2	0	1	7	10
West Oakland	0	0	0	0	0	0	0	0
Total	59	2	0	90	0	39	46	236

E.3 Detailed Risk Assessment Results—Risk Ranking

RISK RANKING-Combined Dam Failure

	Probability		Impact on People			
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor
Central East Oakland	Medium	2	38.41%	High	3	9
Coliseum/Airport	Medium	2	99.37%	High	3	9
Downtown	Medium	2	0.00%	None	0	0
East Oakland Hills	Medium	2	3.39%	Low	1	3
Eastlake/Fruitvale	Medium	2	9.23%	Low	1	3
Glenview/ Redwood Heights	Medium	2	0.00%	None	0	0
North Oakland Hills	Medium	2	0.00%	None	0	0
North Oakland/Adams Point	Medium	2	16.52%	Medium	2	6
West Oakland	Medium	2	1.54%	Low	1	3
Total	Medium	2	15.80%	Medium	2	6

RISK RANKING-Combined Dam Failure

	Impact on Property				Impact on Economy					
	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
Central East Oakland	47.82%	High	3	6	21.06%	High	3	3	**36**	**High**
Coliseum/Airport	84.65%	High	3	6	31.80%	High	3	3	**36**	**High**
Downtown	0.00%	None	0	0	0.00%	None	0	0	**0**	**Low**
East Oakland Hills	3.29%	Low	1	2	2.16%	Low	1	1	**12**	**Low**
Eastlake/Fruitvale	13.24%	Medium	2	4	0.34%	Low	1	1	**16**	**Medium**
Glenview/ Redwood Heights	0.61%	Low	1	2	0.30%	Low	1	1	**6**	**Low**
North Oakland Hills	0.00%	None	0	0	0.00%	None	0	0	**0**	**Low**
North Oakland/Adams Point	11.95%	Medium	2	4	0.35%	Low	1	1	**22**	**Medium**
West Oakland	1.73%	Low	1	2	0.00%	None	0	0	**10**	**Low**
Total	17.21%	Medium	2	4	5.36%	Medium	2	2	**24**	**Medium**

RISK RANKING-100-yr Flood	Probability		Impact on People			
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor
Central East Oakland	High	3	0.35%	Low	1	3
Coliseum/Airport	High	3	0.21%	Low	1	3
Downtown	High	3	0.23%	Low	1	3
East Oakland Hills	High	3	0.10%	Low	1	3
Eastlake/Fruitvale	High	3	0.34%	Low	1	3
Glenview/ Redwood Heights	High	3	0.16%	Low	1	3
North Oakland Hills	High	3	0.57%	Low	1	3
North Oakland/Adams Point	High	3	0.35%	Low	1	3
West Oakland	High	3	0.00%	None	0	0
Total	High	3	0.30%	Low	1	3

RISK RANKING-100-yr Flood										
	Impact on Property				Impact on Economy					
	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
Central East Oakland	0.28%	Low	1	2	0.00%	None	0	0	15	Low
Coliseum/Airport	12.44%	Medium	2	4	0.54%	Low	1	1	24	Medium
Downtown	0.70%	Low	1	2	0.03%	Low	1	1	18	Medium
East Oakland Hills	0.31%	Low	1	2	0.00%	None	0	0	15	Low
Eastlake/Fruitvale	0.16%	Low	1	2	0.00%	None	0	0	15	Low
Glenview/ Redwood Heights	0.12%	Low	1	2	0.00%	None	0	0	15	Low
North Oakland Hills	0.29%	Low	1	2	0.01%	None	0	0	15	Low
North Oakland/Adams Point	0.63%	Low	1	2	0.01%	None	0	0	15	Low
West Oakland	0.01%	None	0	0	0.00%	None	0	0	0	Low
Total	0.94%	Low	1	2	0.03%	Low	1	1	18	Medium

RISK RANKING-500-yr Flood						
	Probability		Impact on People			
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor
Central East Oakland	Medium	2	10.78%	Medium	2	6
Coliseum/Airport	Medium	2	17.76%	Medium	2	6
Downtown	Medium	2	0.69%	Low	1	3
East Oakland Hills	Medium	2	0.11%	Low	1	3
Eastlake/Fruitvale	Medium	2	9.01%	Low	1	3
Glenview/ Redwood Heights	Medium	2	0.35%	Low	1	3
North Oakland Hills	Medium	2	0.59%	Low	1	3
North Oakland/Adams Point	Medium	2	2.49%	Low	1	3
West Oakland	Medium	2	3.29%	Low	1	3
Total	Medium	2	5.66%	Low	1	3

RISK RANKING-500-yr Flood	Impact on Property				Impact on Economy					
	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
Central East Oakland	25.18%	High	3	6	2.96%	Low	1	1	**26**	**Medium**
Coliseum/Airport	50.79%	High	3	6	3.70%	Low	1	1	**26**	**Medium**
Downtown	1.98%	Low	1	2	0.04%	Low	1	1	**12**	**Low**
East Oakland Hills	0.39%	Low	1	2	0.01%	Low	1	1	**12**	**Low**
Eastlake/Fruitvale	12.21%	Medium	2	4	0.78%	Low	1	1	**16**	**Medium**
Glenview/ Redwood Heights	2.45%	Low	1	2	0.96%	Low	1	1	**12**	**Low**
North Oakland Hills	0.33%	Low	1	2	0.01%	Low	1	1	**12**	**Low**
North Oakland/Adams Point	2.00%	Low	1	2	0.05%	Low	1	1	**12**	**Low**
West Oakland	19.19%	Medium	2	4	0.38%	Low	1	1	**16**	**Medium**
Total	11.35%	Medium	2	4	0.90%	Low	1	1	**16**	**Medium**

Susceptibility (Categories Very High & High)						
	Probability		Impact on People			
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor
Central East Oakland	High	3	12.51%	Medium	2	6
Coliseum/Airport	High	3	0.00%	None	0	0
Downtown	High	3	3.01%	Low	1	3
East Oakland Hills	High	3	34.43%	High	3	9
Eastlake/Fruitvale	High	3	38.98%	High	3	9
Glenview/ Redwood Heights	High	3	59.05%	High	3	9
North Oakland Hills	High	3	55.22%	High	3	9
North Oakland/Adams Point	High	3	22.97%	Medium	2	6
West Oakland	High	3	0.00%	None	0	0
Total	High	3	27.15%	High	3	9

Susceptibility (Categories Very High & High)	Impact on Property				Impact on Economy					
	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
Central East Oakland	5.16%	Low	1	2	1.29%	Low	1	1	**27**	**Medium**
Coliseum/Airport	0.00%	None	0	0	0.00%	None	0	0	**0**	**Low**
Downtown	1.50%	Low	1	2	0.38%	Low	1	1	**18**	**Medium**
East Oakland Hills	33.05%	High	3	6	8.26%	Medium	2	2	**51**	**High**
Eastlake/Fruitvale	24.37%	Medium	2	4	6.09%	Medium	2	2	**45**	**High**
Glenview/ Redwood Heights	50.35%	High	3	6	12.59%	High	3	3	**54**	**High**
North Oakland Hills	52.32%	High	3	6	13.08%	High	3	3	**54**	**High**
North Oakland/Adams Point	22.92%	Medium	2	4	5.73%	Medium	2	2	**36**	**High**
West Oakland	0.00%	None	0	0	0.00%	None	0	0	**0**	**Low**
Total	17.00%	Medium	2	4	4.25%	Low	1	1	**42**	**High**

RISK RANKING-Draft Tsunami Hazard Area						
	Probability		Impact on People			
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor
Central East Oakland	Low	1	0.04%	Low	1	3
Coliseum/Airport	Low	1	32.98%	High	3	9
Downtown	Low	1	7.41%	Low	1	3
East Oakland Hills	Low	1	0.00%	None	0	0
Eastlake/Fruitvale	Low	1	0.92%	Low	1	3
Glenview/ Redwood Heights	Low	1	0.00%	None	0	0
North Oakland Hills	Low	1	0.00%	None	0	0
North Oakland/Adams Point	Low	1	0.00%	None	0	0
West Oakland	Low	1	32.07%	High	3	9
Total	Low	1	2.89%	Low	1	3

RISK RANKING-Draft Tsunami Hazard Area	Impact on Property				Impact on Economy					
	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
Central East Oakland	6.08%	Low	1	2	0.00%	None	0	0	**5**	**Low**
Coliseum/Airport	72.00%	High	3	6	0.82%	Low	1	1	**16**	**Medium**
Downtown	11.43%	Medium	2	4	26.09%	High	3	3	**10**	**Low**
East Oakland Hills	0.00%	None	0	0	0.00%	None	0	0	**0**	**Low**
Eastlake/Fruitvale	14.73%	Medium	2	4	3.99%	Low	1	1	**8**	**Low**
Glenview/ Redwood Heights	0.00%	None	0	0	0.00%	None	0	0	**0**	**Low**
North Oakland Hills	0.00%	None	0	0	0.00%	None	0	0	**0**	**Low**
North Oakland/Adams Point	0.00%	None	0	0	0.00%	None	0	0	**0**	**Low**
West Oakland	54.12%	High	3	6	27.58%	High	3	3	**18**	**Medium**
Total	13.75%	Medium	2	4	7.35%	Medium	2	2	**9**	**Low**

RISK RANKING - Sea Level Rise 48" (3)							
	Probability		Impact on People				
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor
Central East Oakland	High	3	0.04%	Low	1	3
Coliseum/Airport	High	3	7.82%	Low	1	3
Downtown	High	3	0.46%	Low	1	3
East Oakland Hills	High	3	0.00%	None	0	0
Eastlake/Fruitvale	High	3	0.00%	None	0	0
Glenview/ Redwood Heights	High	3	0.00%	None	0	0
North Oakland Hills	High	3	0.00%	None	0	0
North Oakland/Adams Point	High	3	0.00%	None	0	0
West Oakland	High	3	0.00%	None	0	0
Total	High	3	0.10%	Low	1	3

RISK RANKING - Sea Level Rise 48" (3)	Impact on Property				Impact on Economy					
	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
Central East Oakland	0.98%	Low	1	2	0.10%	Low	1	1	18	Medium
Coliseum/Airport	22.25%	Medium	2	4	2.23%	Low	1	1	24	Medium
Downtown	0.91%	Low	1	2	0.09%	Low	1	1	18	Medium
East Oakland Hills	0.00%	None	0	0	0.00%	None	0	0	0	Low
Eastlake/Fruitvale	0.11%	Low	1	2	0.01%	Low	1	1	9	Low
Glenview/ Redwood Heights	0.00%	None	0	0	0.00%	None	0	0	0	Low
North Oakland Hills	0.00%	None	0	0	0.00%	None	0	0	0	Low
North Oakland/Adams Point	0.00%	None	0	0	0.00%	None	0	0	0	Low
West Oakland	0.10%	Low	1	2	0.01%	Low	1	1	9	Low
Total	1.38%	Low	1	2	0.14%	Low	1	1	18	Medium

RISK RANKING - Sea Level Rise 108" (3)							
	Probability		Impact on People				
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor
Central East Oakland	High	3	2.93%	Low	1	3
Coliseum/Airport	High	3	50.53%	High	3	9
Downtown	High	3	3.94%	Low	1	3
East Oakland Hills	High	3	0.00%	None	0	0
Eastlake/Fruitvale	High	3	0.42%	Low	1	3
Glenview/ Redwood Heights	High	3	0.00%	None	0	0
North Oakland Hills	High	3	0.00%	None	0	0
North Oakland/Adams Point	High	3	0.12%	Low	1	3
West Oakland	High	3	17.83%	Medium	2	6
Total	High	3	2.58%	Low	1	3

RISK RANKING - Sea Level Rise 108" (3)

	Impact on Property				Impact on Economy					
	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
Central East Oakland	16.36%	Medium	2	4	1.64%	Low	1	1	24	Medium
Coliseum/Airport	92.52%	High	3	6	9.25%	Medium	2	2	51	High
Downtown	9.23%	Low	1	2	0.92%	Low	1	1	18	Medium
East Oakland Hills	0.00%	None	0	0	0.00%	None	0	0	0	Low
Eastlake/Fruitvale	9.22%	Low	1	2	0.92%	Low	1	1	18	Medium
Glenview/ Redwood Heights	0.17%	Low	1	2	0.02%	Low	1	1	9	Low
North Oakland Hills	0.00%	None	0	0	0.00%	None	0	0	0	Low
North Oakland/Adams Point	2.60%	Low	1	2	0.26%	Low	1	1	18	Medium
West Oakland	44.97%	High	3	6	4.50%	Low	1	1	39	High
Total	15.00%	Medium	2	4	1.50%	Low	1	1	24	Medium

RISK RANKING-Wildfire (Very High and High Severity)						
	Probability		Impact on People			
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor
Central East Oakland	High	3	0.02%	Low	1	3
Coliseum/Airport	High	3	0.00%	None	0	0
Downtown	High	3	0.00%	None	0	0
East Oakland Hills	High	3	71.92%	High	3	9
Eastlake/Fruitvale	High	3	0.00%	None	0	0
Glenview/ Redwood Heights	High	3	33.15%	High	3	9
North Oakland Hills	High	3	82.27%	High	3	9
North Oakland/Adams Point	High	3	2.84%	Low	1	3
West Oakland	High	3	0.00%	None	0	0
Total	High	3	13.34%	Medium	2	6

RISK RANKING-Wildfire (Very High and High Severity)	Impact on Property				Impact on Economy					
	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
Central East Oakland	2.52%	Low	1	2	0.63%	Low	1	1	18	Medium
Coliseum/Airport	0.00%	None	0	0	0.00%	None	0	0	0	Low
Downtown	0.00%	None	0	0	0.00%	None	0	0	0	Low
East Oakland Hills	72.47%	High	3	6	18.12%	High	3	3	54	High
Eastlake/Fruitvale	0.00%	None	0	0	0.00%	None	0	0	0	Low
Glenview/ Redwood Heights	27.87%	High	3	6	6.97%	Medium	2	2	51	High
North Oakland Hills	79.25%	High	3	6	19.81%	High	3	3	54	High
North Oakland/Adams Point	1.05%	Low	1	2	0.26%	Low	1	1	18	Medium
West Oakland	0.00%	None	0	0	0.00%	None	0	0	0	Low
Total	10.04%	Medium	2	4	2.51%	Low	1	1	33	Medium

RISK RANKING-Earthquake						
	Probability		Impact on People			
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor
Central East Oakland	Medium	2	100.00%	High	3	9
Coliseum/Airport	Medium	2	100.00%	High	3	9
Downtown	Medium	2	100.00%	High	3	9
East Oakland Hills	Medium	2	100.00%	High	3	9
Eastlake/Fruitvale	Medium	2	100.00%	High	3	9
Glenview/ Redwood Heights	Medium	2	100.00%	High	3	9
North Oakland Hills	Medium	2	100.00%	High	3	9
North Oakland/Adams Point	Medium	2	100.00%	High	3	9
West Oakland	Medium	2	100.00%	High	3	9
TOTAL	Medium	2	100.00%	High	3	9

RISK RANKING-Earthquake										
	Impact on Property				Impact on Economy					
	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
Central East Oakland	100.00%	High	3	6	9.56%	Medium	2	2	34	Medium
Coliseum/Airport	100.00%	High	3	6	10.01%	High	3	3	36	High
Downtown	100.00%	High	3	6	5.94%	Medium	2	2	34	Medium
East Oakland Hills	100.00%	High	3	6	4.53%	Low	1	1	32	Medium
Eastlake/Fruitvale	100.00%	High	3	6	5.79%	Medium	2	2	34	Medium
Glenview/ Redwood Heights	100.00%	High	3	6	5.00%	Medium	2	2	34	Medium
North Oakland Hills	100.00%	High	3	6	3.91%	Low	1	1	32	Medium
North Oakland/Adams Point	100.00%	High	3	6	5.22%	Medium	2	2	34	Medium
West Oakland	100.00%	High	3	6	7.10%	Medium	2	2	34	Medium
TOTAL	100.00%	High	3	6	6.46%	Medium	2	2	34	Medium

RISK RANKING-Earthquake						
	Probability		Impact on People			
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor
Central East Oakland	Medium	2	100.00%	High	3	9
Coliseum/Airport	Medium	2	100.00%	High	3	9
Downtown	Medium	2	100.00%	High	3	9
East Oakland Hills	Medium	2	100.00%	High	3	9
Eastlake/Fruitvale	Medium	2	100.00%	High	3	9
Glenview/ Redwood Heights	Medium	2	100.00%	High	3	9
North Oakland Hills	Medium	2	100.00%	High	3	9
North Oakland/Adams Point	Medium	2	100.00%	High	3	9
West Oakland	Medium	2	100.00%	High	3	9
TOTAL	Medium	2	100.00%	High	3	9

RISK RANKING-Earthquake										
	Impact on Property				Impact on Economy					
	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
Central East Oakland	100.00%	High	3	6	26.51%	High	3	3	**36**	**High**
Coliseum/Airport	100.00%	High	3	6	17.08%	High	3	3	**36**	**High**
Downtown	100.00%	High	3	6	13.64%	High	3	3	**36**	**High**
East Oakland Hills	100.00%	High	3	6	13.33%	High	3	3	**36**	**High**
Eastlake/Fruitvale	100.00%	High	3	6	18.61%	High	3	3	**36**	**High**
Glenview/ Redwood Heights	100.00%	High	3	6	20.94%	High	3	3	**36**	**High**
North Oakland Hills	100.00%	High	3	6	20.06%	High	3	3	**36**	**High**
North Oakland/Adams Point	100.00%	High	3	6	17.16%	High	3	3	**36**	**High**
West Oakland	100.00%	High	3	6	16.01%	High	3	3	**36**	**High**
TOTAL	100.00%	High	3	6	18.49%	High	3	3	**36**	**High**

RISK RANKING-Earthquake						
	Probability		Impact on People			
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor
Central East Oakland	Medium	2	100.00%	High	3	9
Coliseum/Airport	Medium	2	100.00%	High	3	9
Downtown	Medium	2	100.00%	High	3	9
East Oakland Hills	Medium	2	100.00%	High	3	9
Eastlake/Fruitvale	Medium	2	100.00%	High	3	9
Glenview/ Redwood Heights	Medium	2	100.00%	High	3	9
North Oakland Hills	Medium	2	100.00%	High	3	9
North Oakland/Adams Point	Medium	2	100.00%	High	3	9
West Oakland	Medium	2	100.00%	High	3	9
TOTAL	Medium	2	100.00%	High	3	9

RISK RANKING-Earthquake	Impact on Property				Impact on Economy					
	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
Central East Oakland	100.00%	High	3	6	5.02%	Medium	2	2	34	Medium
Coliseum/Airport	100.00%	High	3	6	9.91%	Medium	2	2	34	Medium
Downtown	100.00%	High	3	6	6.37%	Medium	2	2	34	Medium
East Oakland Hills	100.00%	High	3	6	1.40%	Low	1	1	32	Medium
Eastlake/Fruitvale	100.00%	High	3	6	4.40%	Low	1	1	32	Medium
Glenview/ Redwood Heights	100.00%	High	3	6	2.32%	Low	1	1	32	Medium
North Oakland Hills	100.00%	High	3	6	1.88%	Low	1	1	32	Medium
North Oakland/Adams Point	100.00%	High	3	6	3.42%	Low	1	1	32	Medium
West Oakland	100.00%	High	3	6	8.00%	Medium	2	2	34	Medium
TOTAL	100.00%	High	3	6	4.81%	Low	1	1	32	Medium

RISK RANKING-Earthquake						
	Probability		Impact on People			
	Probability (High, Medium, Low, None)	Probability Factor (3,2,1,0)	% Population Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor
Central East Oakland	Medium	2	100.00%	High	3	9
Coliseum/Airport	Medium	2	100.00%	High	3	9
Downtown	Medium	2	100.00%	High	3	9
East Oakland Hills	Medium	2	100.00%	High	3	9
Eastlake/Fruitvale	Medium	2	100.00%	High	3	9
Glenview/ Redwood Heights	Medium	2	100.00%	High	3	9
North Oakland Hills	Medium	2	100.00%	High	3	9
North Oakland/Adams Point	Medium	2	100.00%	High	3	9
West Oakland	Medium	2	100.00%	High	3	9
TOTAL	Medium	2	100.00%	High	3	9

RISK RANKING-Earthquake										
	Impact on Property				Impact on Economy					
	% of Total Value Exposed	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	% of Total Value Damaged	Impact (High, Medium, Low, None)	Impact Factor	Weighted Impact Factor	Risk Ranking Score	Hazard Risk Rating
Central East Oakland	100.00%	High	3	6	15.70%	High	3	3	36	High
Coliseum/Airport	100.00%	High	3	6	14.54%	High	3	3	36	High
Downtown	100.00%	High	3	6	10.81%	High	3	3	36	High
East Oakland Hills	100.00%	High	3	6	7.05%	Medium	2	2	34	Medium
Eastlake/Fruitvale	100.00%	High	3	6	10.00%	Medium	2	2	34	Medium
Glenview/ Redwood Heights	100.00%	High	3	6	8.61%	Medium	2	2	34	Medium
North Oakland Hills	100.00%	High	3	6	7.45%	Medium	2	2	34	Medium
North Oakland/Adams Point	100.00%	High	3	6	10.25%	High	3	3	36	High
West Oakland	100.00%	High	3	6	15.88%	High	3	3	36	High
TOTAL	100.00%	High	3	6	11.60%	High	3	3	36	High

Sub-Area	Dam Failure (1)		Drought (2)		Earthquake (3)	
	Risk Ranking Score	Category	Risk Ranking Score	Category	Risk Ranking Score	Category
Central East Oakland	36	High	6	Low	36	High
Coliseum/Airport	36	High	6	Low	36	High
Downtown	0	Low	6	Low	36	High
East Oakland Hills	12	Low	6	Low	36	High
Eastlake/Fruitvale	16	Medium	6	Low	36	High
Glenview/ Redwood Heights	6	Low	6	Low	36	High
North Oakland Hills	0	Low	6	Low	36	High
North Oakland/Adams Point	22	Medium	6	Low	36	High
West Oakland	10	Low	6	Low	36	High

(1) Combined dam failure results were utilized for risk ranking.
(2) Drought is assessed more qualitatively than other hazards. Generally, drought does not cause injury or death to people or result in property damage. Assumptions for risk ranking include high probability, no impact on people, low impact on property and medium impact on economy.
(3) Haywired M7.05 results were utilized for risk ranking.
(4) Very High and high severity zones results were utilized for risk ranking.
(5) 100-year or 1 percent annual chance flood hazard results were utilized for risk ranking.
(6) Very High and High susceptibility results were utilized for risk ranking.
(7) Sea level rise of 108" results were utilized for risk ranking.
(8) Severe weather is assessed more qualitatively than other hazards. Assumptions for risk ranking include high probability, medium impact on people, low impact on property and low impact on economy.
(9) Tsunami hazard area results were utilized for risk ranking.

Sub-Area	Fire (4)		Flood (5)		Landslide (6)	
	Risk Ranking Score	Category	Risk Ranking Score	Category	Risk Ranking Score	Category
Central East Oakland	18	Medium	15	Low	27	Medium
Coliseum/Airport	0	Low	24	Medium	0	Low
Downtown	0	Low	18	Medium	18	Medium
East Oakland Hills	54	High	15	Low	51	High
Eastlake/Fruitvale	0	Low	15	Low	45	High
Glenview/ Redwood Heights	51	High	15	Low	54	High
North Oakland Hills	54	High	15	Low	54	High
North Oakland/Adams Point	18	Medium	15	Low	36	High
West Oakland	0	Low	0	Low	0	Low

(1) Combined dam failure results were utilized for risk ranking.

(2) Drought is assessed more qualitatively than other hazards. Generally, drought does not cause injury or death to people or result in property damage. Assumptions for risk ranking include high probability, no impact on people, low impact on property and medium impact on economy.

(3) Haywired M7.05 results were utilized for risk ranking.

(4) Very High and high severity zones results were utilized for risk ranking.

(5) 100-year or 1 percent annual chance flood hazard results were utilized for risk ranking.

(6) Very High and High susceptibility results were utilized for risk ranking.

(7) Sea level rise of 108" results were utilized for risk ranking.

(8) Severe weather is assessed more qualitatively than other hazards. Assumptions for risk ranking include high probability, medium impact on people, low impact on property and low impact on economy.

(9) Tsunami hazard area results were utilized for risk ranking.

Sub-Area	Sea Level Rise (7)		Severe Weather (8)		Tsunami (9)	
	Risk Ranking Score	Category	Risk Ranking Score	Category	Risk Ranking Score	Category
Central East Oakland	24	Medium	30	Medium	5	Low
Coliseum/Airport	51	High	30	Medium	16	Medium
Downtown	18	Medium	30	Medium	10	Low
East Oakland Hills	0	Low	30	Medium	0	Low
Eastlake/Fruitvale	18	Medium	30	Medium	8	Low
Glenview/ Redwood Heights	9	Low	30	Medium	0	Low
North Oakland Hills	0	Low	30	Medium	0	Low
North Oakland/Adams Point	18	Medium	30	Medium	0	Low
West Oakland	39	High	30	Medium	18	Medium

(1) Combined dam failure results were utilized for risk ranking.
(2) Drought is assessed more qualitatively than other hazards. Generally, drought does not cause injury or death to people or result in property damage. Assumptions for risk ranking include high probability, no impact on people, low impact on property and medium impact on economy.
(3) Haywired M7.05 results were utilized for risk ranking.
(4) Very High and high severity zones results were utilized for risk ranking.
(5) 100-year or 1 percent annual chance flood hazard results were utilized for risk ranking.
(6) Very High and High susceptibility results were utilized for risk ranking.
(7) Sea level rise of 108" results were utilized for risk ranking.
(8) Severe weather is assessed more qualitatively than other hazards. Assumptions for risk ranking include high probability, medium impact on people, low impact on property and low impact on economy.
(9) Tsunami hazard area results were utilized for risk ranking.

City of Oakland 2021 – 2026 Hazard Mitigation Plan

Appendix F. Status of Previous Plan Actions

F. STATUS OF PREVIOUS PLAN ACTIONS

Status of Actions Identified in the 2016-2021 City of Oakland Local Hazard Mitigation Plan				
Action Item	**Completed**	**Carry Over to 2021 Update**	**Removed or No Longer Feasible**	**2021 Update Action #**
Safer Housing for Oakland: Soft Story Apartment Retrofit Program.	✓	✓		O-1
Comment: *The City has adopted a "soft-story" retrofit ordinance as part of this action. This program is still ongoing and is managed by DHCD. Building Permits are processed by PBD. This project will be listed as completed, and a reframed version of this action will be carried over to the 2021 plan update.*				
Earthquake Safe Homes Program		✓		O-2
Comment: *This program is still ongoing and is managed by DHCD. Building permits are processed by PBD. This action will be carried over to the 2021 plan update.*				
Green Infrastructure Planning Program		✓		O-3
Comment: *The terminology for this action should be updated to "Green Stormwater Infrastructure Planning" to be consistent with state and national terminology for this practice. It also distinguishes between stormwater and other green infrastructure planning (I.e. solar, wind, etc.) The City completed several key green stormwater infrastructure planning documents, however, the endeavor to plan for green stormwater infrastructure opportunities throughout the city is ongoing and is managed by the OPW Watershed and Stormwater Management Division. This action will be carried over to the 2021 plan update*				
"Detain the Rain" – Stormwater detention on private property			✓	
Comment: *Participation in decentralized stormwater detention by property owners can be a critical component of infrastructure protection. The City does not currently have an active program to encourage stormwater detention on private property and is not carrying this action over to the current update, but it is still an important action that will likely be pursued in the future.*				
City of Oakland, Stormwater infrastructure improvements		✓		O-4
Comment: *This is an ongoing action and is managed by the OPW Watershed and Stormwater Management (WSM) Division. The WSM is currently initiating development of a new Storm Drainage Master Plan for the City. This action will be reframed and carried over to the 2021 plan update to better align with the new stormwater master plan update.*				
Review and collaborate with the San Francisco Bay Conservation and Development Commission on Adapting to Rising Tides mitigation strategies	✓			
Comment: *This action is being shown as completed via the completion of the City's "Sea-level rise Road Map" in the fall of 2017. A new derivation of this action associated with the implementation of the Road Map will be added to the 2021 plan update*				
Wildfire Prevention Assessment District re-authorization			✓	
Comment: *This action is being removed as the Legislation was reintroduced in 2017 but did not pass with the required votes. The Wildfire Prevention Assessment District was dissolved in 2017.*				
Defensible Space Vegetation Program to manage wildfire hazards		✓		O-5
Comment: *This is an ongoing action. The vegetation management plan is currently being updated. The 45-day public comment period closed in February of 2021. This action will be reframed and carried over to the 2021 plan update.*				

Status of Actions Identified in the 2016-2021 City of Oakland Local Hazard Mitigation Plan				
Action Item	**Completed**	**Carry Over to 2021 Update**	**Removed or No Longer Feasible**	**2021 Update Action #**
Maintain Reliable water supply during fires	✓			
Comment: *The water supplies are reliable for most areas of the City. The Oakland Fire Department participates in annual meetings with EBMUD and other local jurisdictions. This action will be shown as complete.*				
Continuity of Operations Emergency Planning		✓		O-6
Comment: *Several Continuity of Operations Plans were updated in 2017, but never published. Additionally, 5 departments never had a plan developed. We are currently working with staff to develop & updated Continuity of Operations Plans. This action will be carried over to the 2021 plan update*				
Emergency Notification Systems	✓			
Comment: *Sirens were updated in 2017 – currently use the Everbridge program for emergency notification. This program has wireless emergency alerting capabilities. This action will be considered complete as of this plan update.*				
Implement Energy Assurance Plan		✓		O-7
Comment: *No action was taken on this action item during the performance period. This action is still considered to be an important strategy for the City and will be carried over to the 2021 plan update.*				
Assessment and retrofits of critical facilities & infrastructure		✓		O-8
Comment: *This action will be carried over to the 2021 plan update*				
Oakland International Airport, Old Earhart Road Floodwall Improvements			✓	
Comment: *This action will be removed as the core planning team deemed it to be no longer feasible.*				
Oakland International Airport Perimeter Dike			✓	
Comment: *This action will be removed as the core planning team deemed it to be no longer feasible.*				
Maritime Terminal Study on Liquefaction Potential		✓		O-13
Comment: *This action will be carried over to the 2021 plan update*				
Middle Harbor Shoreline Park Dike repair		✓		O-14
Comment: *This action will be carried over to the 2021 plan update*				
Maritime Intelligent Transportation System		✓		O-15
Comment: *This action will be carried over to the 2021 plan update*				
Maritime Area Seismic Monitors		✓		O-16
Comment: *This action will be carried over to the 2021 plan update*				
Sea-level rise Vulnerability and Assessment Improvement Plan	✓			
Comment: *This action is being shown as completed via the completion of the City's "Sea-level rise Road Map" in the fall of 2017. A new derivation of this action associated with the implementation of the Road Map will be added to the 2021 plan update*				

Appendix G. City of Oakland Adoption Resolution

G. City of Oakland Adoption Resolution

TO BE PROVIDED WITH FINAL DRAFT

City of Oakland 2021 – 2026 Hazard Mitigation Plan

Appendix H. Progress Report Template

H. PROGRESS REPORT TEMPLATE

Reporting Period: *(Insert reporting period)*

Background: The City of Oakland developed a hazard mitigation plan to reduce risk from hazards by identifying resources, information, and strategies for risk reduction. The federal Disaster Mitigation Act requires state and local governments to develop hazard mitigation plans as a condition for federal disaster grant assistance. To prepare the plan, the City organized resources, assessed risks from hazards, developed planning goals and objectives, reviewed mitigation alternatives, and developed an action plan to address probable impacts from natural hazards. By completing this process, the City maintained compliance with the Disaster Mitigation Act, achieving eligibility for mitigation grant funding opportunities afforded under the Robert T. Stafford Act. The plan can be viewed on-line at:

Insert web link

Summary Overview of the Plan's Progress: The performance period for the hazard mitigation plan became effective on __[date]__, with the final approval of the plan by FEMA. The performance period for this plan will be 5 years, with an anticipated update to the plan to occur before __[date]__. As of this reporting period, the performance period for this plan is considered to be __% complete. The hazard mitigation plan has targeted 21 hazard mitigation actions to be pursued during the 5-year performance period. As of the reporting period, the following overall progress can be reported:

- __ out of __ actions (__%) reported ongoing action toward completion.
- __ out of __ actions (__%) were reported as being complete.
- __ out of __ actions (___%) reported no action taken.

Purpose: The purpose of this report is to provide an annual update on the implementation of the action plan identified in the hazard mitigation plan. The objective is to ensure that there is a continuing and responsive planning process that will keep the hazard mitigation plan dynamic and responsive to the needs and capabilities of the City of *Oakland*. This report discusses the following:

- Hazard events that have occurred within the last year.
- Changes in risk exposure within the planning area.
- Mitigation success stories.
- Review of the action plan.
- Changes in capabilities that could impact plan implementation.
- Recommendations for changes/enhancement.

The Plan Maintenance Oversight Committee: It was determined through the plan's development process that a designated committee, made up of City staff, would oversee maintenance of the plan. At a minimum, the plan maintenance oversight committee is to provide technical review and oversight on the development of the annual progress report. The committee reviewed and approved this progress report at its annual meeting held on __[date]__. For this reporting period, the plan maintenance oversight committee membership is as indicated in Table 1.

Table 1. Plan Maintenance Oversight Committee Members

Name	Title	Department/Agency

Hazard Events within the Planning Area: During the planning period, there were __ hazard events in the planning area that had a measurable impact on people or property. A summary of these events is as follows:

- ______________________________
- ______________________________

Changes in Risk Exposure in the Planning Area: *(Insert brief overview of any natural hazard event in the planning area that changed the probability of occurrence or ranking of risk for the hazards addressed in the hazard mitigation plan)*

Mitigation Success Stories: *(Insert brief overview of mitigation accomplishments during the reporting period)*

Review of the Action Plan: Table 2 reviews the action plan, reporting the status of each action. Reviewers of this report should refer to the hazard mitigation plan for more detailed descriptions of each action and the prioritization process.

Table 2. Action Plan Matrix

Action Taken? (Yes or No)	Time Line	Priority	Status[a]	Status (X, O,✓)[b]
Action #: Action Title—Action Description				
Action #: Action Title—Action Description				
Action #: Action Title—Action Description				
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Action #: Action Title—Action Description				
Action #: Action Title—Action Description				

Action Taken? (Yes or No)	Time Line	Priority	Status[a]	Status (X, O,✓)[b]
Action #: Action Title—Action Description				

a. Items addressed to determine action status:
Was any element of the action carried out during the reporting period?
If no action was completed, why?
Is the timeline for implementation for the action still appropriate?
If the action was completed, does it need to be changed or removed from the action plan?

b. Completion status legend:
✓= Project Completed
O = Action ongoing toward completion
X = No progress at this time

New Actions to Include in the Plan: *(List any new actions added to the action plan; see Chapter 21 of the hazard mitigation plan for description of the information to be provided).*

Table 3. New Actions to Add to Action Plan

Lead Agency	Support Agency	Estimated Cost	Sources of Funding	Timeline	Implementation Priority	Grant Pursuit Priority
Action #: Action Title—Action Description *Hazards Mitigated:* ______						
______	______	______	______	______	______	______
Action #: Action Title—Action Description *Hazards Mitigated:* ______						
______	______	______	______	______	______	______
Action #: Action Title—Action Description *Hazards Mitigated:* ______						
______	______	______	______	______	______	______
Action #: Action Title—Action Description *Hazards Mitigated:* ______						
______	______	______	______	______	______	______
Action #: Action Title—Action Description *Hazards Mitigated:* ______						
______	______	______	______	______	______	______

Changes That May Impact Implementation of the Plan: *(Insert brief overview of any significant changes in the planning area that would have a profound impact on the implementation of the plan. Specify any changes in technical, regulatory and financial capabilities identified during the plan's development)*

Recommendations for Changes or Enhancements: Based on the review of this report by the plan maintenance oversight committee, the following recommendations will be noted for future updates or revisions to the plan:

- ______________________________
- ______________________________

- ______________________________
- ______________________________
- ______________________________
- ______________________________

Public review notice: *The contents of this report are considered to be public knowledge and have been prepared for total public disclosure. Copies of the report have been provided to the City of Oakland City Council and to local media outlets. The report is posted on the City of Oakland Hazard Mitigation Plan website. Any questions or comments regarding the contents of this report should be directed to:*

Insert Contact Info Here