CITY OF

HERCULES

LOCAL HAZARD MITIGATION PLAN

FINAL – Adopted May 25, 2021

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HAZARD MITIGATION PLAN POINT OF CONTACT

Primary Point of Contact
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Mike Roberts, Public Works Director/City Engineer
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Hercules, CA, 94549
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JURISDICTION PROFILE

The following is a summary of key information about the jurisdiction and its history:

- **Date of Incorporation**—December 15th, 1900
- **Current Population**—26,224 (California Department of Finance estimate as of May 1, 2019)
- **Population Growth**—1 percent annual increase according to the California Department of Finance
- **Location and Description**—The City is located in the western portion of Contra Costa County, one of the nine counties comprising the San Francisco Bay Area. Hercules has a total area of 19.98 square miles with 6.41 square miles of land and 13.57 square miles of water. The City is in the path of growth in the Bay Area - accessible by freeway to employment areas in West Contra Costa County, Northern Alameda County, and the Benicia area. There is a Bay Area Rapid Transit (BART) station in Richmond, nine miles south of Hercules, which provides West Contra Costa County with mass transit service to destinations along the industrial corridor between the cities of Richmond and Fremont and the City of San Francisco. The Union Pacific Railroad runs along the bayfront. The Burlington Northern Santa Fe Railway runs through the center of Hercules.

  The City of Hercules is a planned community which is an extension of an urbanized area already served by major transportation and utility systems. The plan incorporates open space and conservation areas and provides for improved environmental design. The City has the governmental framework to provide its future residents with needed urban services.
- **Brief History**— The "Hercules Site" of the California Powder Works was established in 1879. Originally occupying a site in what is now Golden Gate Park in San Francisco, the company decided to find another location and selected a tract of land in San Pablo Bay which was a part of the former Spanish land grant called Rancho El Pinole. In about 1903, the DuPont company acquired the California Powder Works, and thereafter the plant comprised part of the E. I. DuPont de Nemours organization. In 1912, the Hercules Powder Company was incorporated (now known as Hercules Incorporated) and purchased the Hercules, California plant from the DuPont company together with other explosive materials manufacturing plants operated by the DuPont company in other states. The Hercules, California plant was the largest producer of TNT in World War I, supplying explosives to Great Britain, France, and Russia before the United States entered the war.

  Several of the houses in the historic district were built prior to 1900, with the majority erected during World War I. In 1902, the Hercules Water Company was formed to supply water to the area between San

Pablo and Rodeo. This company operated until 1953 when it became a part of East Bay Municipal Utility District. In 1975, construction of new housing began east of Interstate-80. This marked the beginning of new Hercules. In 1978, Hercules, Inc. sold the plant and ended almost a hundred years of activity in the City.

- **Climate**— Hercules has a mild Mediterranean climate like much of the Bay Area and Contra Costa County. The climate is mild with warm dry summers and cool wet winters. The average temperature from June to October is low 70s with temperatures from November to May ranging between the mid 40s to low 60s. The average annual rainfall is 23.35 inches, which is concentrated from November to March.
- **Governing Body Format**— The City of Hercules is a general law city and functions as a Council–Manager form of government. The City is governed by a council of five members elected at large. The City Council assumes responsibility for the adoption of this plan, and the City Manager will oversee its implementation.

PLANNING PROCESS

Coordination with member of the public, stakeholders and agencies was essential to the development of the City of Hercules first Local Hazard Mitigation Plan. Opportunities for the public to comment on the plan during drafting and 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 was accomplished through the following actions.

Steering Committee

The City of Hercules began the planning process in July 2019 by forming a steering committee, each member of the Steering Committee was sent an Invitation to Participate on July 16, 2019. The first meeting was held on August 19, 2019, to review roles and responsibilities, draft of public survey, and receive recommendations. The Steering Committee met seven times on a monthly basis from August 19, 2019 to February 17, 2020 to identify objectives, provide content, and support the development of a Local Hazard Mitigation Plan and update to the Safety Element of the City's General Plan. The Steering Committee held a total of eight meetings, which concluded with a virtual meeting on March 19, 2020.

Steering Committee Members:

- Robert Reber, Community Development Director
- William Imboden, Chief of Police
- Bryan Craig, Rodeo-Hercules Fire District Chief
- David Biggs, Hercules City Manager
- Christopher Roke, Recreation Director
- Mike Robert, Public Works Director
- Edwin Gato, Finance Director

Steering Committee Meetings:

- August 19, 2019
- September 16, 2019
- October 21, 2019
- November 18,2019
- December 16, 2019
- January 21, 2020
- May 19, 2020 (Virtual)

Figure 1. September 2019 Community Workshop

Agency Notification - The following agencies were invited via email on September 3, 2019 to attend the community workshop and participate in the plan development process (Figure 2):

- FEMA Region IX (xing.liu@fema.dhs.gov)
- Bay Area Air Quality Management District (ayoung@baaqmd.gov)
- East Bay Parks (bholt@ebparks.org)
- Department of Water Resources (Bill.Ehorn@water.ca.gov)
- Pacific Gas & Electric (Ddw6@PGE.com)
- Department of Transportation (david.man@dot.ca.gov)
- Chevron (CPLCAO@chevron.com)
- Contra Costa County Conservation & Development (Judi.Kallerman@dcd.cccounty.us, john.Kopchik@dcd.cccounty.us, Jason.Crapo@dcd.cccounty.us)
- Rodeo-Hercules Fire District (craig@rhfd.org)
- American Society of Landscape Architects (governmentaffairs@asla.org)
- Association of Bay Area Governments (emma.greenbaum@bcdc.ca.gov, mgermeraad@bayareametro.gov)
- East Bay Municipal Water District (NBO@ebmud.com, nancy.li@ebmud.com, jennifer.mcgregor@ebmud.com)
- State of California HCD (huntley@hcd.ca.gov)
- WCCTAC (jnemeth@wcctac.org)
- StopWaste (jwest@stopwaste.org)
- Cal OES (Karen.McCready-Hoover@CalOES.ca.gov)
- National Parks Service (Katie_beltrano@Nps.gov)
- USGS (lisa+ehpweb@usgs.gov)
- California Office of Planning and Research (suzanne.hague@opr.ca.gov)
- Bay Area News Group (wctlegals@bayareanewsgroup.com
- County of Santa Clara (tamara.clark@prk.sccgov.org)
- City of Pinole (RTobey@ci.pinole.ca.us)
- West County Wastewater District (M.Mcneil@wcwd.org)
- California State Parks (info@parks.ca.gov)
- California Native American Heritage Commission (Gayle.Totton@nahc.ca.gov)

Figure 2. Agency Notification Email

The City of Hercules is kicking off the planning process for their Hazard Mitigation Plan, and you are invited to a community workshop Wednesday, September 25th from 6:30 – 7:30p at the City of Hercules Public library located at 109 Civic Dr, Hercules. Join the City of Hercules Hazard Mitigation Steering Committee for a presentation, and provide feedback on ways the city might reduce its vulnerability to impacts from natural hazards such as flood, earthquake, and fire. If you are unable to attend the event, but want to remain on the future notification list, please let Holly Smyth, Director of Planning, or Michele Rodriguez, Adjunct Planner know and we will keep you on a future notification list. Feel free to publish the flyer to your contact list. Thank you.

Michele Rodriguez, Adjunct Planner
City of Hercules
510-799-8242

Public Involvement

Broad public participation in the planning process helps ensure that diverse points of view about local needs are considered and addressed. The public must have opportunities to comment on disaster mitigation plans during the drafting stages and prior to plan approval (44 CFR, Section 201.6(b)(1)).

Workshops

In addition to meetings held with the Steering Committee, a public engagement and outreach process was developed to give members of the public the opportunity to contribute to the plans. Notifications for the workshops where sent out through the bi-weekly City Manager's report which is posted to the city website and emailed to all e-Notice subscribers. Notices were also posted on the City's social media pages (Facebook and NextDoor), Printed flyers were posted at City Hall, the Hercules Community Center, and Ohlone Community Center. The Police Department posted both workshops to its website, Facebook, NextDoor and Twitter. The Rodeo–Hercules Fire District included workshop information in its email list serve. To keep the community updated about plan progress, a Safety Element Update and Hazard Mitigation Plan web page was developed on the City website (https://www.ci.hercules.ca.us/government/planning/safety-element-hazard-mitigation, shown in Figure 3).

Workshop 1

On September 25, 2019, the City held a community workshop to kick off the Hazard Mitigation Plan and Safety Element update (Figure 1).

The first workshop was attended by twenty-two members of the general public in addition to the steering committee members, and representatives from Cal OES and the Bay Area Air Quality Management District. At the workshop, participants identified several areas of concern related to natural disaster resilience in the city:

- Evacuation Routes—including concern about neighborhoods with one way in and out, evacuation of schools, senior housing, people with disabilities, and others with access and functional needs.
- Infrastructure Failure—overpasses, bridges, rail lines, roads, and underground utility lines.
- Duck Pond Park channel flooding.
- Train derailments or gas line explosion.
- Training and education for the public such as CERT training, flyers on preparing for emergency, training at schools.

Workshop 2

The second public workshop was held online via Zoom on July 21, 2020, to obtain feedback on the draft Local Hazard Mitigation Plan and update to the Safety Element. Along with City of Hercules staff, members of the Steering Committee and CalOES were available to answer questions. This workshop was attended by sixteen members of the community and local stockholders. A draft version of the Local Hazard Mitigation Plan was posted to the website in advance of the workshop to allow the community ample time to review the document. The workshop consisted of a brief presentation and time for attendees to ask questions and make suggestions. Following the workshop, a video recording of the meeting was posted to the City's website and any questions referred to the appropriate Steering Committee member or department. Areas of continued concern identified at the second workshop included:

- Concern about wildfire and one way in and out in the Foxboro neighborhood.

- Need for better communication between the City, homeowners' associations, and neighborhood leaders around fire and other hazards.
- Concern about climate change and how the city will mitigate greenhouse gases.

Survey

The City conducted an online community survey (Figure 4) to gauge the public's understanding of citywide hazards, identify ways the City might educate the public on hazards, and guide the development of hazard policies and programs in the Local Hazard Mitigation Plan. Notification of the survey was posted to the Facebook pages of the City of Hercules, Police Department, and Rodeo-Hercules Fire District, as well as on the city website and NextDoor. The survey was open between October 1, 2019, and January 23, 2020, during which the City received 66 responses. Respondents expressed concerns about many natural and non-natural hazards in Hercules. Earthquake, wildfire, and severe weather were among the top natural hazard concerns, and non-natural hazards such as oil/gas spills, utility/power failure, active shooter, and hazardous material were among the top concerns for respondents. The full survey results have been posted to the Safety Element Update and Hazard Mitigation Plan web page. The survey results have been used to identify opportunities for community partners and the City of Hercules.

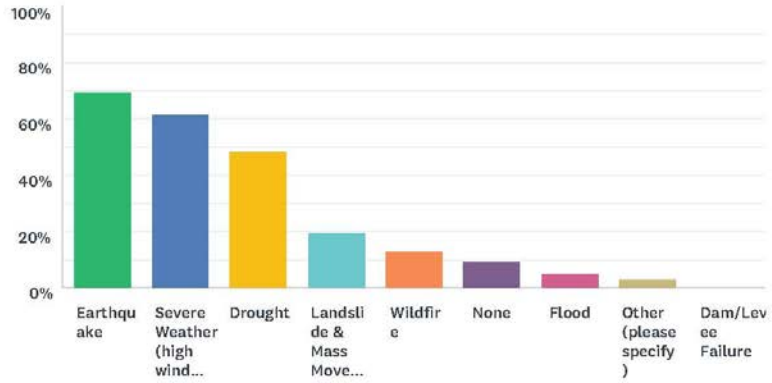
Figure 3. Sample Page from Website

Figure 4. Community Survey Page

Hercules Hazard Mitigation Survey

Q1 Which of the following natural hazard events have you experienced in Hercules?

Answered: 62 Skipped: 0



ANSWER CHOICES	RESPONSES	
Earthquake	69.35%	43
Severe Weather (high wind, heavy rain, lightning, etc.)	61.29%	38
Drought	48.39%	30
Landslide & Mass Movements (sinkholes, geologic hazards)	19.35%	12
Wildfire	12.90%	8
None	9.68%	6
Flood	4.84%	3
Other (please specify)	3.23%	2
Dam/Levee Failure	0.00%	0
Total Respondents: 62		

Integration of Public Comments

The planning team reviewed the comments received during the workshops, public responses to the community online survey, and public responses to the draft Local Hazard Mitigation Plan posted to the website on June 30, 2020. Most of the comments received fell outside the scope of this plan and were noted by the planning team for possible inclusion into the Safety Element being updated simultaneously. Copies of the comments were retained by the planning team and are available upon request. The community online survey provided the majority of the public guidance used in the Local Hazard Mitigation Plan. The following areas of concern where identified by the public and generally incorporated into the plan.

- Earthquake — The risk associated with earthquakes was identified as the top concern for the residents of Hercules with 68% of respondents to the community online survey stating they were extremely or very concerned about the risk. Earthquakes also ranked high in the city's risk assessment found on page 24 of this plan.

- Wildfire Hazard — The wildfire risk ranking was modified to reflect the community's concerns regarding wildfire hazards and the increased risks to the city due to climate change. The planning team incorporated comments received during the workshops and from the community survey which showed that 52% of respondents were extremely or very concerned about the risk of wildfire in the city.

- Drought and Severe Weather Hazard — While drought was one of the top public concerns expressed in the survey, the probability and impact to the city remain low at this time. This plan does however address the risk of severe weather in the form of heavy rain, atmospheric rivers, thunderstorms, hail, extreme heat and damaging winds. Severe weather and drought are certainly connected, as an increase in extreme heat and fewer periods of heavy rain would likely lead to drought conditions in the future. The planning team will continue to examine the risk of drought as new data and tools become available.

- Community Education — Comments received during the workshops and nearly 80% of respondents to the community survey expressed the need for additional education and programs that promote citizen actions to reduce exposure to the risks associated with natural hazards. Many of the objectives and actions beginning on page 80 of this plan focus on educating the public on the risk from natural hazards and increasing awareness, preparation, mitigation, response, and recovery activities.

DEVELOPMENT TRENDS

The City of Hercules has been recovering over the last few years from the housing market crash and great recession of 2008. The pace of development slowed considerably and then stopped completely from 2008 to 2013. In 2014 the City approved 43 single-family units, followed by 38 single-family units in 2016 but zero commercial or multi-units. This was a considerable decrease from development from 2000 to 2008 when 1,999 residential units were built in the City. There are currently about 8,436 housing units in Hercules, of which 65.9% are single-family detached. The median home value estimate is $565,400 which is consistent with surrounding cities. Hercules is nearly built out with single-family, low-density housing but has worked to increase the development of multi-family units over the last several years.

The significantly better economy and increases in housing market values have led to an increase in development in the City. In 2008 the City of Hercules approved the Waterfront District Master Plan which planned for the Historic Town Center, Transit Village, and Hercules Point sub-district amendments. The Bayfront project is consistent with the Waterfront District Master Plan and the first phase of the development is under construction.

Table 1 summarizes development in the city from 2012 - 2019

Table 1. Recent and Expected Future Development Trends

Criterion	Response
Has your jurisdiction annexed any land since the development of the previous hazard mitigation plan? • If yes, give the estimated area annexed and estimated number of parcels or structures.	No N/A
Is your jurisdiction expected to annex any areas during the performance period of this plan?	No
Are any areas targeted for development or major redevelopment in the next five years? • If yes, please briefly describe	Yes • Bayfront—Phase I is completed. Phase II under construction. Phase III is in building plan check, and prepared to pull building permit. The full build-out will include: o 1,526 multi-family residences (5% set aside for low income (60% of median income) affordable housing) o 93,000 square feet of retail o 35,000 square feet of office space o Regional Intermodal Transportation Center, combining rail (Capitol Corridor), ferry (WETA), and bus (WestCAT) transit services. • Sycamore Crossing (approved, construction anticipated to start early 2021): o 120 multi-family residences o 105-room hotel o 29,500 sf of retail • Hilltown—Entitlements approved as part of development agreement, with construction anticipated to start in 2021; full build-out to include: o 598 residential units, consisting of 198 condominiums/apartments and 400 townhomes/motor court units (5% set aside for moderate-income housing) o 4,200 square feet of retail
How many building permits were issued in your jurisdiction since the development of the previous hazard mitigation plan?	
Please provide the number of permits for each hazard area or provide a qualitative description of where development has occurred.	• Special Flood Hazard Areas: 0 • Landslide: 0 • High Liquefaction Areas: 0 • Dam Failure Inundation Area: 0 • Wildfire Risk Areas: 0

	2012	2013	2014	2015	2016	2017	2018	2019
Single-Family	0	0	43	0	38	41	56	17
Multi-Family	0	0	0	0	0	0	172	232
Other (commercial, mixed-use)	0	0	0	0	0	0	2	3

CAPABILITY ASSESSMENT

The City of Hercules has performed an inventory and analysis of existing capabilities, plans, programs and policies that enhance its ability to implement mitigation strategies. The introduction at the beginning of this volume of the hazard mitigation plan describes the components included in the capability assessment and their significance for hazard mitigation planning. This section summarizes the following findings of the assessment:

- An assessment of legal and regulatory capabilities is presented in Table 2.
- Development and permitting capabilities are presented in Table 3 .
- An assessment of fiscal capabilities is presented in Table 4.
- An assessment of administrative and technical capabilities is presented in Table 5.
- An assessment of education and outreach capabilities is presented in Table 6.
- Information on National Flood Insurance Program (NFIP) compliance is presented in Table 7.
- Classifications under various community mitigation programs are presented in Table 8.
- The community's adaptive capacity for the impacts of climate change is presented in Table 9.

Table 2. Legal and Regulatory Capability

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Codes, Ordinances, & Requirements				
Building Code	Yes	Yes	Yes	Yes
Comment: *Hercules Municipal Code Title 9 adopted the California Administrative Code, 2019 Edition, which is the technical codes of building regulations adopted 12/10/2019, Contra Costa Building Inspection Department serves under contract to implement the building code.*				
Zoning Code	Yes	No	Yes	Yes
Comment: *Hercules Municipal Code Title 13 is the City of Hercules Zoning Ordinance adopted 10/13/98 and codified into municipal code on 10/9/2018- The Zoning Ordinance is the primary tool for implementing the goals, objectives, policies, and standards of the Hercules General Plan.*				
Subdivisions	Yes	No	Yes	Yes
Comment: *Hercules Municipal Code Title 10, Chapter 2 adopted 1983 – To control and regulate the division of any real property within the City and such real property as may be annexed to the City, except such divisions of real property as are specifically excepted from the provisions of this Chapter.*				
Stormwater Management	Yes	No	Yes	Yes
Comment: *Hercules Municipal Code Title 5, Chapter 8 adopted 1/26/1996 updated in 2018- To protect and enhance the water quality in the City of Hercules' watercourses pursuant to and consistent with the Porter-Cologne Water Quality Control Act and the Federal Clean Water Act.*				
Post-Disaster Recovery	No	Yes	Yes	Yes
Comment: *California Disaster Assistance Act Title 2, Division 1, Chapter 7.5; California Code of Regulations Title 19, Division 2, Article 1 State Public Assistance Program.- Authorizes the Director of the California Governor's Office of Emergency Services (Cal OES) to administer a disaster assistance program that provides financial assistance from the state for costs incurred by local governments as a result of a disaster event.*				
Real Estate Disclosure	No	Yes	Yes	No
Comment: *California State Civil Code §1102 requires full disclosure on natural hazard exposure of the sale/re-sale of any and all real Property.*				
Growth Management	Yes	No	Yes	No
Comment: *Hercules General Plan, Growth Management Element, Section 10 adopted 11-12-2013; Cal. Gov. Code §65300 et seq.- Establishes a comprehensive, long-range program that will match the demands for multi-modal transportation facilities and services generated by new development with plans, capital improvement programs, and development mitigation programs.*				
Site Plan Review	Yes	No	No	Yes
Comment: *Hercules Municipal Code Title 13 Chapter 42 adopted 10/9/2018 – To improve the general standards of orderly development of the City through design review of individual buildings, structures, and their environs.*				
Environmental Protection	Yes	Yes	Yes	Yes
Comment: *California Environmental Quality Act (CEQA) - Requires state and local government agencies to inform decision makers and the public about the potential environmental impacts of proposed projects, and to reduce those environmental impacts to the extent feasible.*				
Flood Damage Prevention	Yes	Yes	Yes	Yes
Comment: *The city participates and is in good standing with the National Flood Insurance Program, Hercules Municipal Code Title 10, Chapter 7 adopted 5/12/2009, Contra Costa Flood Control and Water Conservation District - To promote the public health, safety, and general welfare, and to minimize public and private losses due to flood conditions in specific areas by legally enforceable regulations applied uniformly throughout the community to all publicly and privately owned land within flood prone, mudslide or flood-related erosion areas.*				
Emergency Management	Yes	Yes	Yes	Yes

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Comment: *Hercules Municipal Code Title 3, Chapter 1 Disasters and Emergencies adopted 1983, Threat Assessment / Emergency Action Plan 2008, City of Hercules Emergency Operations Plan 2014, Resolution NO. 06-102 adopted 7/25/2006 which accepted the National Incident Management Systems (NIMS) as part of the city's Standardized Organization Structure, and Cal. Gov. Code §8500 et.seq.-*				
Climate Change	Yes	Yes	Yes	Yes
Comment: *General Plan: Safety Element; California Senate Bill 379 – To reduce the potential short-, and long-term unreasonable risk of death, injuries, and property damage, and economic and social dislocation resulting from the effects of hazards. SB 1000 approved 9/24/2016 amends SB 379 and requires cities and counties to identify their "disadvantaged communities" and include an Environmental Justice element in their General Plan if "disadvantaged communities" are present.*				
Planning Documents				
General Plan	Yes	No	Yes	Yes
Is the plan compliant with Assembly Bill 2140?	Yes			
Comment: *Hercules General Plan approved 9/22/1998 will comply when the Safety Element is adopted in conjunction with the Local Hazard Mitigation Plan.*				
Capital Improvement Plan	Yes	No	Yes	Yes
How often is the plan updated? *CIP is updated every 5 years*				
Comment: *Hercules Capital Improvement Plan – The City's spending plan is focused on achieving the overall Goals, Strategies, and Objectives set forth in the Strategic Plan. Projects include repairs to sewer and storm drain systems, pavement maintenance, new road construction, pedestrian improvements, traffic and park improvements, and other city construction projects.*				
Floodplain or Watershed Plan	Yes	Yes	Yes	Yes
Comment: *The city participates and is in good standing with the National Flood Insurance Program, Contra Costa County Flood Control and Water Conservation District, Refugio Creek Watershed Vision Plan adopted 2010*				
Stormwater Plan	Yes	Yes	Yes	Yes
Comment: *City is a member of the Contra Costa Clean Water Program, Stormwater Resource Plan, SB 790 Stormwater Resources Act effective January 1, 2010*				
Urban Water Management Plan	No	Yes	No	Yes
Comment: *East Bay Municipal Utility District provides water and wastewater services to the City of Hercules. EBMUD is required by the California Water Code to update and adopt an Urban Water Management Plan (UWMP) and submit a completed plan to the Department of Water Resources every five years. The current Urban Water Management Plan was adopted on 6/28/2016. In 2009 the city adopted the State's model water efficient landscape ordinance, and is amicable to further collaboration in future.*				
Habitat Conservation Plan	No	Yes	No	No
Comment: *No local plan identified. California Department of Fish and Wildlife. U.S Fish and Wildlife Service.*				
Economic Development Plan	Yes	No	No	No
Comment: *Hercules General Plan, Economic Development Element, adopted 1-8-1991 – Provides the policy basis and conceptual framework for pursuing economic development in Hercules.*				
Shoreline Management Plan	No	No	No	No
Comment: *None identified*				
Community Wildfire Protection Plan	No	Yes	No	Yes
Comment: *Community Wildfire Protection Plan Contra Costa County Update 2014 Draft, Prepared by Diablo Fire Safe Council – A collaboratively developed plan that identifies wildland fire hazards, prioritizes ways to reduce those hazards, and recommends measures for homeowners and communities to reduce ignitability of structures. The Contra Costa County CWPP Update 2019 is currently in the review stage.*				
Forest Management Plan	No	No	No	No
Comment: *None identified*				

	Local Authority	Other Jurisdiction Authority	State Mandated	Integration Opportunity?
Climate Action Plan	No	No	No	No
Comment: *None identified – Contra Costa County Climate Action Plan includes unincorporated areas with the county. The City of Hercules does not have a Climate Action Plan.*				
Comprehensive Emergency Management Plan	Yes	Yes	Yes	Yes
Comment: *City of Hercules Emergency Operations Plan 2014 - Provides the community with effective preparation should an emergency occur. The City coordinates City facilities, assigning specific tasks to personnel, while specifying the policies and general procedures that are relative to emergency preparedness. The plan includes the City of Hercules into the S.E.M.S regulations as well as the County and Statewide Emergency Management System. The plan is updated as situations change.*				
Threat & Hazard Identification & Risk Assessment (THIRA)	No	No	No	No
Comment: *None identified*				
Post-Disaster Recovery Plan	Yes	Yes	No	Yes
Comment: *None identified*				
Continuity of Operations Plan	No	No	No	No
Comment: *None identified*				
Public Health Plan	No	Yes	Yes	No
Comment: *Contra Costa County Health Department has a comprehensive plan and overall responsibility for public health.*				
Strategic Plan	Yes	No	No	Yes
Comment: *Hercules Strategic Plan was initially adopted on 7/11/2017, updated on 5/8/2018 and reviewed on an annual basis. The Strategic Plan includes a SWOT Analysis (Strengths, Weaknesses, Opportunities, Threats) and a series of goals, strategies and objectives for the city.*				

Table 3. Development and Permitting Capability

Criterion	Response
Does your jurisdiction issue development permits?	Yes
• If no, who does? If yes, which department?	Community Development Department
Does your jurisdiction have the ability to track permits by hazard area?	Yes, manually
Does your jurisdiction have a buildable lands inventory?	Yes
• If yes, please briefly describe.	The City of Hercules has a buildable land inventory as part of the Housing Element in the General Plan. There are currently 87.33 buildable acres with potential for 2,732 residential units that the city has identified. The buildable land is concentrated in the Bayfront and Hilltown areas of the city.
• If no, please quantitatively describe the level of buildout in the jurisdiction.	N/A

Table 4. Fiscal Capability

Financial Resource	Accessible or Eligible to Use?
Community Development Block Grants	Yes, City would be eligible
Capital Improvements Project Funding	Yes
Authority to Levy Taxes for Specific Purposes	No, Require voter approval
User Fees for Water, Sewer, Gas or Electric Service	Yes, Sewer
Incur Debt through General Obligation Bonds	Yes
Incur Debt through Special Tax Bonds	Yes
Incur Debt through Private Activity Bonds	No

Financial Resource	Accessible or Eligible to Use?
Withhold Public Expenditures in Hazard-Prone Areas	No
State-Sponsored Grant Programs	Yes
Development Impact Fees for Homebuyers or Developers	Yes
Other	N/A

Table 5. Administrative and Technical Capability

Staff/Personnel Resource	Available?	Department/Agency/Position
Planners or engineers with knowledge of land development and land management practices	Yes	Community Development Department & Engineering and Public Works
Engineers or professionals trained in building or infrastructure construction practices	Yes	Engineering and Public Works
Planners or engineers with an understanding of natural hazards	Yes	Community Development Department & Engineering and Public Works
Staff with training in benefit/cost analysis	Yes	Finance & Human Resources
Surveyors	Yes	Contract as required
Personnel skilled or trained in GIS applications	Yes	Community Development Department & Engineering and Public Works
Scientist familiar with natural hazards in local area	Yes	Contract as required
Emergency Manager	Yes	City Manager, Emergency Services
Grant writers	Yes	Contract as required
Other	N/A	N/A

Table 6. Education and Outreach Capability

Criterion	Response
Do you have a Public Information Officer or Communications Office?	Yes
Do you have personnel skilled or trained in website development?	Yes for content update. No for comprehensive modifications, can contract as needed
Do you have hazard mitigation information available on your website? • If yes, please briefly describe.	Yes Emergency Preparedness page on the website with links to emergency evacuation routes, state of readiness, preparing for emergencies, what to do during and after a disaster and other emergency resources.
Do you utilize social media for hazard mitigation education and outreach? • If yes, please briefly describe.	Yes Safety Element update and Hazard Mitigation Plan information has been distributed through Facebook pages of the Rodeo-Hercules Fire District and Hercules Police Department.
Do you have any citizen boards or commissions that address issues related to hazard mitigation? • If yes, please briefly describe.	Yes Planning Commission, and City Council for hazard-related ordinances.
Do you have any other programs already in place that could be used to communicate hazard-related information? • If yes, please briefly describe.	Yes CERT Training thru the Fire Department
Do you have any established warning systems for hazard events? • If yes, please briefly describe.	Yes Contra Costa County Community Warning System

Table 7. National Flood Insurance Program Compliance

Criterion	Response
What local department is responsible for floodplain management?	Engineering and Public Works
Who is your floodplain administrator? (department/position)	Mike Roberts, Public Works Director / City Engineer
Are any certified floodplain managers on staff in your jurisdiction?	No, A licensed civil engineer
What is the date that your flood damage prevention ordinance was last amended?	2009
Does your floodplain management program meet or exceed minimum requirements? • If exceeds, in what ways?	Meets minimum requirements N/A
When was the most recent Community Assistance Visit or Community Assistance Contact? Julia Gillespie, Floodplain Management Specialist Region IX 510-627-7248	September 2012
Does your jurisdiction have any outstanding NFIP compliance violations that need to be addressed? June 16, 2020 • If so, please state what they are.	No N/A
Do your flood hazard maps adequately address the flood risk within your jurisdiction? • If no, please state why.	No Pinole Creek needs to be re-mapped
Does your floodplain management staff need any assistance or training to support its floodplain management program? • If so, what type of assistance/training is needed?	No N/A
Does your jurisdiction participate in the Community Rating System (CRS)? • If yes, is your jurisdiction interested in improving CRS Classification? • Is your jurisdiction interested in joining the CRS program?	No N/A No
How many Flood Insurance policies are in force in your jurisdiction?[a] • What is the insurance in force? • What is the average premium in force?	16 $6,963,000 $435
How many total loss claims have been filed in your jurisdiction?[a] • How many claims were closed without payment/are still open? • What were the total payments for losses?	None N/A N/A

a. According to FEMA statistics as of June 16, 2020

Table 8. Community Classifications

	Participating?	Classification	Date Classified
Community Rating System	No	N/A	N/A
Building Code Effectiveness Grading Schedule	No	N/A	N/A
Public Protection	No	N/A	N/A
Storm Ready	No	N/A	N/A
Firewise	No	N/A	N/A

Table 9. Adaptive Capacity for Climate Change

Criterion	Jurisdiction Rating
Technical Capacity	
Jurisdiction-level understanding of potential climate change impacts	Low
Comments/Additional Information:	*None provided*

Criterion	Jurisdiction Rating
Jurisdiction-level monitoring of climate change impacts	Low
Comments/Additional Information: *None provided*	
Technical resources to assess proposed strategies for feasibility and externalities	Low
Comments/Additional Information: *None provided*	
Jurisdiction-level capacity for development of greenhouse gas emissions inventory	Low
Comments/Additional Information: *GHG emissions inventory has not been done.*	
Capital planning and land use decisions informed by potential climate impacts	Low
Comments/Additional Information: *None provided*	
Participation in regional groups addressing climate risks	Medium
Comments/Additional Information: *ART- Adapting to Rising Tides: Contra Costa County Assessment and Adaption Project March 2017*	
Implementation Capacity	
Clear authority/mandate to consider climate change impacts during public decision-making processes	Low
Comments/Additional Information: *None provided*	
Identified strategies for greenhouse gas mitigation efforts	Low
Comments/Additional Information: *None provided*	
Identified strategies for adaptation to impacts	Low
Comments/Additional Information: *None provided*	
Champions for climate action in local government departments	Low
Comments/Additional Information: *None provided*	
Political support for implementing climate change adaptation strategies	Low
Comments/Additional Information: *None provided*	
Financial resources devoted to climate change adaptation	Low
Comments/Additional Information: *None provided*	
Local authority over sectors likely to be negative impacted	Medium
Comments/Additional Information: *Authority over development in Bayfront and Hercules Point*	
Public Capacity	
Local residents knowledge of and understanding of climate risk	Low
Comments/Additional Information: *None provided*	
Local residents support of adaptation efforts	Low
Comments/Additional Information: *None provided*	
Local residents' capacity to adapt to climate impacts	Low
Comments/Additional Information: *None provided*	

Criterion	Jurisdiction Rating
Local economy current capacity to adapt to climate impacts	Low
Comments/Additional Information: *None provided*	
Local ecosystems capacity to adapt to climate impacts	Medium
Comments/Additional Information: *Refugio Creek Watershed Vision Plan*	

INTEGRATION WITH OTHER PLANNING INITIATIVES

The information on hazards, risk, vulnerability and mitigation contained in this hazard mitigation plan is based on the best available data. Plan integration is the incorporation of this information into other relevant planning mechanisms, such as general planning and capital facilities planning. It includes the integration of natural hazard information and mitigation policies, principles and actions into local planning mechanisms and vice versa. Additionally, plan integration is achieved through the involvement of key staff and community officials in collaboratively planning for hazard mitigation.

Opportunities for Future Integration

As this hazard mitigation plan is implemented, City of Hercules will use information from the plan and the best available science and data on natural hazards. The capability assessment presented in this annex identifies codes, plans and programs that provide opportunities for integration. New opportunities for integration also will be identified as part of the annual progress report. The capability assessment identified the following plans and programs that provide opportunities to integrate goals or recommendations of the hazard mitigation plan in the future:

- **General Plan-** Updates to the General Plan will consider the LHMP and associated maps for inclusion into all future elements.
- **Climate Action Plan –** The City of Hercules does not have a Climate Action Plan and intends to develop one as a mitigation planning action during the next five years. The plan will build on the mitigation goals and objectives identified in the mitigation plan.
- **Municipal Code**—Title 10 Land Use and Title 13 Zoning Ordinance restrict developments in flood hazard areas identified by FEMA. Portions of the LHMP plan and associated maps will be considered for inclusion into future updates.
- **City of Hercules Emergency Operations Plan, 2014 –** The LHMP will be considered in future updates to the EOP.
- **Hercules Strategic Plan 2017-** The Strategic Plan may take into consideration hazard mitigation potential as a means of evaluating project prioritization.
- **Urban Water Management Plan –** The city has been collaborating with East Bay Municipal Utility District's Urban Water Management Plan and is willing to collaborate with future actions.

JURISDICTION-SPECIFIC NATURAL HAZARD EVENT HISTORY

Table 10 lists past occurrences of natural hazards for which specific damage was recorded in City of Hercules.

Table 10. Past Natural Hazard Events

Type of Event	FEMA Disaster # (if applicable)	Date	Damage Assessment
Landslide – Carson Street	N/A	2000	No estimates available, damage was limited to two residential structures.
Landslide – Carson Street	N/A	2006	No estimates available, damage was limited to two residential structures.
Loma Prieta (Earthquake)	DR-845	October 17, 1989	$25 million in the County A few buildings in the City of Hercules experienced some structural damage.
Flooding of Refugio Creek	N/A	1983	No estimates available

KEY VULNERABILITIES

Critical facilities and infrastructure are assets, systems and networks, whether physical or virtual, whose incapacity or destruction would have a debilitating impact on security, economic security, public health or safety, or any combination. Risk assessment of hazards considers the potential impact of a hazard on the function of critical facilities and infrastructure. All critical facilities and infrastructure were analyzed in FEMA's Hazus model to help rank risk and identify mitigation actions. The risk assessment for each hazard discusses critical facilities with regard to that hazard.

The Hazus model used for risk assessment in this plan defines specific types of critical facilities and infrastructure as well as broader categories that include multiple types. For example, fire stations and police stations are specific types of facilities, both of which fall under the broader category of "protective function" facilities. Figure 5 and Figure 6 show the location of critical facilities and infrastructure in the planning area, with symbols showing each specific type of facility. The figure legend identifies the broader category that encompasses each type. Table 11 and Table 12 summarize the number of critical facilities and infrastructure within each broad category. Due to the sensitivity of this information, a detailed list of facilities is not provided. The list is on file with Contra Costa County OES.

Table 11. Critical Facilities

Medical and Health	Government Functions	Protective Functions	School and Educational Facilities	Hazmat
0	1	2	6	0

Table 12. Critical Infrastructure

Bridges	Water Supply	Wastewater	Power	Communications	Other Critical Functions	Other Critical Infrastructure
6	1	1	1	2	0	1

Repetitive loss records are as follows:

- Number of FEMA-identified Repetitive-Loss Properties: None identified
- Number of FEMA-identified Severe-Repetitive-Loss Properties: None identified
- Number of Repetitive-Loss Properties or Severe-Repetitive-Loss Properties that have been mitigated: None identified

Other noted vulnerabilities include the following:

- Discrepancies between FEMA's printed and digital Flood Insurance Rate Maps.
- Discrepancies between CAL Fire Wildfire Severity Zone maps and Association of Bay Area Governments Resilience Program maps.
- Limited available funding sources or funding shortfalls may affect the completion of projects or continuation of programs aimed at mitigating hazards.
- Major transportation corridors and rail lines are vulnerable to disruption, particularly from earthquake hazard.
- The City of Hercules has developed detailed evacuation routes, alternate routes and shelters but needs to better educate residents before an emergency.

Figure 5. Critical Facilities

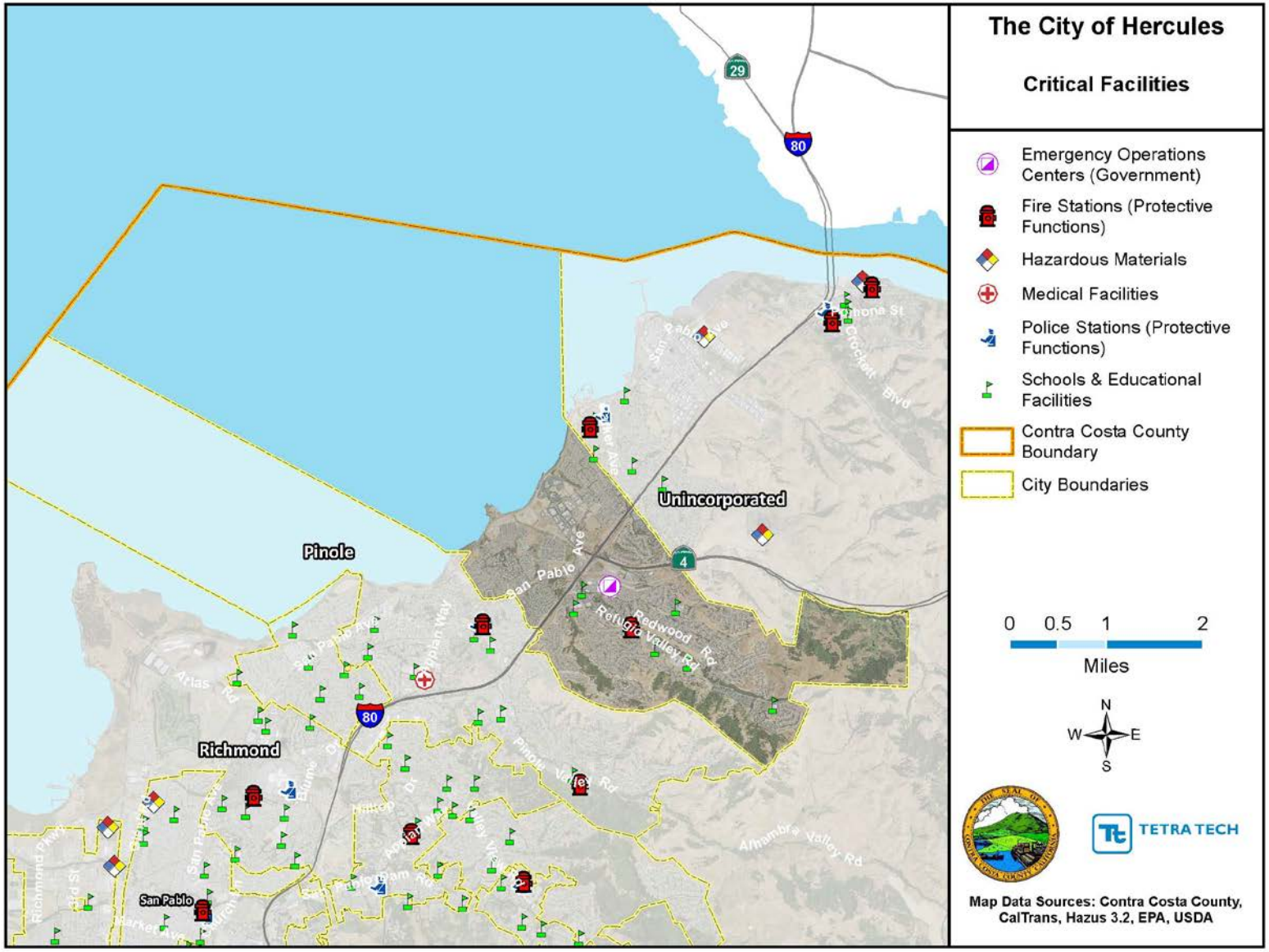
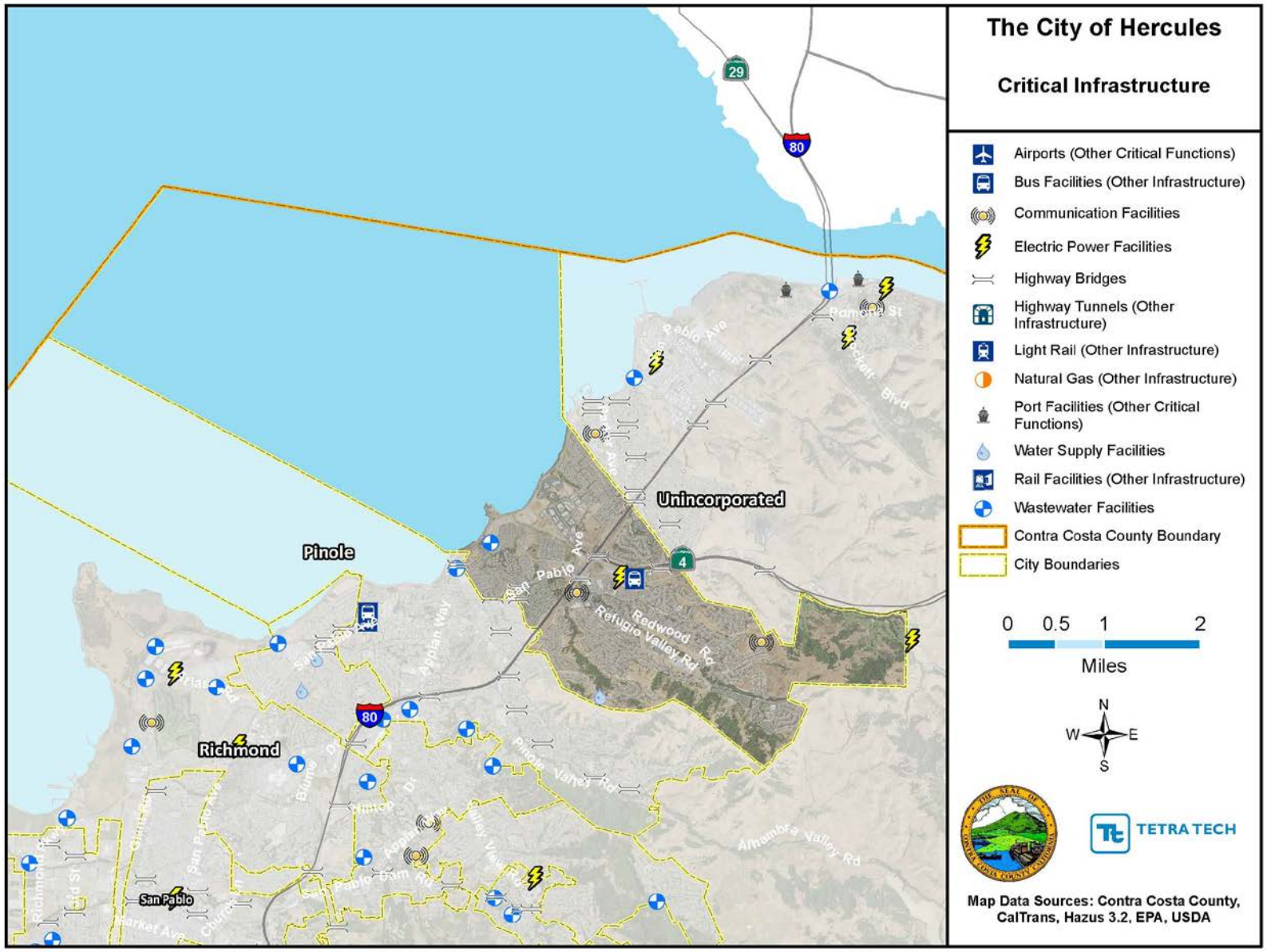


Figure 6. Critical Infrastructure



HAZARD RISK RANKING

Table 13 presents a hazard risk ranking for the City of Hercules of all hazards of concern within Contra Costa County. Volume 1 of Contra Costa Counties multi-jurisdictional hazard mitigation plan provides complete risk assessments of all hazards. The City of Hercules hazard mitigation actions are focused on hazards that rank high and medium on the risk ranking for the city. The ranking process involves an assessment of the likelihood of occurrence for each hazard, along with its potential impacts on people, property and the economy.

Risk Ranking: This ranking serves two purposes, first to describe the probability that a hazard will occur, and second to describe the impact a hazard will have on people, property, and the economy. Risk estimates are based on the methodology used to prepare the risk assessment for this plan. The following equation shows the risk ranking calculation:

Risk Ranking = Probability x Impact (people + property + economy)

Table 13. Hazard Risk Ranking

Rank	Hazard Type	Risk Rating Score (Probability x Impact)	Category
1	Earthquake[b]	54	High
1	Landslide[e]	54	High
1	Severe-weather	30	High
2	Wildfire[f]	20	Medium
3	Sea-level rise[d]	12	Low
3	Flood[c]	9	Low
4	Drought	9	Low
5	Dam and levee failure[a]	6	Low
6	Tsunami	0	None

a. Based on the level of detail conducted in the risk assessment, the risk ranking for this hazard is focused solely on dam failure impacts. See Chapter 6.4 of Volume 1 for combined dam inundation list on which this assessment is based.
b. Haywired M7.05 event was used to assign probability and impacts
c. 1-percent annual chance event was used to assign probability and impacts
d. 2100 upper range estimates and extreme tide are used to assign probability and impacts
e. Very High and High severity zones were used to assign probability and impacts
f. There is no mapped risk within the jurisdiction; however, this score was revised up due to neighborhoods in the eastern portion of the city being adjacent to High Severity Zones in Local Responsibility areas and the increase of wildfire activity due to climate change.

RISK ASSESSMENT

The Planning team conducted a risk assessment to determine the potential impacts of hazards to the people, economy, and natural and build environment in the City of Hercules.

Risk Assessment: Risk assessment is 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 and focuses on (1) hazard identification; (2) impacts of hazards on physical, social, and economic assets; (3) vulnerability identification; and (4) estimates of the cost of damage or costs that could be avoided through mitigation.

The risk assessment included:

- A description of the type, location, and extent of all natural hazards that can affect the city.

- Information and description of the jurisdiction's vulnerability to previous occurrences of hazard events and on the probability of future hazard events.
- An overall summary of each hazard and its impact on the community.

IDENTIFED 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, and the Hazard Risk Ranking (Table 11) this plan addresses the following hazards of concern:

- Earthquake
- Landslide
- Severe Weather
- Wildfire

EARTHQUAKE

Based on history, all of the San Francisco Bay Area is considered seismically active. There is no method by which the location, magnitude, or time of future seismic occurrences can be predicted. However, it is possible to identify certain types of seismic hazards and foretell which areas of the City will be particularly subject to damage by earthquakes.

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

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. Movement of the tectonic plates against one another creates stress, which is released as energy that moves through the earth as seismic waves.

Faults

Hercules, as part of the San Francisco Bay Area, is in one of the most seismically active regions in the United States (Figure 8). The study area could be affected by ground shaking due to movement along any one of several active faults in the region. The San Andreas Fault lies about 21 miles to the southwest of the City, the Hayward Fault lies about two and a half miles southwest of the city, and the Concord-Green Valley Fault lies about 11 miles to the east. The Calaveras Fault lies approximately 40 miles to the southeast. The Rodgers Creek Fault, which connects with the Hayward Fault beneath San Pablo Bay, is another major fault only about 10 miles away to the west. The area within Hercules would be subject to strong ground motion in the event of a moderate to severe earthquake in the Bay Area.

In addition to the active faults noted above, two inactive faults are in the Hercules vicinity. Two traces of the Pinole Fault pass immediately southwest of Hercules, and the Franklin Fault lies about three miles to the northeast. Neither of these two faults shows evidence of surface displacement in Quaternary time (the last two million years), and future movement along them is much more unlikely than along the active faults associated with the Pinole fault.

The Alquist-Priolo Special Studies Zones Act requires the state to identify zones around "active" faults (those having evidence of surface displacement within about the last 11,000 years) in order to manage development near possible surface rupture sites. There are no Special Studies Zones within Hercules (the closest Special Studies Zone is along the Hayward Fault, about two and one half to four miles to the southwest). The northern end of the Pinole Fault was originally included in a Special Studies Zone but was removed from the active category after further analysis.

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. It is commonly expressed by ratings on either of two scales (USGS, 2017):

The **Richter scale** measures magnitude of earthquakes based on the amplitude of the largest energy wave released by the earthquake. Richter scale readings are suitable for smaller earthquakes; however, because it is a logarithmic scale, the scale does not distinguish clearly the magnitude of large earthquakes above a certain level. Richter scale magnitudes and corresponding earthquake effects are as follows:

- 2.5 or less—Usually not felt, but can be recorded by seismograph
- 2.5 to 5.4—Often felt, but causes only minor damage
- 5.5 to 6.0—Slight damage to buildings and other structures
- 6.1 to 6.—May cause a lot of damage in very populated areas
- 7.0 to 7.9—Major earthquake; serious damage
- 8.0 or greater—Great earthquake; can totally destroy communities near the epicenter

A more commonly used magnitude scale today is the **moment magnitude (Mw) scale**. The moment magnitude 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). Moment magnitude roughly matches the Richter scale but provides more accuracy for larger magnitude earthquakes. 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—Mw < 3

Intensity: Currently the most commonly used intensity scale is the modified Mercalli intensity scale, with ratings defined as follows (USGS, 1989):

> I. Not felt except by a very few under especially favorable conditions
>
> II. Felt only by a few persons at rest, especially on upper floors of buildings.
>
> III. Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it is an earthquake. Standing cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.

IV. Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation like a heavy truck striking building. Standing cars rocked noticeably.

V. Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.

VI. Felt by all; many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.

VII. Damage negligible in buildings of good design and construction; slight in well-built ordinary structures; considerable in poorly built or badly designed structures. Some chimneys broken.

VIII. Damage slight in specially designed structures; considerable damage in ordinary buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.

XI. Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.

XII. Damage total. Lines of sight and level are distorted. Objects thrown into the air.

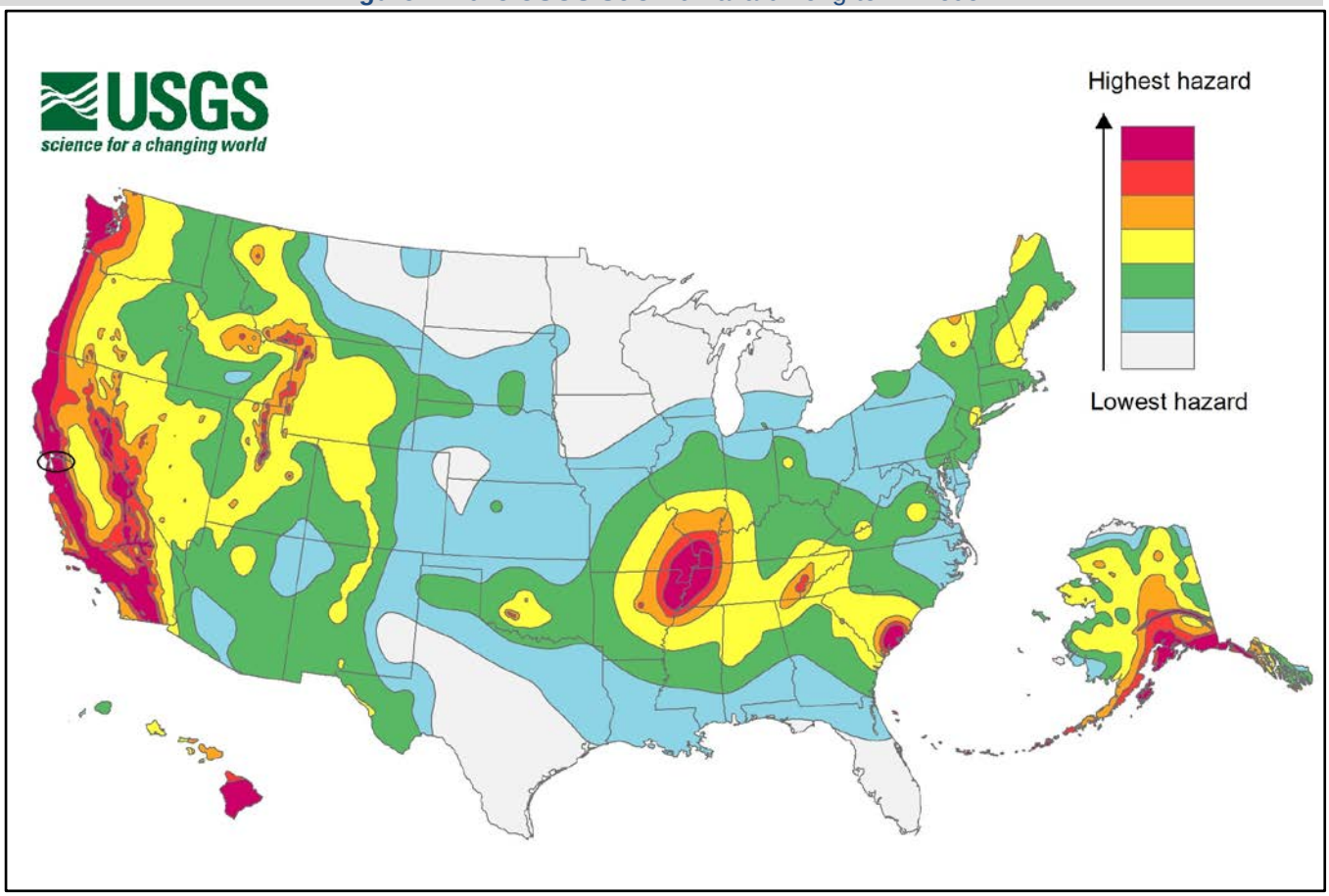
Ground Motion

Earthquake hazard assessment is also based on expected ground motion. The ground experiences acceleration as it shakes during an earthquake. The peak ground acceleration (PGA) is the largest acceleration recorded by a monitoring station during an earthquake. PGA is a measure of how hard the earth shakes in a given geographic area. It is expressed as a percentage of the acceleration due to gravity (%g). Horizontal and vertical PGA varies with soil or rock type. Instruments called accelerographs record levels of ground motion due to earthquakes at stations throughout a region. These readings are recorded by state and federal agencies that monitor and predict seismic activity. Earthquake hazard assessment involves estimating the annual probability that certain ground motion accelerations will be exceeded, and then summing the annual probabilities over a time period of interest.

National maps of earthquake shaking hazards, which have been produced since 1948, 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 7 represents the best available data as determined by the USGS.

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. Buildings, bridges, highways and utilities built to meet modern seismic design requirements are typically able to withstand earthquakes better, with less damage and disruption. 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).

Figure 7. 2018 USGS Seismic Hazard Long-term Model



Note: The black circle indicates the approximate location of the City of Hercules

Earthquake Hazards Profile

The Bay region lies within the active boundary between the Pacific and the North American tectonic plates. The Pacific Plate is constantly moving northwest past the North American Plate at a rate of about 2 inches per year (Cal OES, 2013). Earthquakes in the San Francisco Bay region result from strain energy constantly accumulating across the region because of the motion of the Pacific Plate relative to the North American Plate. The San Andreas Fault, on which earthquakes of magnitude 7.8 and 7.9 have occurred in the past, including the 1906 San Francisco earthquake, is the fastest slipping fault along the plate boundary.

Past Events

California has been included in 12 FEMA major disaster (DR) or emergency (EM) declarations for earthquakes. Contra Costa County was included in only one declaration: DR-845 for the Loma Prieta Earthquake, which occurred in October 1989. The declaration for this event also covered Alameda, Marin, Monterey, Sacramento, San Benito, San Francisco, San Joaquin, San Mateo, Santa Clara, Santa Cruz, and Solano Counties. Table 14 summarize recent earthquakes of magnitude of 5.0 or greater impacting the Bay Area.

Table 14. Recent Earthquakes Magnitude 5.0 or Larger Near Planning Area

Date	Magnitude	Epicenter Location
8/24/2014 – South Napa Earthquake	6.0	South Napa
10/20/2012 – King City Earthquake	5.3	28 km east-northeast of King City, CA
10/31/2007 – Alum Rock Earthquake	5.6	San Francisco Bay area, California
5/14/2002 – Gilroy Earthquake	5	Northern California
9/3/2000 – Yountville Earthquake	5	Northern California
8/12/1998 – San Juan Bautista Earthquake	5.2	Central California
4/18/1990 – Northern California	5.4	Near Aromas, Northern California
10/18/1989 – Loma Prieta Earthquake	7.2	Northern California
8/8/1989 – Santa Cruz County Earthquake	5.2	Central California
6/27/1989	5.3	Northern California
6/13/1988	5.3	San Francisco Bay area, California
2/20/1988	5.1	Central California
3/31/1986	5.6	Northern California
1/26/1986	5.4	Central California

Fault Locations

Calaveras (North Central): The Calaveras (North Central) Fault is a major branch of the San Andreas Fault, located east of the Hayward Fault. It extends 76 miles from the San Andreas Fault near Hollister to Danville at its northern end. The Calaveras Fault is one of the most geologically active and complex faults in the Bay Area (USGS, 2003). The probability of experiencing a Magnitude 6.7 or greater earthquake along the Calaveras Fault in the next 30 years is 26 percent.

Concord-Green Valley: The Concord-Green Valley Fault, named for being located under the City of Concord, is connected to the main Green Valley Fault. The fault extends approximately 11 miles east of West Napa Fault, from Mount Diablo to the Carquinez Strait. It is considered to be under high stress and has a 16 percent probability of experiencing a Magnitude 6.7 or greater earthquake in the next 30 years.

Greenville: The Greenville Fault is in the eastern Bay Area in Contra Costa and Alameda Counties. This dextral strike-slip fault zone borders the eastern side of Livermore Valley and is considered to be part of the larger San Andreas fault system in the central Coast Ranges. The fault zone extends from northwest of Livermore Valley along the Marsh Creek and Clayton faults toward Clayton Valley.

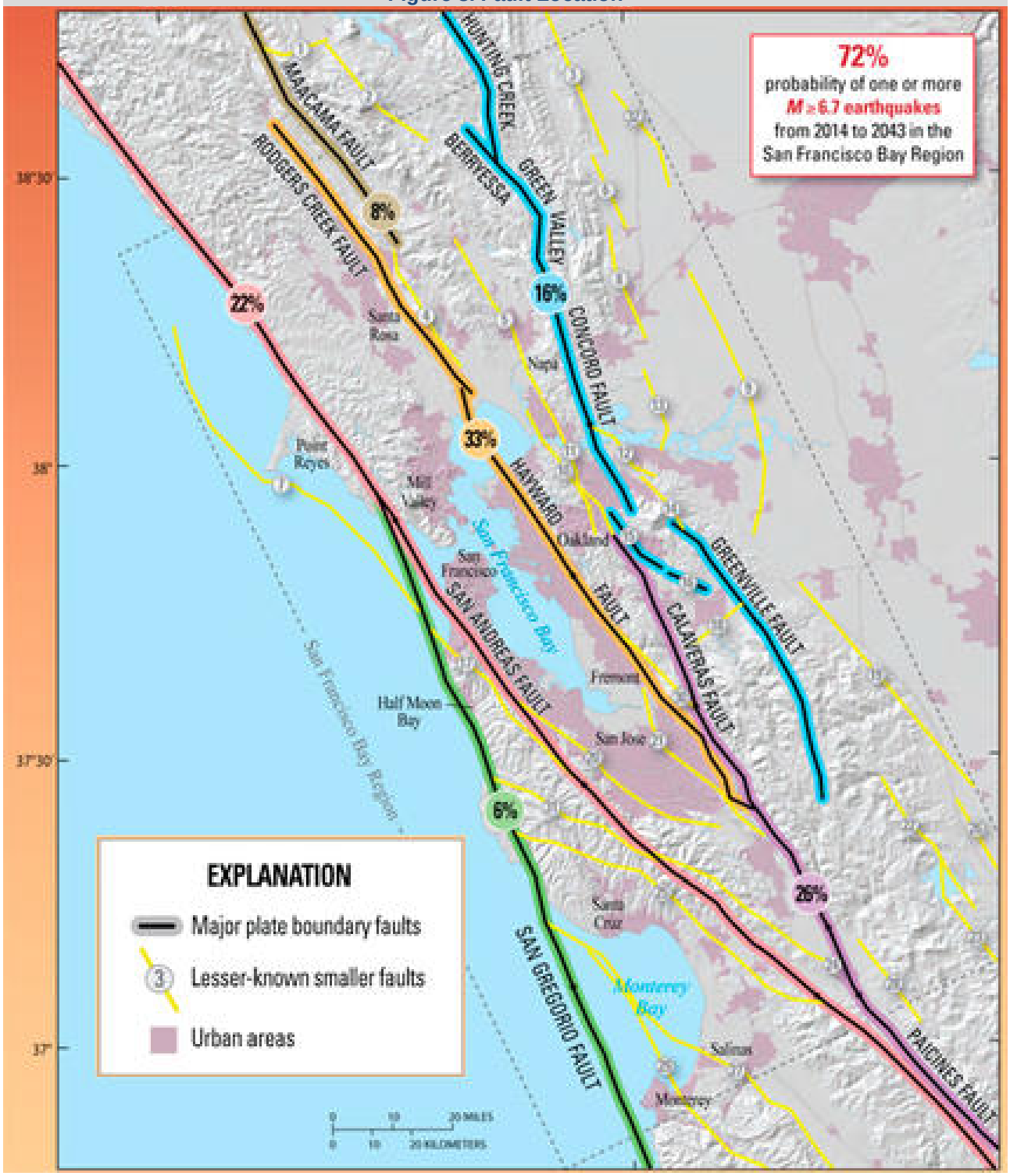
Hayward Fault: The Hayward Fault is an approximately 45-mile-long fault that runs through densely populated areas on the East Bay, parallel to the San Andreas Fault. The Hayward Fault extends through some of the Bay Area's most populated areas, including San Jose, Oakland, and Berkeley. The Hayward Fault is a right-lateral slip fault.

The Hayward Fault is increasingly becoming a hazard priority throughout the Bay Area because of its increased chance for activity and its intersection with highly populated areas and critical infrastructure. The probability of experiencing a Magnitude 6.7 or greater earthquake along the Hayward Fault in the next 30 years is 33 percent. An earthquake of this magnitude has regional implications for the entire Bay Area, as the Hayward Fault crosses transportation and resource infrastructure, such as multiple highways and the Hetch-Hetchy Aqueduct.

Mount Diablo: The Mount Diablo thrust fault is in the vicinity of Mount Diablo in Contra Costa County. The fault lies between the Calaveras Fault, the Greenville Fault, and the Concord Fault, all right-lateral strike slip

faults, and appears to transfer movement from the Calaveras and Greenville Faults to the Concord Fault, while continuing to uplift Mount Diablo.

Figure 8. Fault Location



USGS 2017

Mapping of Earthquake Impact

Identifying the extent and location of an earthquake is not as simple as it is for other hazards such as flood, landslide or wild fire. The impact of an earthquake is largely a function of the following components:

- Ground shaking (ground motion accelerations)
- Liquefaction (soil instability)
- Distance from the source (both horizontally and vertically).

Mapping that shows the impacts of these components was used to assess the risk of earthquakes within the planning area. While the impacts from each of these components can build upon each other during an earthquake event, the mapping looks at each component individually. The mapping used in this assessment is described below.

Shake Maps

A shake map is a representation of ground shaking produced by an earthquake. The information it presents is different from the earthquake magnitude and epicenter that are released after an earthquake because shake maps focus on the ground shaking resulting from the earthquake, rather than the parameters describing the earthquake source. 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 extent and variation of ground shaking in a 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. Earthquake scenario maps describe the expected ground motions and effects of hypothetical large earthquakes for a region. The following scenarios were chosen for this plan:

Calaveras (North Central) Fault Scenario—A Magnitude-7.0 event with a depth of 7 km and epicenter 0.7 miles south southwest of the Roundhouse Market & Conference Center in the City of San Ramon. (See Figure 9)

Concord-Green Valley Fault Scenario—A Magnitude-6.8 event with a depth of 9 km and epicenter 20 miles north of the City of Martinez. (See Figure 10)

Greenville Fault Scenario—A Magnitude-7.0 event with a depth of 12 km and epicenter 29 miles southeast of the City of San Ramon. (See Figure 11)

Haywired Fault Scenario—A Magnitude-7.05 event with a depth of 8 km and epicenter 3.5 miles southwest of the Town of Moraga. (See Figure 12)

Mount Diablo Fault Scenario—A Magnitude-6.7 event with a depth of 14 km and epicenter 10.5 miles east of the City of Danville. (See Figure 13).

Figure 9. Calaveras Earthquake Scenario

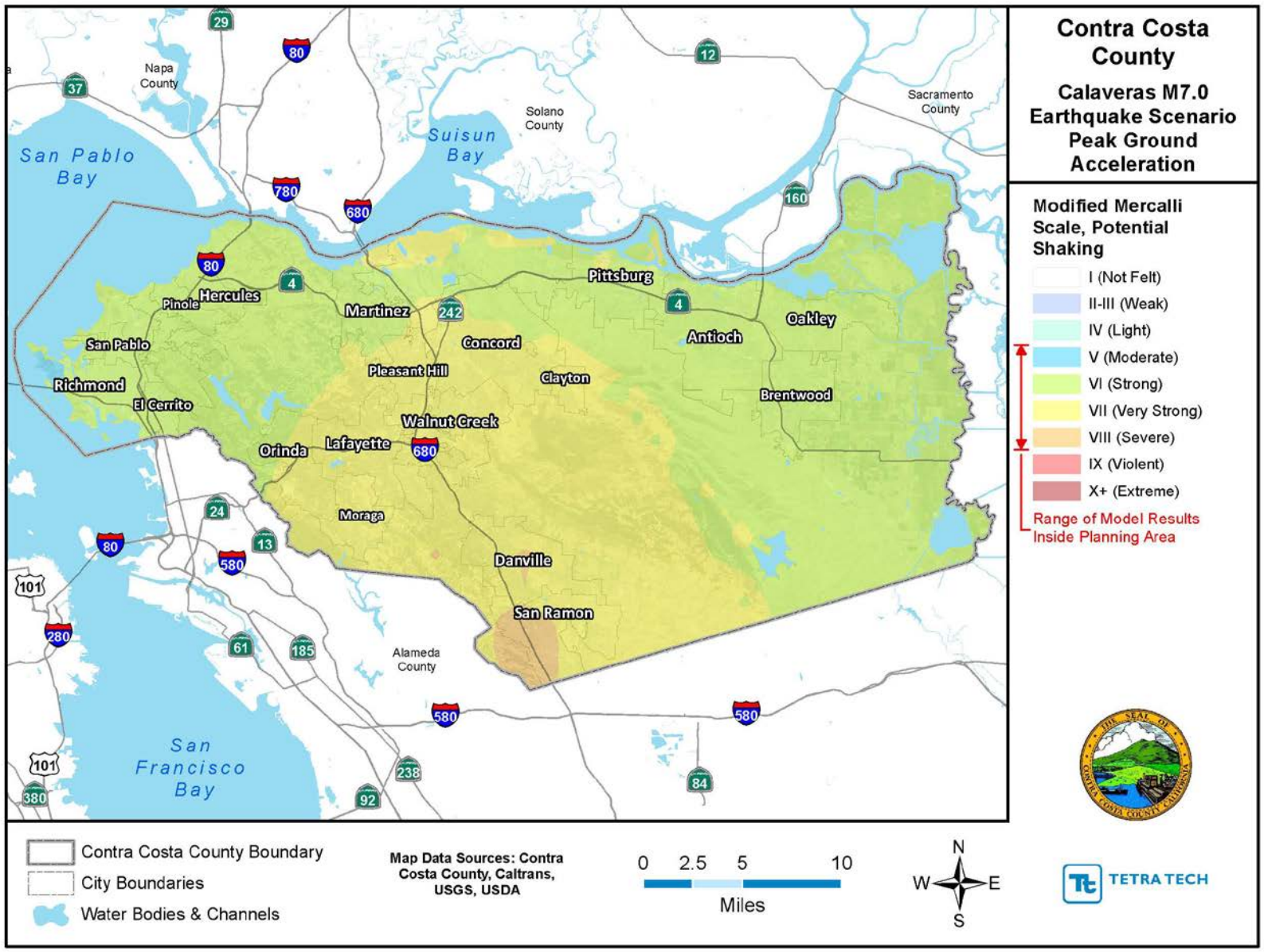


Figure 10. Concord Green Valley Earthquake Scenario

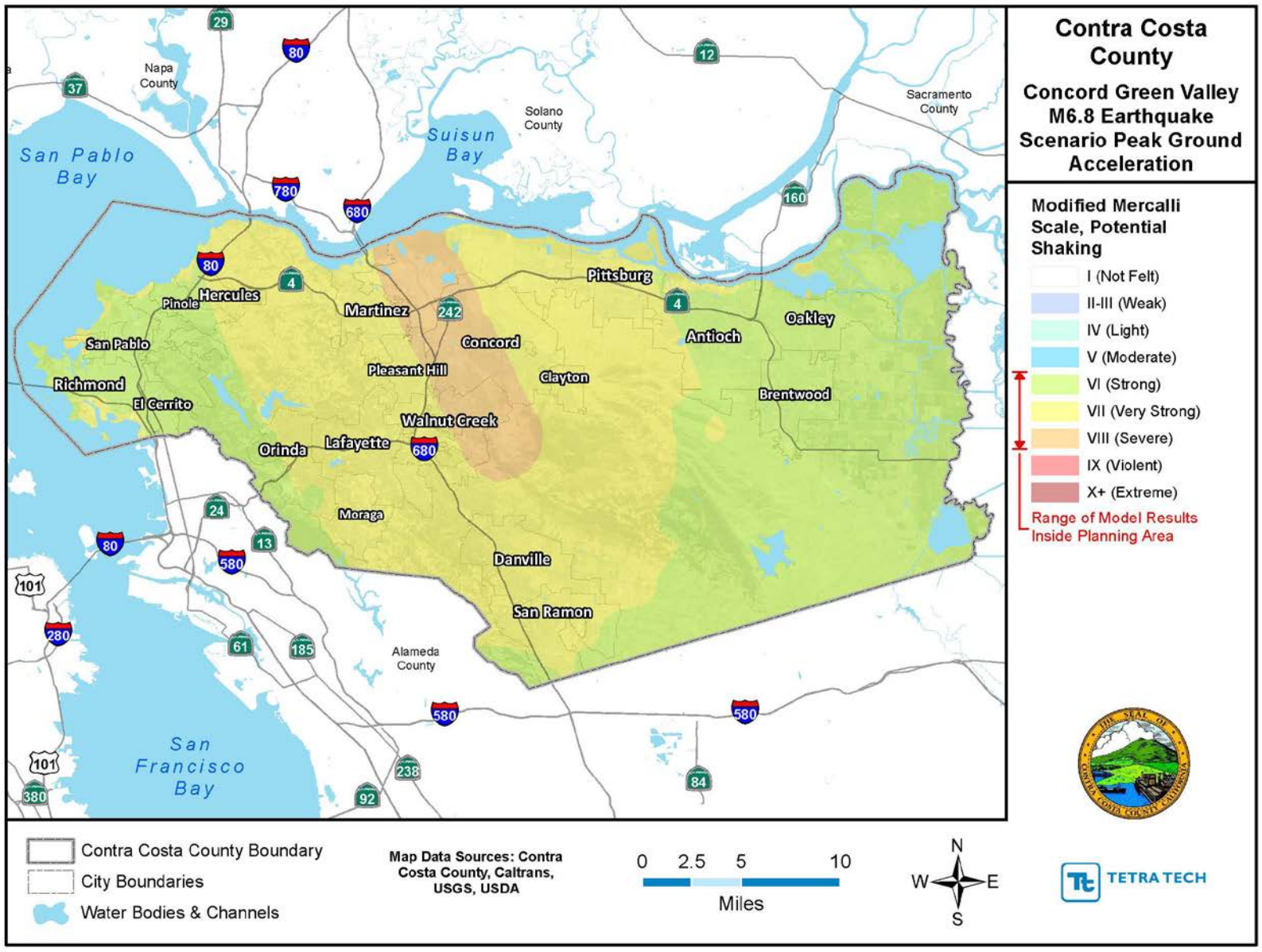


Figure 11. Greenville Earthquake Scenario

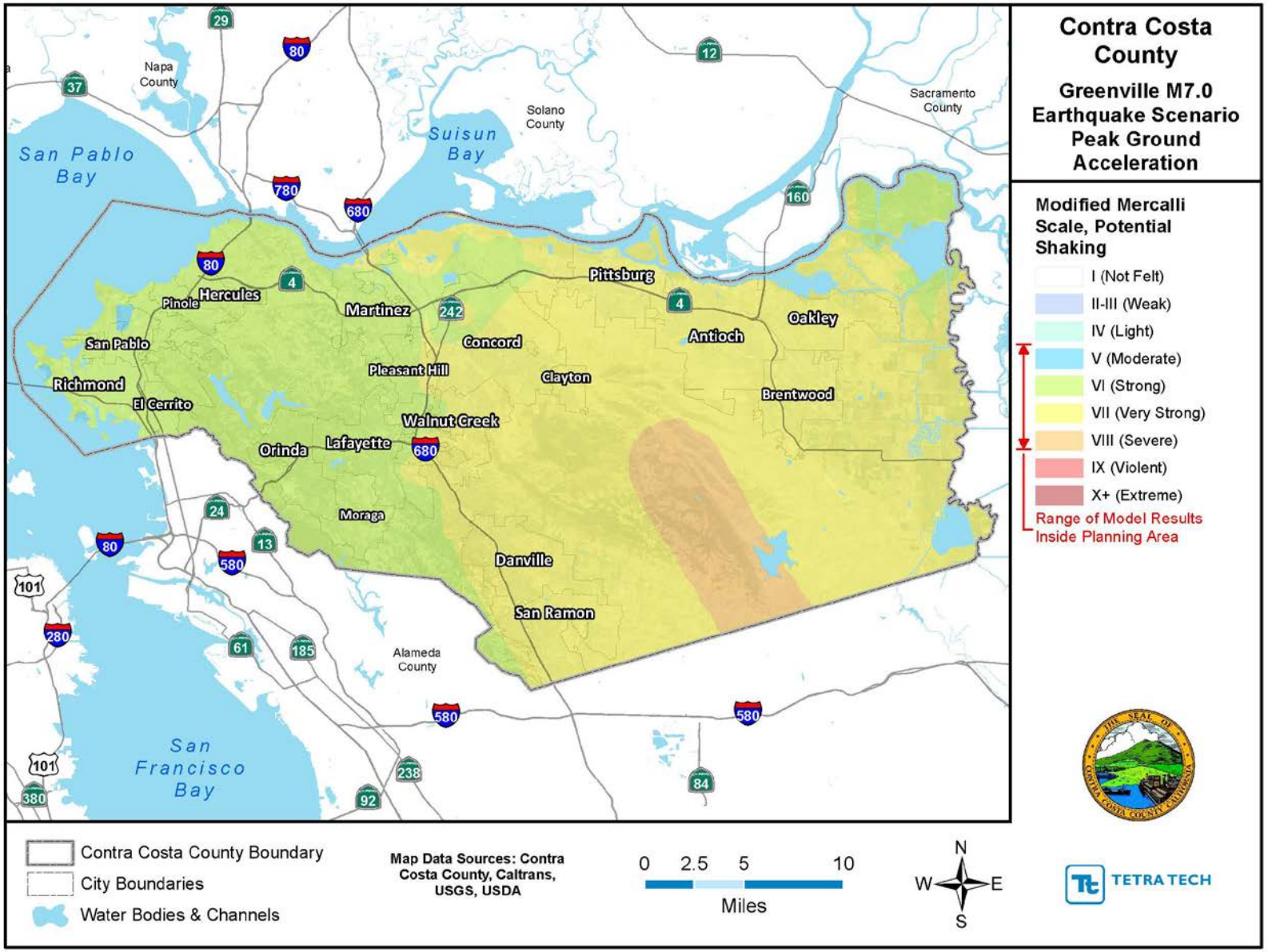


Figure 12. Haywired Earthquake Scenario

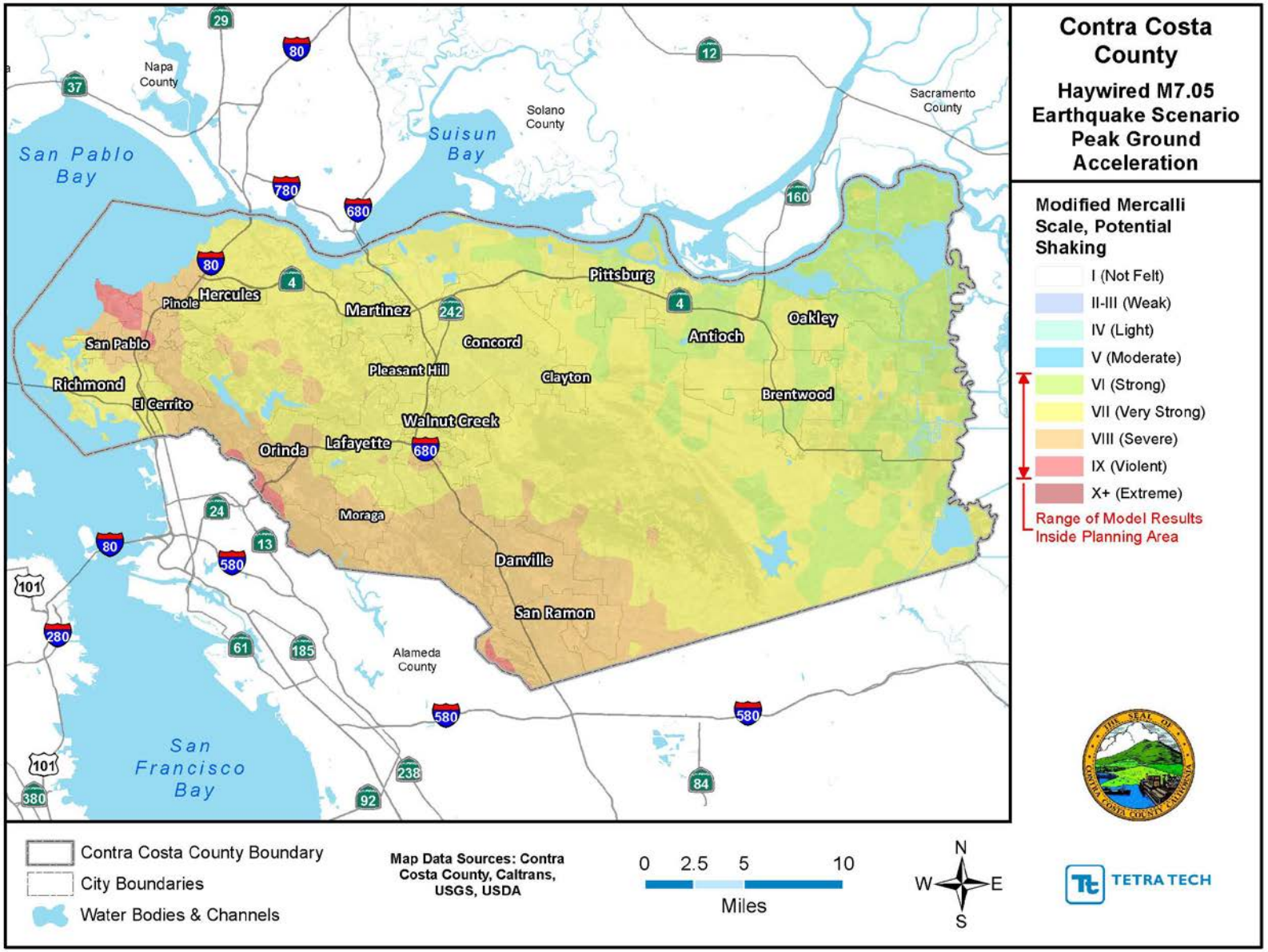


Figure 13. Mt. Diablo Earthquake Scenario

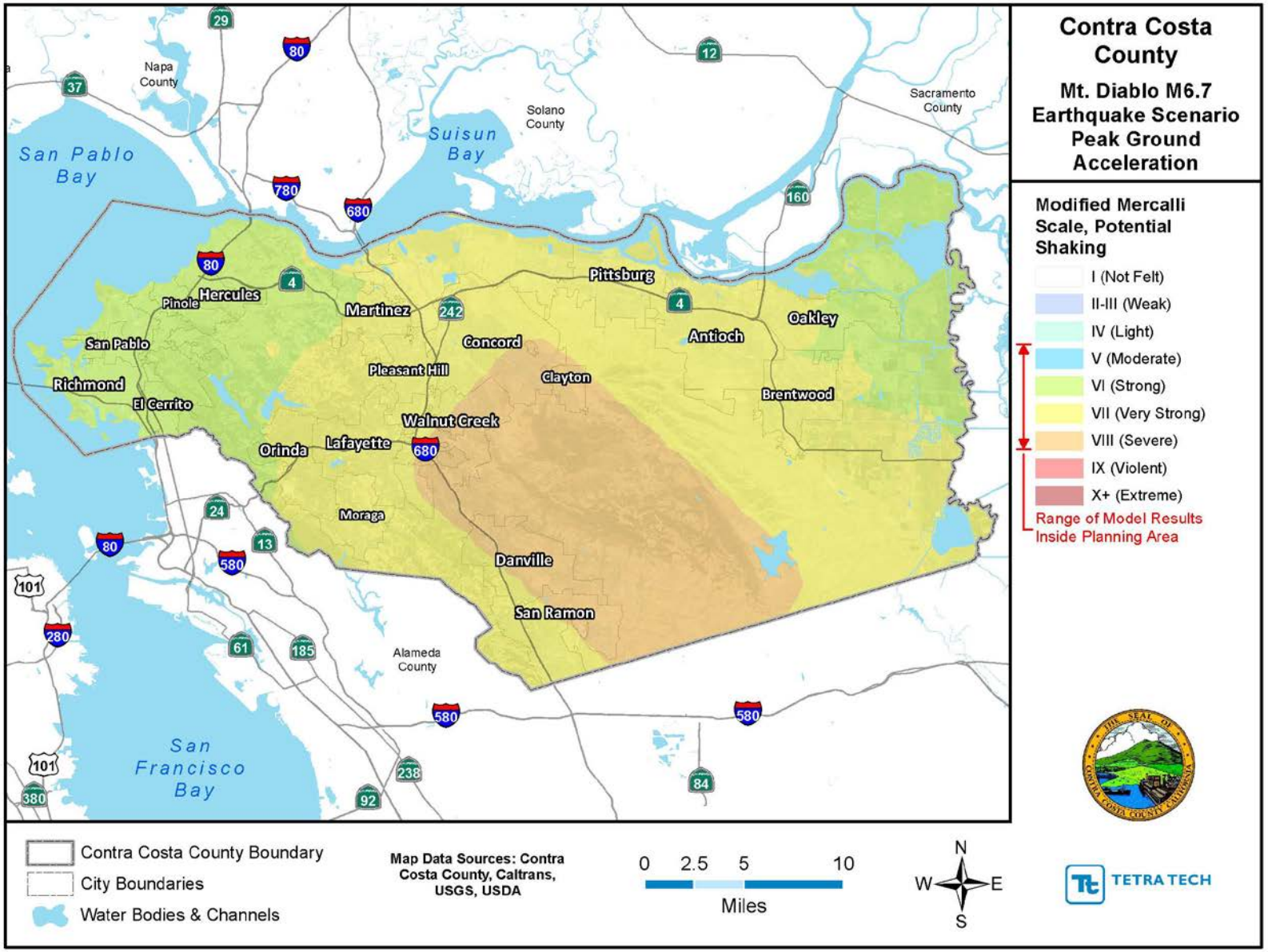


Figure 14. NEHRP Soil Class

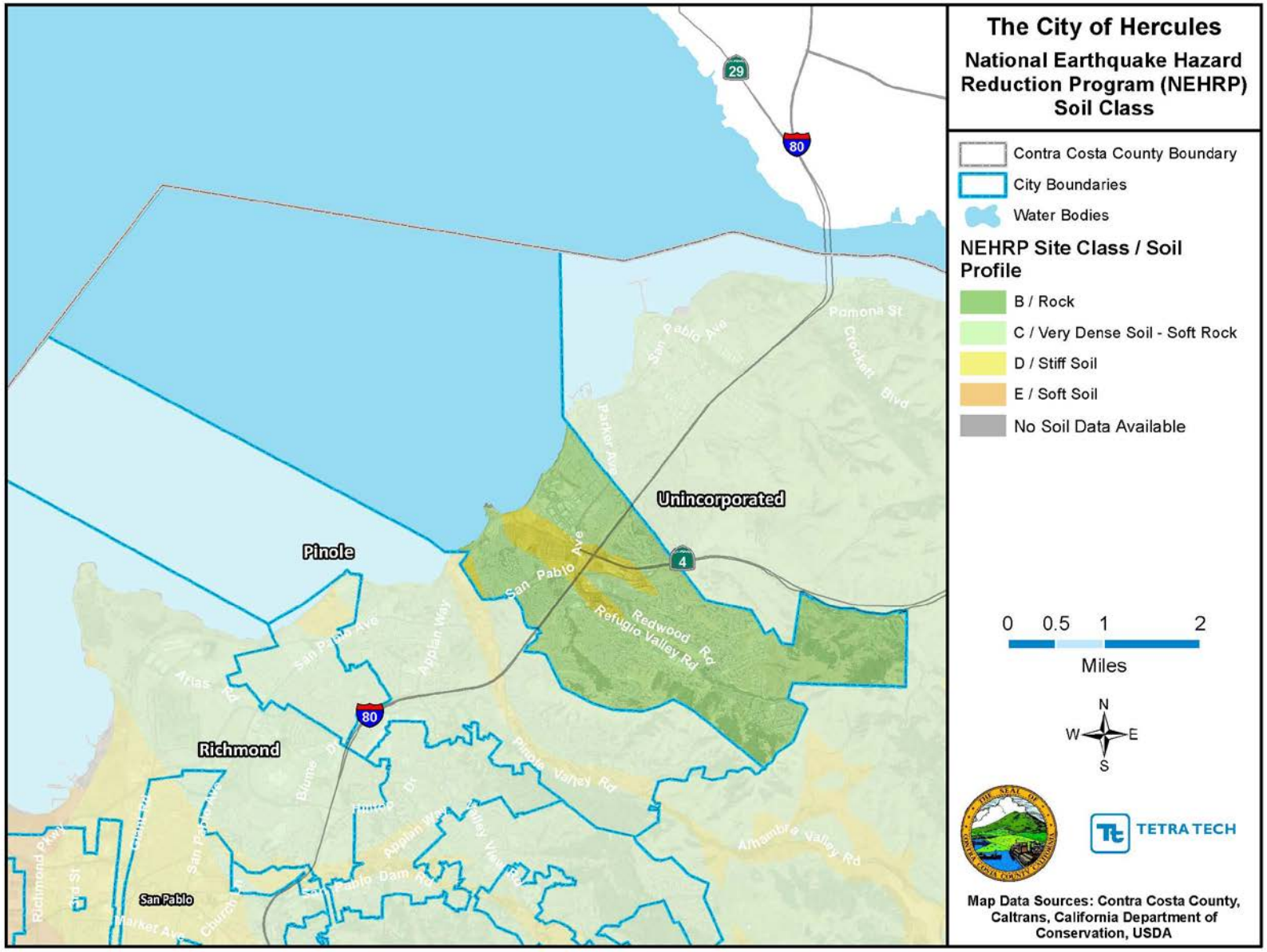
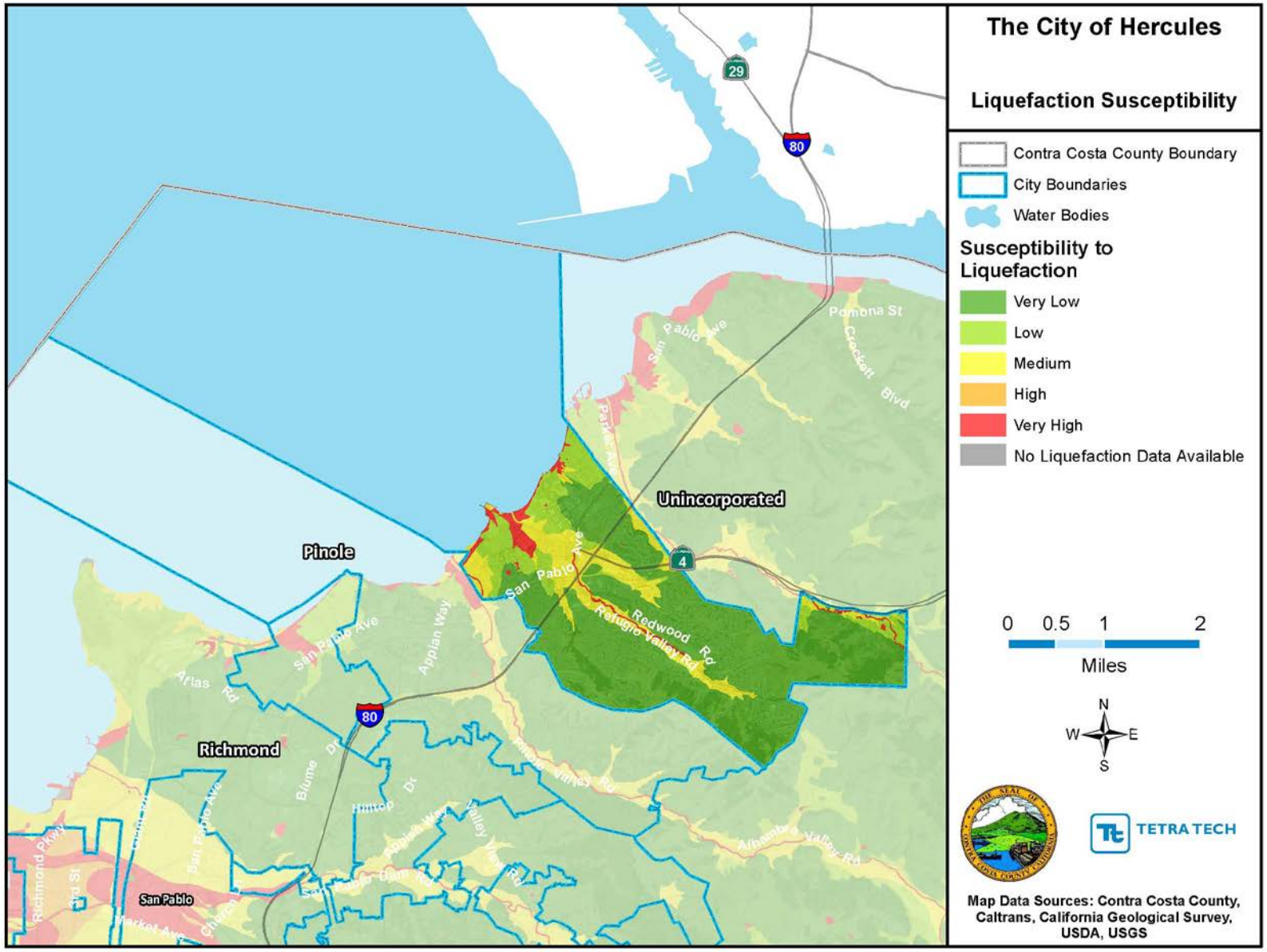


Figure 15. Liquefaction Susceptibility



NEHRP Soil Maps

NEHRP soil types define the locations that will be significantly impacted by an earthquake. NEHRP Soils B and C typically can sustain low-magnitude ground shaking without much effect. The areas that are most commonly affected by ground shaking have NEHRP Soils D, E and F. Figure 14 shows NEHRP soil classifications in the Hercules.

Liquefaction Maps

Soil liquefaction maps are useful tools to assess potential damage from earthquakes. When the ground liquefies, sandy or silty materials saturated with water behave like a liquid, causing pipes to leak, roads and airport runways to buckle, and building foundations to be damaged. In general, areas with NEHRP Soils D, E and F are also susceptible to liquefaction. If there is a dry soil crust, excess water will sometimes come to the surface through cracks in the confining layer, bringing liquefied sand with it, creating sand boils. Figure 15 shows the liquefaction susceptibility in the planning area.

Alquist-Priolo Zone Maps

The sliding movement of earth on either side of a fault is called a fault rupture. Fault rupture begins below the ground surface at the earthquake hypocenter, typically between 3 and 10 miles below the ground surface in California. If an earthquake is large enough, the fault rupture will travel to the ground surface, potentially destroying structures built across its path (Cal OES, 2013).

California's Alquist-Priolo Zone maps define regulatory zones for potential surface fault rupture where fault lines intersect with future development and populated areas. The purpose of these maps is to assist in a geologic investigation before construction begins to ensure that structures will not be located on an active fault. Contra Costa County is located in a designated Alquist-Priolo Zone for active faults (California Department of Conservation, 2010).

Alquist-Priolo maps were referenced, but not specifically used, in the assessment of risk for this plan. This plan assumes that the studies conducted and information provided by the State of California are the best available data for surface rupture risk and could not be improved through a separate assessment for this plan. Alquist-Priolo maps are available to the public on the California Department of Conservation website.

Frequency

California experiences hundreds of earthquakes each year, most with minimal damage and magnitudes below 3.0 on the Richter Scale. Earthquakes that cause moderate damage to structures occur several times a year. According to the USGS, a strong earthquake measuring greater than 5.0 on the Richter Scale occurs every 2 to 3 years and major earthquakes of more than 7.0 on the Richter Scale occur once a decade.

The U.S. Geological Survey has estimated that there is a 72 percent probability of one or more earthquakes of magnitude 6.7 or greater (comparable to the 1989 Loma Prieta earthquake of magnitude 6.9) in the San Francisco Bay Area between 2014-2043., with the Hayward Fault having the highest probability of 33%. Ground shaking, rather than surface fault rupture, is the cause of most damage during earthquakes.

The 2013 State of California Multi-Hazard Mitigation Plan cites projections that in the next 30 years there is more than a 99-percent probability of a Magnitude 6.7 earthquake in California and a 94-percent probability of a Magnitude 7.0 earthquake. Probabilities for earthquakes on major fault lines in the San Francisco Bay Area have

been estimated by the USGS in a 2016 report (see Table 15). The Hayward and Rodgers Creek Faults have high potential for experiencing major to great events.

Table 15. Earthquake Probabilities for San Francisco Bay Area, 2017-2043

Fault	Probability of One or More M≥6.7 Quake 2014-2043
Hunting Creek	16%
Green Valley	16%
Concord	16%
Greenville	16%
Berryessa	16%
Calaveras	26%
Maacama	8%
Rodgers Creek Fault	33%
Hayward	33%
San Andreas	22%
San Gregorio	6%

Source: USGS, 2016

Severity

The severity of an earthquake can be expressed in terms of intensity or magnitude:

- Intensity represents the observed effects of ground shaking at any specified location. The intensity of earthquake shaking lessens with distance from the earthquake epicenter. Tabulated peak ground accelerations for a listed "maximum credible earthquakes" are a measure of how a site will be affected by seismic events on distant faults.
- Magnitude represents the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments. Magnitude is thus represented by a single, instrumentally determined value.

USGS ground motion maps, based on current information about fault zones, show the Peak Ground Acceleration that has a certain probability of being exceeded in a 50-year period. The maps, last updated in 2014 with the best currently available data, show that the PGA with a 10-percent probability of exceedance in 50 years for Contra Costa County is 0.4g (see Table 4). ABAG estimates a potential loss of 159,000 housing units in Bay Area communities after a large earthquake. This loss would have disastrous effects on local and regional economies. Recovery, repair, and rebuilding time for each household would be lengthy.

Warning Time

There is no current reliable way to predict the day or month that an earthquake will occur at any given location. Research is being done with warning systems that use the low energy waves that precede major earthquakes. These potential warning systems give approximately 40 seconds notice that a major earthquake is about to occur. The warning time is very short but it could allow for someone to get under a desk, step away from a hazardous material they are working with, or shut down a computer system.

Secondary Hazards

Earthquakes can cause disastrous landslides. River valleys are vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. 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.

Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes. Earthen dams and levees are highly susceptible to seismic events, and the impacts of their eventual failures can be considered secondary risk exposure to earthquakes. Depending on the location, earthquakes can also trigger tsunamis. Tsunamis significantly damage many locations beyond what the earthquake struck; however, coastal communities near the earthquake epicenter that are also vulnerable to tsunamis could experience devastating impacts. Additionally, fires can result from gas lines or power lines that are broken or downed during the earthquake. It may be difficult to control a fire, particularly if the water lines feeding fire hydrants are also broken.

Exposure

Population

The entire population of the planning area is potentially exposed to direct and indirect impacts from earthquakes. Whether directly impacted or indirectly impact, 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.

Property

There are 8,284 buildings in the planning area, with a total replacement value of $4.178 billion (Table 16). Since all structures in the planning area are susceptible to earthquake impacts to varying degrees, this represents the property exposure to seismic events.

Critical Facilities and Infrastructure

All critical facilities in the planning area (see Table 11 and Table 12) are exposed to the earthquake hazard. Hazardous materials releases can occur during an earthquake from fixed facilities or transportation-related incidents. Transportation corridors can be disrupted during an earthquake, leading to the release of materials to the surrounding environment. Facilities holding hazardous materials are of particular concern because of possible isolation of neighborhoods surrounding them. 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

Table 16. Building Earthquake Exposure

	Total # of Buildings	Total Building Value—Structure and Contents
Hercules	8,284	$4,178,980,493

The following major roads in the planning area intersect moderate to very high liquefiable soils and thus are exposed to earthquakes:

- Interstate 80
- State Hwy 4
- John Muir Parkway

Environment

Environmental problems as a result of an earthquake can be numerous. Secondary hazards will likely have some of the most damaging effects on the environment. Earthquake-induced landslides can significantly damage surrounding habitat. It is also possible for streams to be rerouted after an earthquake. Rerouting can change the water quality, possibly damaging habitat and feeding areas. Streams fed by groundwater wells can dry up because of changes in underlying geology.

Vulnerability

Earthquake vulnerability data was generated using a Hazus analysis. Once the location and size of a hypothetical earthquake are identified, Hazus estimates the intensity of the ground shaking, the number of buildings damaged, the number of casualties, the damage to transportation systems and utilities, the number of people displaced from their homes, and the estimated cost of repair and clean up.

Population

Residents of High Risk Areas

The degree of vulnerability is dependent on many factors, including the age and construction type of the structures people live in, the soil type their homes are constructed on, their proximity to fault location, etc. There are estimated to be 25,343 people living in the City of Hercules all of which are vulnerable to earthquake hazards.

Susceptible Population Groups

Two groups are particularly vulnerable to earthquake hazards:

Population Below Poverty Level—An estimated 3.3% of households in areas have household incomes at or less than the poverty level. These households may lack the financial resources to improve their homes to prevent or mitigate earthquake damage. Economically disadvantaged residents are also less likely to have insurance to compensate for losses in earthquakes.

Population Over 65 Years Old—An estimated 14.6% or 3,709 residents in the city are over 65 years old. This population group is vulnerable because they are more likely to need special medical attention, which may not be available due to isolation caused by earthquakes. Elderly residents also have more difficulty leaving their homes during earthquake events and could be stranded in dangerous situations.

Estimated Impacts on Persons and Households

Impacts on persons and households in the planning area were estimated for the five selected earthquake scenarios through the Hazus analysis. Table 17 summarizes the results.

Table 17. Estimated Earthquake Impact on Persons

Scenario	Number of Displaced Households	Number of Persons Requiring Short-Term Shelter
Calaveras North Central	15	12
Concord-Green Valley	59	45
Greenville	15	11
Haywired	398	266
Mount Diablo	14	11

Property

There are approximately 1,555 buildings on moderate to very high liquefiable soils in Hercules, or about 19% of the total building stock, on these soils.

Loss Potential

Property losses were estimated through the Hazus analysis for the five scenario events. Results for two types of property loss are shown on Table 18 through Table 22:

- Structural loss, representing damage to building structures
- Contents loss, representing the value of lost contents and inventory, relocation, income loss, rental loss, and wage loss.

Table 18. Loss Estimates for Calaveras (North Central) Fault Scenario Earthquake

Estimated Loss Associated with Earthquake			% of Total Replacement Value
Structure	Contents	Total	
$20,554,472	$7,342,326	$27,896,798	0.7%

Table 19. Loss Estimate for Concord- Green Valley Fault Scenario Earthquake

Estimated Loss Associated with Earthquake			% of Total Replacement Value
Structure	Contents	Total	
$58,279,030	$20,629,448	$78,908,478	1.9%

Table 20. Loss Estimates for Greenville Fault Scenario Earthquake

Estimated Loss Associated with Earthquake			% of Total Replacement Value
Structure	Contents	Total	
$15,117,244	$5,854,570	$20,971,814	0.5%

Table 21. Loss Estimates for Haywired Fault Scenario Earthquake

Estimated Loss Associated with Earthquake			% of Total Replacement Value
Structure	Contents	Total	
$310,159,915	$88,843,782	$399,003,696	9.5%

Table 22. Loss Estimates for Mount Diablo Fault Scenario Earthquake

Estimated Loss Associated with Earthquake			% of Total Replacement Value
Structure	Contents	Total	
$18,447,602	$6,990,786	$25,438,389	0.6%

Debris Estimates: The Hazus analysis also estimated the amount of earthquake-caused debris in the planning area for the five scenario events, as summarized in Table 23.

Table 23. Estimated Earthquake-Caused Debris

Earthquake Scenario	Debris to Be Removed (tons)
Calaveras (North Central)	4.74
Concord-Green Valley	14.11
Greenville	3.31
Haywired	104.54
Mount Diablo	4.01

Critical Facilities and Infrastructure

Level of Damage: Hazus classifies the vulnerability of critical facilities to earthquake damage in five categories: no damage, slight damage, moderate damage, extensive damage, or complete damage. The model was used to assign a probability of each damage state to every critical facility in the planning area, which was then averaged across the facility category. The results for the five fault scenario events are summarized in Table 24 through Table 28.

Time to Return 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 five fault scenarios. Results are summarized in Table 29 through Table 33.

Table 24. Estimated Damage to Critical Facilities From Calaveras (North Central) Fault Scenario

Category	Probability of Experiencing Damage Level (Average for All Facilities in Category)				
	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	N/A	N/A	N/A	N/A	N/A
Government Functions	95.13%	4.81%	0.05%	0%	0%
Protective Functions	95.13%	4.84%	0.05%	0%	0%
Schools	93.62%	6.28%	0.9%	0%	0%
Hazardous Materials	N/A	N/A	N/A	N/A	N/A
Bridges	93.65%	5.46%	0.50%	0.32%	0.04%
Water Supply	93.53%	5.78%	0.67%	0%	0%
Wastewater	93.53%	5.78%	0.67%	0%	0%
Power	95.38%	4.19%	0.41%	0%	0%
Communications	91.36%	8.04%	0.56%	0%	0%
Other Critical Infrastructure	95.13%	4.81%	0.05%	0%	0%

Table 25. Estimated Damage to Critical Facilities from Concord-Green Valley Fault Scenario

Category	Probability of Experiencing Damage Level (Average for All Facilities in Category)				
	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	N/A	N/A	N/A	N/A	N/A
Government Functions	92.11%	7.76%	0.12%	0%	0%
Protective Functions	90.81%	7.66%	0.15%	0.13%	1.25%

Schools	92.86%	5.17%	0.39%	0.28%	1.25%
Hazardous Materials	N/A	N/A	N/A	N/A	N/A
Bridges	88.03%	9.72%	1.16%	0.91%	0.15%
Water Supply	89.02%	9.53%	1.42%	0.01%	0%
Wastewater	89.02%	9.53%	1.42%	0.01%	0%
Power	90.10%	6.31%	0.82%	0.26%	2.49%
Communications	80.25%	9.89%	6.87%	0.93%	2.04%
Other Critical Infrastructure	89.50%	7.55%	0.18%	0.26%	2.49%

Table 26. Estimated Damage to Critical Facilities from Greenville Fault Scenario

Category	Probability of Experiencing Damage Level (Average for All Facilities in Category)				
	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	N/A	N/A	N/A	N/A	N/A
Government Functions	98.84%	1.13%	0.01%	0%	0%
Protective Functions	98.84%	1.13%	0.01%	0%	0%
Schools	98.84%	1.13%	0.01%	0%	0%
Hazardous Materials	N/A	N/A	N/A	N/A	N/A
Bridges	96.13%	3.36%	0.29%	0.18%	0.02%
Water Supply	98.49%	1.40%	0.09%	0%	0%
Wastewater	98.49%	1.40%	0.09%	0%	0%
Power	98.64%	1.26%	0.08%	0%	0%
Communications	95.92%	3.95%	0.12%	0%	0%
Other Critical Infrastructure	98.84%	1.13%	0.01%	0%	0%

Table 27. Estimated Damage to Critical Facilities from Haywired Fault Scenario

Category	Probability of Experiencing Damage Level (Average for All Facilities in Category)				
	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	N/A	N/A	N/A	N/A	N/A
Government Functions	29.68%	57.45%	12.75%	0.10%	0%
Protective Functions	31.47%	47.92%	9.58%	1.56%	9.46%
Schools	45.76%	40.87%	6%	1.06%	6.30%
Hazardous Materials	N/A	N/A	N/A	N/A	N/A
Bridges	23.23%	30.01%	10.80%	20.92%	15.02%
Water Supply	15.10%	32.64%	47.66%	4.53%	0.04%
Wastewater	1.52%	9.85%	53.38%	24.74%	10.47%
Power	11.71%	26.84%	45.76%	5.59%	10.07%
Communications	15.38%	27.09%	36.25%	3.70%	17.56%

Other Critical Infrastructure	32.63%	48.84%	8.47%	0.06%	9.99%

Table 28. Estimated Damage to Critical Facilities from Mount Diablo Fault Scenario

Category	Probability of Experiencing Damage Level (Average for All Facilities in Category)				
	No Damage	Slight Damage	Moderate Damage	Extensive Damage	Complete Damage
Medical and Health	N/A	N/A	N/A	N/A	N/A
Government Functions	95.13%	4.81%	0.05%	0%	0%
Protective Functions	95.13%	4.81%	0.05%	0%	0%
Schools	95.04%	4.84%	0.08%	0.02%	0.01%
Hazardous Materials	N/A	N/A	N/A	N/A	N/A
Bridges	93.65%	5.46%	0.50%	0.32%	0.04%
Water Supply	93.53%	5.78%	0.67%	0%	0%
Wastewater	96.66%	3.06%	0.27%	0%	0%
Power	95.38%	4.19%	0.41%	0%	0%
Communications	83.51%	6.63%	4.09%	3.35%	2.41%
Other Critical Infrastructure	95.13%	4.81%	0.05%	0%	0%

Table 29. Functionality of Critical Facilities for Calaveras (North Central) Fault Scenario

Category	# of Critical Facilities	Probability of Being Fully Functional (%)					
		At Day 1	At Day 3	At Day 7	At Day 14	At Day 30	At Day 90
Medical and Health	0	N/A	N/A	N/A	N/A	N/A	N/A
Government Functions	1	95.1	95.2	99.8	99.9	99.9	99.9
Protective Functions	2	95.1	95.2	99.8	99.9	99.9	99.9
Schools	6	95.1	95.2	99.8	99.9	99.9	99.9
Hazardous Materials	0	N/A	N/A	N/A	N/A	N/A	N/A
Bridges	6	97.8	99.4	99.6	99.6	99.6	99.8
Water Supply	1	95.4	99.6	99.9	99.9	99.9	99.9
Wastewater	1	95.4	99.1	99.9	99.9	99.9	99.9
Power	1	97.5	99.7	99.9	99.9	99.9	99.9
Communications	2	99.7	99.9	99.9	99.9	99.9	99.9
Other Critical Infrastructure	1	99.9	99.9	99.9	99.9	99.9	99.9

Table 30. Functionality of Critical Facilities for Concord-Green Valley Fault Scenario

Category	# of Critical Facilities	Probability of Being Fully Functional (%)					
		At Day 1	At Day 3	At Day 7	At Day 14	At Day 30	At Day 90

Medical and Health	0	N/A	N/A	N/A	N/A	N/A	N/A
Government Functions	1	90.8	90.9	98.2	98.4	98.55	98.6
Protective Functions	2	95.1	95.2	99.8	99.9	99.9	99.9
Schools	6	88.7	88.9	98.0	98.3	99.1	99.3
Hazardous Materials	0	N/A	N/A	N/A	N/A	N/A	N/A
Bridges	6	95.6	98.5	98.9	98.9	99	99.5
Water Supply	1	92.2	99.2	99.8	99.9	99.9	99.9
Wastewater	1	92.1	98.4	99.8	99.9	99.9	99.9
Power	1	93.4	96.9	97.5	97.8	98.7	99.9
Communications	2	94.0	97.4	97.8	98.3	98.7	99.7
Other Critical Infrastructure	1	97.4	97.5	97.5	97.6	97.7	98.2

Table 31. Functionality of Critical Facilities for Greenville Fault Scenario

Category	# of Critical Facilities	Probability of Being Fully Functional (%)					
		At Day 1	At Day 3	At Day 7	At Day 14	At Day 30	At Day 90
Medical and Health	0	N/A	N/A	N/A	N/A	N/A	N/A
Government Functions	1	98.8	98.8	99.9	99.9	99.9	99.9
Protective Functions	2	98.8	98.8	99.9	99.9	99.9	99.9
Schools	6	98.8	98.8	99.9	99.9	99.9	99.9
Hazardous Materials	0	N/A	N/A	N/A	N/A	N/A	N/A
Bridges	6	98.7	99.7	99.8	99.8	99.8	99.9
Water Supply	1	98.9	99.9	99.9	99.9	99.9	99.9
Wastewater	1	98.9	99.8	99.9	99.9	99.9	99.9
Power	1	99.2	99.9	99.9	99.9	99.9	99.9
Communications	2	99.9	99.9	99.9	99.9	99.9	99.9
Other Critical Infrastructure	1	99.9	99.9	99.9	99.9	99.9	99.9

Table 32. Functionality of Critical Facilities for Haywired Fault Scenario

Category	# of Critical Facilities	Probability of Being Fully Functional (%)					
		At Day 1	At Day 3	At Day 7	At Day 14	At Day 30	At Day 90
Medical and Health	0	N/A	N/A	N/A	N/A	N/A	N/A
Government Functions	1	29.6	30.9	85.8	87.1	99.8	99.9
Protective Functions	2	31.4	32.5	78.3	79.4	88.9	89.7
Schools	6	45.7	46.6	85.6	86.6	92.6	93.1
Hazardous Materials	0	N/A	N/A	N/A	N/A	N/A	N/A
Bridges	6	49.8	60.6	64.9	65.9	67.5	78.9
Water Supply	1	36.2	71.5	92.5	96.2	96.4	97.6
Wastewater	1	12.9	32.8	60.8	66	68.8	88.7

Power	1	29.8	62.4	87.5	91.2	94.9	99.9
Communications	2	64.0	82.0	84.1	86.3	89.5	98.1
Other Critical Infrastructure	1	85.6	89.7	91.1	91.2	91.5	93

Table 33. Functionality of Critical Facilities for Mount Diablo Fault Scenario

Category	# of Critical Facilities	Probability of Being Fully Functional (%)					
		At Day 1	At Day 3	At Day 7	At Day 14	At Day 30	At Day 90
Medical and Health	0	N/A	N/A	N/A	N/A	N/A	N/A
Government Functions	1	95.1	95.2	99.8	99.9	99.9	99.9
Protective Functions	2	95.1	95.2	99.8	99.9	99.9	99.9
Schools	6	95.0	95.1	99.7	99.8	99.9	99.9
Hazardous Materials	0	N/A	N/A	N/A	N/A	N/A	N/A
Bridges	6	97.8	99.4	99.6	99.6	99.6	99.8
Water Supply	1	95.4	99.6	99.9	99.9	99.9	99.9
Wastewater	1	97.6	99.6	99.9	99.9	99.9	99.9
Power	1	97.5	99.7	99.9	99.9	99.9	99.9
Communications	2	93.2	95.5	96.4	97.6	98.5	99.7
Other Critical Infrastructure	1	99.9	99.9	99.9	99.9	99.9	99.9

Future Development Trends

Land use in the planning area will be directed by general plans adopted under California's General Planning Law. The safety elements of the general plans establish standards and plans for the protection of the community from hazards. The information in this plan provides a tool to ensure that there is no increase in exposure in areas of high seismic risk. Development in the planning area will be regulated through building standards and performance measures so that the degree of risk will be reduced. The geologic hazard portions of the planning area are heavily regulated under California's General Planning Law. The International Building Code establishes provisions to address seismic risk.

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. River valley hydraulic-fill sediment areas are also vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Soil liquefaction would occur in water-saturated sands, silts or gravelly soils.

Issues

- More information is needed on the exposure and performance of soft-story construction within the planning area.
- Based on the modeling of critical facility performance performed for this plan, a moderate 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.
- 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.
- Residents are expected to be self-sufficient up to 3 days after a major earthquake without government response agencies, utilities, private-sector services, and infrastructure components. Education programs are currently in place to facilitate development of individual, family, neighborhood, and business earthquake preparedness. Government alone can never make this region fully prepared. It takes individuals, families, and communities working in concert with one another to truly be prepared for disaster.
- After a major seismic event, Hercules is likely to experience disruptions in the flow of goods and services resulting from the destruction of major transportation infrastructure across the broader region.

LANDSLIDE

The U.S. Geological Survey definition of landslides includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors. Landslides and mudslides can be initiated by storms, earthquakes, fires, volcanic eruptions or human modification of the land.

When landslides occur—in response to such changes as increased water content, earthquake shaking, addition of load, or removal of downslope support—they deform and tilt the ground surface. The result can be destruction of foundations, offset of roads, breaking of underground pipes, or overriding of downslope property and structures. They can move rapidly down slopes or through channels, and can strike with little or no warning at avalanche speeds, posing a serious hazard to properties on or below hillsides.

The USGS defines land subsidence as the loss of surface elevation due to the removal of subsurface support. In California, the two principal causes for land subsidence are aquifer compaction due to excessive groundwater pumping and decomposition of wetland soils exposed to air after wetland conversion to farmland.

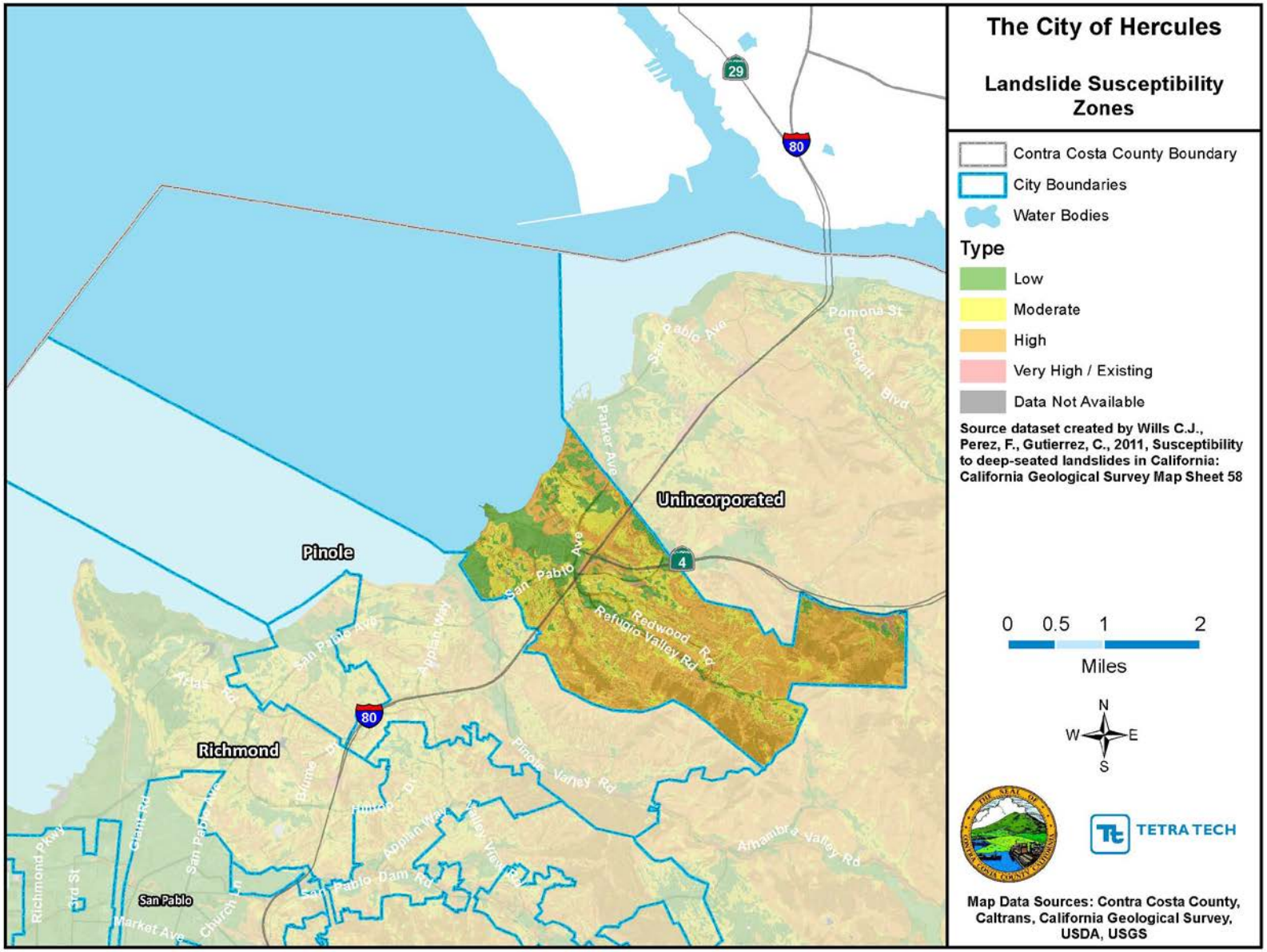
Landslide Hazard Profile

Past Events

Numerous shallow landslides of various sizes are present in Hercules, particularly in the southeastern part of the City. As recently as 2000 and 2006, landslides occurred and several homes were lost following heavy rains (Table 10).

In addition to the landslides, soil creep movements are occurring on certain slopes within the City. Creep movement is generally most active and widespread on the steeper slopes. Rates and depths of creep movement are much slower and shallower than those associated with active landslides.

Figure 16. Landslide Susceptibility



Location

The best available predictor of where movement of slides and earth flows might occur is the location of past movements. Past landslides can be recognized by their distinctive topographic shapes, which can remain in place for thousands of years. Most 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 proportion of them may become active in any given year, with movements concentrated within all or part of the landslide masses or around their edges.

The recognition of ancient dormant mass movement sites is important in the identification of areas susceptible to flows and slides because they 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.

In 2011, the California Geological Survey conducted a statewide analysis of landslide susceptibility using a combination of regional rock strength and slope data to create classes of susceptibility. The methodology used for the analysis assumed, in general, that landslide susceptibility is low on very low slopes in all rock materials, and that susceptibility increases with slope and in weak rocks. The analysis also factored in locations of past landslides. Figure 16 shows the susceptibility classes grouped into low, moderate, high, and very high/existing landslide categories.

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. In the City of Hercules, landslides typically occur during and after severe storms, so the potential for landslides largely coincides with the potential for sequential severe storms that saturate steep, vulnerable soils. According to the National Centers for Environmental Information's storm event database, the planning area has been impacted by severe storms at least once every three years. Until better data is generated specifically for landslide hazards, this severe storm frequency is appropriate for the purpose of ranking risk associated with the landslide hazard.

Severity

Landslides destroy property and infrastructure and can take the lives of people. Slope failures in the United States result in an average of 25 lives lost per year and an annual cost to society of about $1.5 billion. Landslides can pose a serious hazard to properties on or below hillsides. When landslides occur — in response to such changes as increased water content, earthquake shaking, addition of load, or removal of downslope support − they deform and tilt the ground surface. The result can be destruction of foundations, offset of roads, breaking of underground pipes, or overriding of downslope property and structures. The landslides experienced in Hercules have been relatively minor but have required the demolition of multiple home.

Warning Time

Mass movements 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. Some methods used to monitor mass movements 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. 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 road beds
- 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

Secondary Hazards

Landslides can cause several types of secondary effects, such as blocking access to 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.

Exposure

Population

Exposure to the population could not be examined by landslide hazard area because census block group areas do not coincide with the hazard areas. However, population was estimated using the residential building count in each mapped hazard area and multiplying by the 2018 estimated average population per household. Using this approach, the estimated population living in the “moderate landslides” risk area is 10,450, the estimated population living in “high landslide” risk area is 8,885 and the estimated population living in “very high landslide” risk area is 12. The total population exposed to moderate, high and very high landslide areas is 19,347.

Property

The number and replacement value of exposed structures in the moderate, high and very high landslide risks areas are listed below. Over 99 percent of the exposed structures are dwellings.

Exposure and Value of Structures in Moderate Landslide Risk Areas: 3,350 residential, 9 commercial, 5 industrial, 2 religion, 3 government, and 2 education structures.

Table 34. Exposure and Value of Structures in Moderate Landslide Risk Areas

Total Number of Structures	Structure Value	Contents Value	Total Value
3,371	$972,407,558	$588,638,003	$1,561,045,560

Exposure and Value of Structures in High Landslide Risk Areas: 2,844 residential, 14 commercial, 6 industrial, 1 government, and 1 education structures.

Table 35. Exposure and Value of Structures in High Landslide Risk Areas

Total Number of Structures	Structure Value	Contents Value	Total Value
2,866	$928,430,952	$553,081,968	$1,481,512,920

Exposure and Value of Structures in Very High Landslide Risk Areas: 4 residential structures.

Table 36. Exposure and Value of Structures in Very High Landslide Risk Areas

Total Number of Structures	Structure Value	Contents Value	Total Value
4	$1,395,982	$697,991	$2,093,973

Critical Facilities and Infrastructure: Critical facilities and infrastructure exposed to the landslide hazard are summarized below. No loss estimation of these facilities was performed due to the lack of established damage functions for the landslide hazard.

Table 37. Critical Facilities in High Landslide Risk Areas

Facility Name	Address	Facility/ Infrastructure Type
Rodeo Hercules Fire Station	1680 Refugio Valley Rd.	Protective Functions
Hanna Ranch Elementary School	2482 Refugio Valley Rd.	School and Educational
Hercules High School	1900 Refugio Valley Rd.	School and Educational
Franklin Substation	1213 Willow Ave.	Power
Luzon Voter Site		Communication

Table 38. Critical Facilities in Moderate Landslide Risk Areas

Facility Name	Address	Facility/ Infrastructure Type
AT&T Switching Office / Facility	1540 Sycamore Avenue	Communication
City of Hercules EOC	111 Civic Drive.	Government
San Pablo Ave.		Bridge
Hercules Police Department	1213 Willow Ave.	Protective Functions
Mendocino Reservoir	1100 Block Turquoise Drive	Water Supply
Ohlone Elementary School	1616 Pheasant Dr.	School and Educational
Junior High School (Future site)	Refugio Valley Rd.	School and Educational
City of Hercules		Wastewater

A significant amount of infrastructure can be exposed to landslides:

- Roads—Access to major roads after a disaster is crucial to safety and to response operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems and delays for public and private transportation. This can result in economic losses for businesses.
- Bridges—Landslides can significantly impact road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- Power Lines−Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.

Environment

Environmental problems as a result of mass movements can be numerous. 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 for prolong periods of time due to landslides.

Vulnerability

Population

Due to the nature of census data, it is difficult to determine demographics of populations vulnerable to mass movements. In general, all of the estimated 6,198 persons exposed to higher 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.

Property

Although only a partial list of historical landslides in Hercules is available, the available records suggest a significant vulnerability to this hazard. 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 39 shows the general building stock loss estimates in the moderate, high, and very high landslide risk areas**.**

Table 39. Loss Potential in the Combined Moderate, High and Very High Landslide Risk Areas

	Estimated Loss Potential from Landslide		
Exposed Value	10% Damage	30% Damage	50% Damage
$3,044,652,453	$304,465,245	$913,395,736	$1,522,326,227

Critical Facilities and Infrastructure

There are 13 critical facilities exposed to the landslide hazard to some degree. 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.

Several types of infrastructure are exposed to mass movements, including transportation, water and sewer and power infrastructure. At this time all infrastructure and transportation corridors identified as exposed to the landslide hazard are considered vulnerable until more information becomes available.

Environment

The environment vulnerable to landslide hazard is the same as the environment exposed to the hazard.

Future Development Trends

Hercules has experienced moderate growth over the past 10 years, averaging a 1 percent increase in population every year from 2010 through 2019. The city is equipped to handle future growth within landslide hazard areas. Landslide risk areas are addressed in the Hercules General Plan Safety Element. The city will be referencing and

linking their General Plan to this hazard mitigation plan. This will create an opportunity for wise land use decisions as future growth impacts landslide hazard areas.

The State of California has adopted the International Building Code (IBC) by reference in its California Building Standards Code. 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.

Scenario

Landslides in Hercules occur as a result of soil conditions that have been affected by severe storms, groundwater or human development. The worst-case scenario for landslide hazards in the planning area would generally correspond to a severe storm that had heavy rain and caused flooding. Landslides are most likely during late winter when the water table is high. After heavy rains from November to December, 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. A short intense storm could cause saturated soil to move, resulting in landslides. As rains continue, the groundwater table rises, adding to the weakening of the slope. Gravity, poor drainage, a rising groundwater table and poor soil exacerbate hazardous conditions.

Mass movements are becoming more of a concern as development moves outside of city centers and into areas less developed in terms of infrastructure. Most mass movements would be isolated events affecting specific areas. It is probable that private and public property, including infrastructure, will be affected. Mass movements could affect bridges that pass over landslide prone ravines and knock out rail service through the county. Road obstructions caused by mass movements would create isolation problems for residents and businesses in sparsely developed areas. Property owners exposed to steep slopes may suffer damage to property or structures. Landslides carrying vegetation such as shrubs and trees may cause a break in utility lines, cutting off power and communication access to residents.

Continued heavy rains and flooding will complicate the problem further. As emergency response resources are applied to problems with flooding, it is possible they will be unavailable to assist with landslides in multiple locations around the city.

Issues

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

- There are existing homes in landslide risk areas throughout the city. The degree of vulnerability of these structures depends on the codes and standards the structures were constructed to. Information to this level of detail is not currently available.
- 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.
- The impact of climate change on landslides is uncertain. If climate change impacts atmospheric conditions, then exposure to landslide risks is likely to increase.
- Landslides may cause negative environmental consequences, including water quality degradation.
- 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.

SEVERE WEATHER

Severe weather refers to any dangerous meteorological phenomena with the potential to cause damage, serious social disruption, or loss of human life. It includes thunderstorms, downbursts, tornadoes, waterspouts, snowstorms, ice storms, and dust storms. Severe weather can be categorized into two groups: systems that form over wide geographic areas are classified as general severe weather; those with a more limited geographic area are classified as localized severe weather. Severe weather, technically, is not the same as extreme weather, which refers to unusual weather events at the extremes of the historical distribution for a given area.

The most common severe weather events that impact the planning area are heavy rains/atmospheric rivers/thunderstorms, extreme heat, and damaging winds. These types of severe weather are described in the following sections.

When reading this section, it is important to note that when the term "severe weather" is used, it is referring in aggregate to the sub-hazards profiled in this chapter (heavy rain/atmospheric rivers/thunderstorms, extreme heat and wind). These hazards have been grouped for the following reasons:

- Each hazard can impact and has impacted the entire planning area and has no clearly defined extent or location mapping.
- Records indicate that each of these hazards has impacted the planning area to some degree, and all have similar frequencies of occurrence based on these records.
- Because there is no clearly defined extent or location mapping available for these hazards, no quantitative, geospatial analysis is available to support exposure or vulnerability analysis. Therefore, the analyses for these hazards are qualitative and are based on the aggregate exposure of all the sub-hazards.

Heavy Rain, Atmospheric River or Thunderstorm

Most severe storms in the Hercules consist of atmospheric rivers, heavy rains or thunderstorms. Heavy rain refers to events where the amount of rain exceeds normal levels. The amount of precipitation needed to qualify as heavy rain varies with location and season. Heavy rain is distinct from climate change analyses on increasing precipitation. It does not mean that the total amount of precipitation at a location has increased, just that the rain is occurring in a more intense event. More frequent heavy rain events, however, can serve as indicators of changing precipitation levels. Heavy rain is most frequently measured by tracking the frequency of events, analyzing the mean return period, and measuring the amount of precipitation in a certain period (most typically inches of rain within a 24-hour period) (EPA, 2016).

A relatively common weather pattern that brings southwest winds and heavy rain to California is often referred to as an atmospheric river. Atmospheric rivers are long, narrow regions in the atmosphere that transport most of the water vapor carried away from the tropics. These columns of vapor move with the weather, carrying large amounts of water vapor and strong winds. When the atmospheric rivers make landfall, they often release this water vapor in the form of rain or snow, causing flooding and mudslide vents.

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as "severe" when it contains one or more of the following: hail with a diameter of three-quarter inch or greater, winds gusting in excess of 50 knots (57.5 mph), or tornado. Tornadoes are not common in Hercules; only four have been recorded in the County since 1950. All were F0-rated tornadoes except one rated EF1.

Three factors cause thunderstorms to form: moisture, rising unstable air (air that keeps rising when disturbed), and a lifting mechanism to provide the disturbance. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise (hills or mountains can cause rising motion, as can the interaction of warm air and cold air or wet air and dry air) it will continue to rise as long as it weighs less and stays warmer than

the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool and it condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound waves we hear as thunder.

There are four types of thunderstorms:

- **Single-Cell Thunderstorms**—Single-cell thunderstorms usually last 20 to 30 minutes. A true single-cell storm is rare, because the gust front of one cell often triggers the growth of another. Most single-cell storms are not usually severe, but a single-cell storm can produce a brief severe weather event. When this happens, it is called a pulse severe storm.
- **Multi-Cell Cluster Storm**—A multi-cell cluster is the most common type of thunderstorm. The multi-cell cluster consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. Mature cells are usually found at the center of the cluster and dissipating cells at the downwind edge. Multi-cell cluster storms can produce moderate-size hail, flash floods and weak tornadoes. Each cell in a multi-cell cluster lasts only about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.
- **Multi-Cell Squall Line**—A multi-cell line storm, or squall line, consists of a long line of storms with a continuous well-developed gust front at the leading edge. The line of storms can be solid, or there can be gaps and breaks in the line. Squall lines can produce hail up to golf-ball size, heavy rainfall, and weak tornadoes, but they are best known as the producers of strong downdrafts. Occasionally, a strong downburst will accelerate a portion of the squall line ahead of the rest of the line. This produces what is called a bow echo. Bow echoes can develop with isolated cells as well as squall lines. Bow echoes are easily detected on radar but are difficult to observe visually.
- **Super-Cell Storm**—A super-cell is a highly organized thunderstorm that poses a high threat to life and property. It is similar to a single-cell storm in that it has one main updraft, but the updraft is extremely strong, reaching speeds of 150 to 175 miles per hour. Super-cells are rare. The main characteristic that sets them apart from other thunderstorms is the presence of rotation. The rotating updraft of a super-cell (called a mesocyclone when visible on radar) helps the super-cell to produce extreme weather events, such as giant hail (more than 2 inches in diameter), strong downbursts of 80 miles an hour or more, and strong to violent tornadoes.

NOAA classifies a thunderstorm as a storm with lightning and thunder produced by cumulonimbus clouds, usually producing gusty winds, heavy rain, and sometimes hail. Thunderstorms are usually short in duration (seldom more than two hours). Heavy rains associated with thunderstorms can lead to flash flooding during the wet or dry season. According to the American Meteorological Society Glossary of Meteorology, thunderstorms are reported as light, medium, or heavy according to the following characteristics:

- Nature of the lightning and thunder
- Type and intensity of the precipitation, if any
- Speed and gustiness of the wind
- Appearance of the clouds
- Effect on surface temperature.

Hail Storms

Hail occurs when updrafts in thunderstorms carry raindrops upward into extremely cold areas of the atmosphere where they freeze into ice. Eventually, the hailstones encounter downdraft air and fall to the ground.

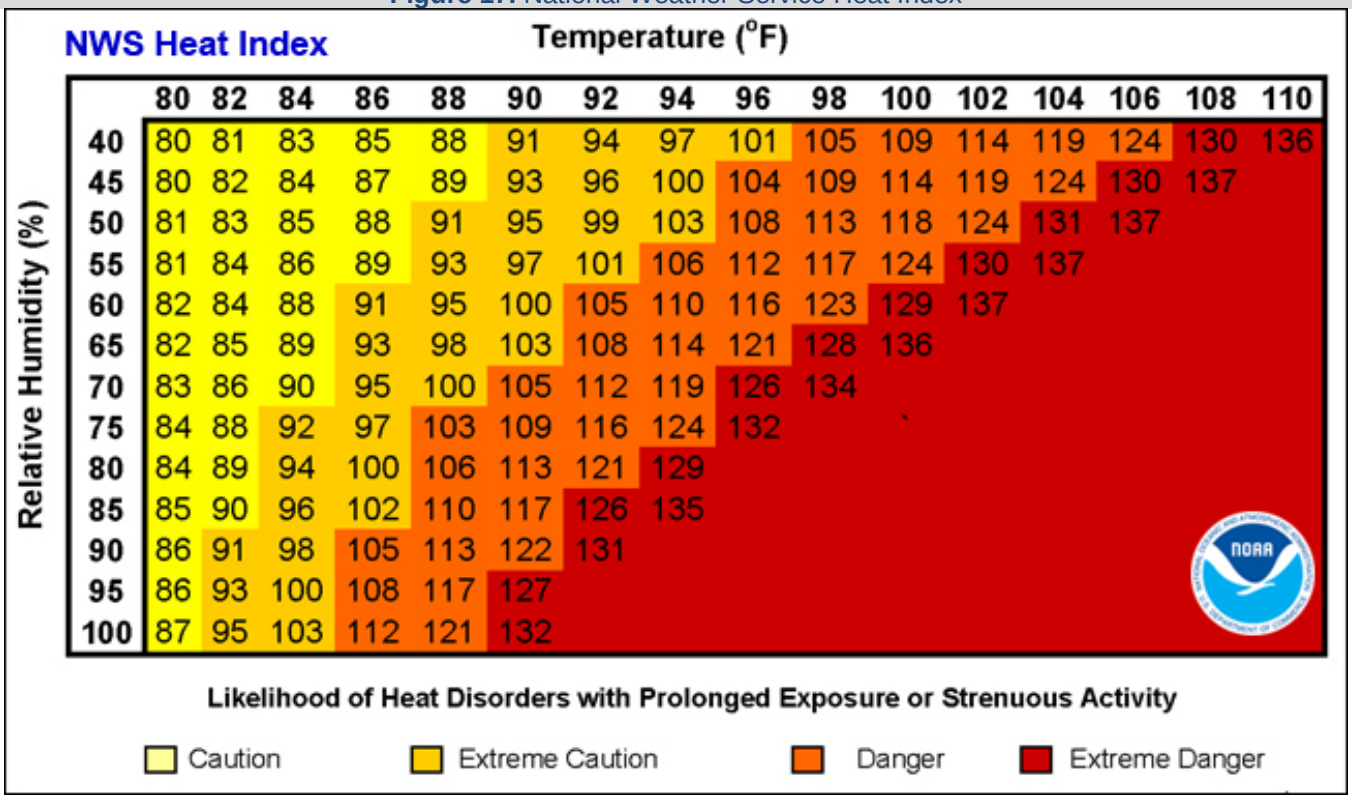
Hailstones grow two ways: by wet growth or dry growth. In wet growth, a tiny piece of ice is in an area where the air temperature is below freezing, but not super-cooled. When the tiny piece of ice collides with a super-cooled drop, the water does not freeze on the ice immediately. Instead, liquid water spreads across tumbling hailstones and slowly freezes. Since the process is slow, air bubbles can escape, resulting in a layer of clear ice. Dry growth hailstones grow when the air temperature is well below freezing and the water droplet freezes immediately as it collides with the ice particle. The air bubbles are "frozen" in place, leaving cloudy ice.

Hailstones can have layers like an onion if they travel up and down in an updraft, or they can have few or no layers if they are "balanced" in an updraft. One can tell how many times a hailstone traveled to the top of the storm by counting its layers. Hailstones can begin to melt and then re-freeze together, forming large and very irregularly shaped hail.

Extreme Heat

Extreme heat is unexpected, unusual, or unseasonable hot temperature that can create dangerous situations. It is defined as temperatures that hover 10ºF or more above the average high temperatures for the region for several weeks. Ambient air temperature and relative humidity are components of heat conditions, together defining a heat index, as shown in Figure 17. Extreme heat is the primary weather-related cause of death in the U.S. In a 30-year average of weather fatalities across the nation from 1986-2015, excessive heat claimed more lives each year than floods, lightning, tornadoes, and hurricanes. In 2015, heat claimed 45 lives, though none of them were in California (NOAA, 2017).

Figure 17. National Weather Service Heat Index



Damaging Winds

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.

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.

Severe Weather Hazard Profile

Past Events

Table 40 summarizes severe weather events in the Contra Costa County area since 1980, as recorded by the NOAA National Centers for Environmental Information Storm Events Database and FEMA disaster declarations. Contra Costa County has been included in nine FEMA declarations for severe weather events.

Table 40. Past Severe Weather Events Impacting Planning Area

Dates of Event	FEMA Disaster	Event Type	Losses/Impacts
02/01 to 02/23/2017	4308	Severe storms, flooding, and mudslides	Great amounts of rain to the region caused widespread flooding, debris flow, accidents, and over topping of reservoir spillways.
1/22/2017	4305	Severe storms, flooding, and	Heavy rain, lightning, wind, hail, snow (above 2500 feet), and record breaking surf were observed in a series of three storms.
1/03 to 1/12/2017	4301	Severe storms, flooding, and mudslides	Strong winds, flooding, and debris flows occurred throughout this event. Snow was recorded at higher elevations. High winds with severe storm caused trees to cover roadways and power outages throughout the Bay Area.
10/24/2016	N/A	High Winds	Moderately strong winds occurred across the region and caused an 80-foot tree to topple over in a neighboring county.
2/6/2015	N/A	High Winds	A strong storm had wind gust of 62 mph.
12/11/2014	N/A	High Winds	A wind gust of 83 mph was measured with the severe storm event.
10/27/2013	N/A	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	N/A	High Winds	Strong northeast winds which gusted up to 62 mph led to critical fire weather conditions.
4/8/2013	N/A	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	N/A	High Winds	High winds hit the Bay Area with winds gusting to 60 mph and caused an estimated $150,000 in damage.

1/23/2010	N/A	Tornado	A low topped super cell produced an EF1 tornado near Brentwood. The tornado crossed power lines and destroyed a utility pole. An eyewitness described the tornado as high winds from a swirling white cloud. The 40-foot pole was twisted to the ground and the top one-third of it was splintered. 55 customers lost power.
1/19/2010	N/A	High Winds	High winds hit the Bay Area with winds gusting to 62 mph that caused power outages.
12/17/2005 to 1/3/2006	1628	Severe storms, flooding, mudslides, and landslides	A series of rain storm events caused significant runoff with localized evacuations, some slope failures, and road closures throughout the declared counties. Urban flooding initiated landslides that contributed to the damage. Much of the damage was in Walnut Creek, Richmond, San Pablo, Martinez and Orinda. Damaged facilities included schools, parks and several government agency structures.
2/17/2004	N/A	High Winds	Strong winter storm produced a 74 mph wind gust on Kregor Peak in the East Bay Hills.
12/14/2003	N/A	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.
11/7/2002	N/A	High Winds	For a three-day period starting on November 7, rainfall totaling 2 to 5 inches fell across the North Bay counties. Since this was the first appreciable rain of the season, no major flooding occurred, with the ground absorbing most of the rain. Only urban and small stream advisories were needed. 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. 96 mph gust at
1/25/2001	N/A	High Winds	A strong cold front from the northwest formed a squall line that produced high winds, small hail and snow as low as 800 feet. 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	N/A	High Winds	A gust of 71 mph was reported at the Oakland north Remote Automated Weather Station in Contra Costa County. A large Monterey Pine tree was blown down onto a house causing extensive damage in the Montclair district. 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	N/A	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.
12/21/1999	N/A	High Winds	A strong high pressure inland and a low offshore created strong northeasterly downslope wind in the Oakland and Contra Costa County hills. A strong offshore gradient created high down slope winds in the Oakland hills area. Many trees were downed and power was lost for 10,000 people. The event caused approximately $125,000 in damage.
2/9/1999	N/A	High Winds	Wind gusts up to 60 mph were reported in five Bay Area counties causing an estimated $1 million in damage.
12/16/1998	N/A	High Winds	Wind gusts up to 61 mph were reported in Alameda and Contra
12/5/1998	N/A	Tornado	An F0 tornado 150 yards wide and 1.5 miles long was reported in Richmond causing an estimated $200,000 in damage.
11/29/1998	N/A	High Winds	Wind gusts up to 75 mph were reported within eight bay area counties causing an estimated $1.8 million in damage.
2/19/1998	N/A	Tornado	Weak tornado (F0) demolished a shade structure at a nursery as well as a chicken coop and a tool shed causing an estimated $50,000 in damage.
2/02 to 4/30/1998	1203	Severe winter storms and El	$550 million; 17 deaths from El Niño causing widespread heavy rains, flooding, and landslides throughout the Bay Area. Record
12/28/1996 to 4/01/1997	1155	Severe storms, flooding, mud, landslides	300 square miles in California were flooded including the Yosemite Valley. Over 12,000 people were evacuated in northern California. Several levee breaks were reported across the Sacramento and San Joaquin Valleys. Over 23,000 homes and business, agricultural lands, bridges, and roads were damaged. Eight deaths resulted from this event. Overall, the state had $1.8 billion in damage.
12/9/1995	N/A	Winter Storm/High Winds	Widespread winds over 40 mph many reported 60 to 80 mph. Max wind 135 mph from PG&E in San Francisco Area. An estimated $60 million in damage was reported in San Francisco Bay area. Power outages to around 1.5 million people resulted from this storm and some power was out for more than a week, causing financial damage and personal hardship, particularly in mountainous areas. The wind strength and area coverage were labeled as the worst in the San Francisco area since 1962-63. Many reports of houses and other buildings damaged by falling trees and broken glass due to wind-driven debris. 169 schools closed in the area. 14 inches of rain in a 36-hour period over the Russian River Basin.
2/13 to 4/19/1995	1046	Severe winter storms, flooding, landslides, mud flows	Several feet of snow a day fell in the mountains. Winds to 80 mph were reported in mountains. Winds to 55 mph were reported along the coast south of Pt. Reyes. More than 1.5 million people were without power during this period, primarily the San Francisco Bay area. 89 mph winds in Belmont. Roof ripped off the San Ramon Valley High School.

1/03 to 2/10/1995	1044	Severe winter storms, flooding, landslides, mud	High winds with severe storm caused trees to cover roadways and power outages throughout the Bay Area.
11/4/1994	N/A	Strong Winds	South winds 42 mph gusting to 79 mph.
2/7/1994	N/A	Severe Thunderstorm	Severe weather developed in the cold air behind the first of two Pacific storm systems to hit California. The severe thunderstorm produced wind gusts in excess of 60 mph were reported within the County.
4/29/1983	N/A	Hail	Hail up to 0.75" was reported in portions of Contra Costa County.
1/05 to 3/20/1993	979	Severe winter storm, mud and	High winds with severe storm caused trees to cover roadways and power outages throughout the Bay Area.
1/21 to 3/30/1983	677	Coastal storms, floods, slides,	High winds with severe storm caused trees to cover roadways and power outages throughout the Bay Area.
12/19/1981 to 1/08/1982	651	Severe storms, flood, mudslides,	High winds with severe storm caused trees to cover roadways and power outages throughout the Bay Area.

Location

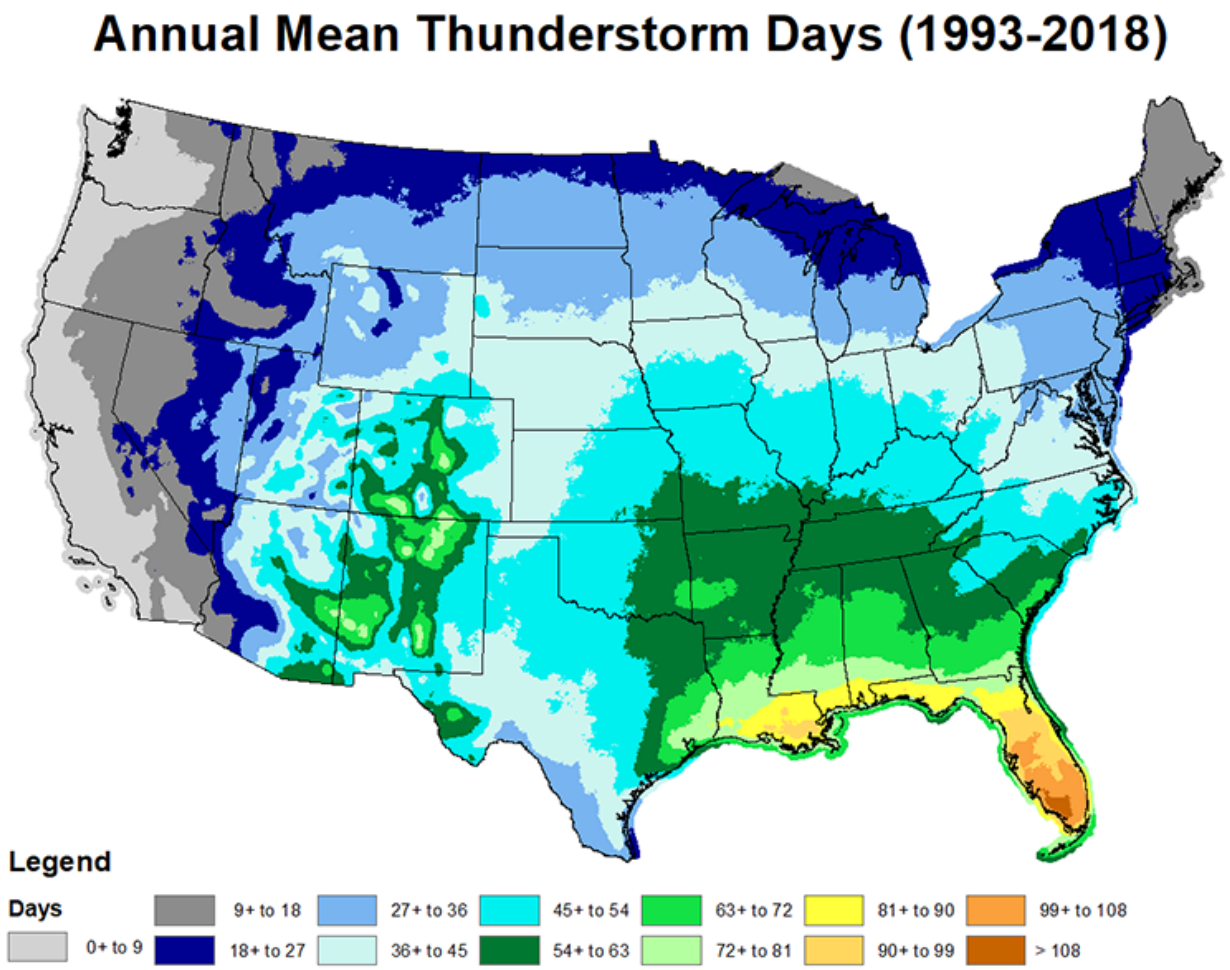
All severe weather events profiled in this assessment have the potential to happen anywhere in Hercules. Communities in low-lying areas next to streams are more susceptible to flooding. Wind events are most damaging to areas that are heavily wooded or at higher elevation.

Heavy Rain, Atmospheric River or Thunderstorm

The entire City of Hercules is vulnerable to heavy rainfall, thunderstorm and atmospheric river events as they make landfall in the Bay Area. These events can drop up to 12 inches of rain over a few days and cause widespread flooding and disruption to road and air travel.

Thunderstorms affect relatively small localized areas, rather than large regions. It is estimated that there are as many as 40,000 thunderstorms each day worldwide. Thunderstorms can strike in all regions of the United States; however, they are most common in the central and southern states. Figure 18 shows the annual number of thunderstorms in the United States. According to this figure, the planning area can experience between 0-9 thunderstorms each year (NWS, 2016).

Figure 18. Annual Number of Thunderstorm Days in United States



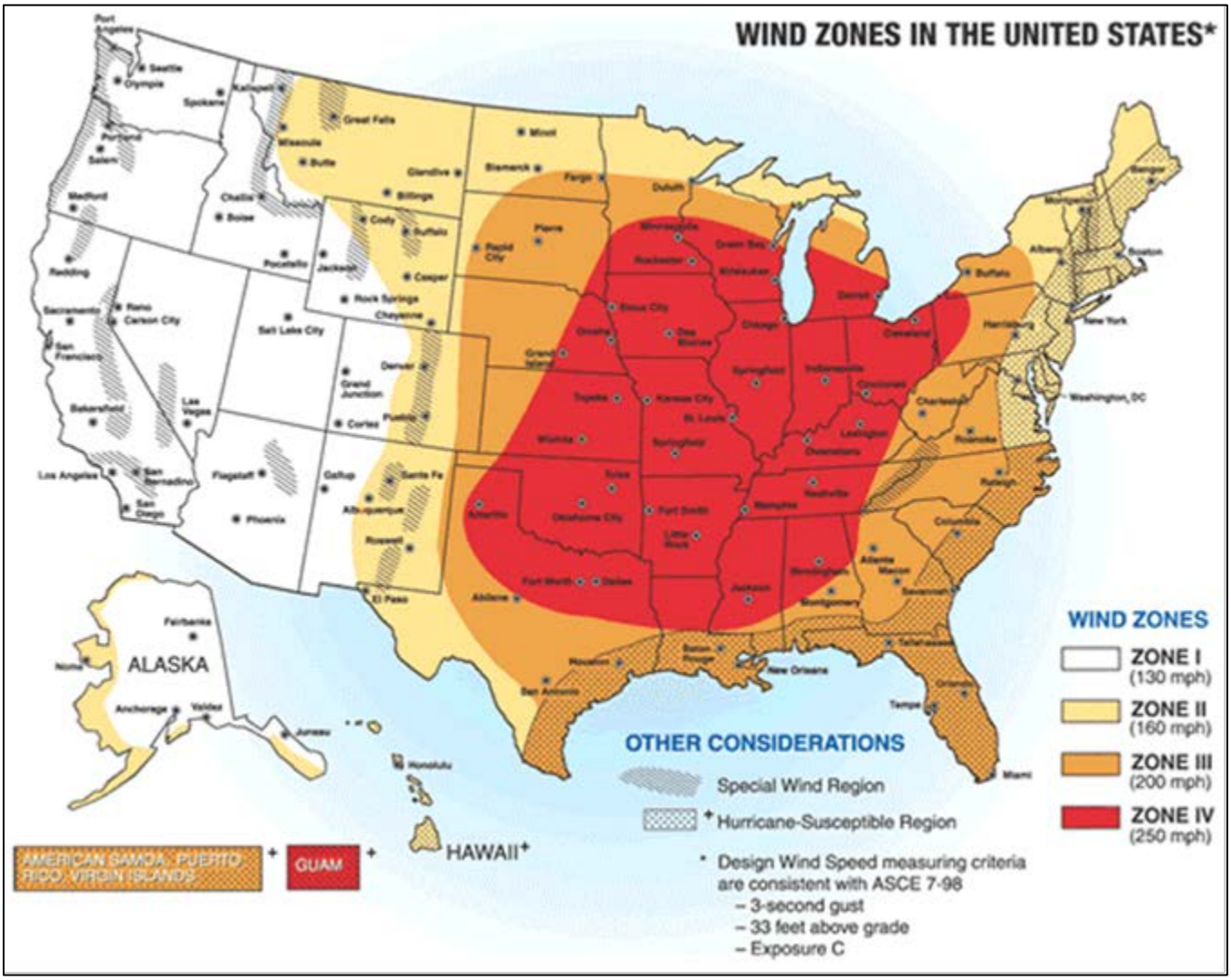
Extreme heat

Extreme heat can occur anywhere in the planning area and there is no clearly defined extent and location mapping available for this hazard to support geospatial analysis. Extreme heat is a concern to people, animals and pets a well as local nursery crops, cut flowers, and vegetable crops. However, it is rare that extreme heat events directly damage property or infrastructure.

Damaging Winds

The entire city is subject to high winds from thunderstorms and other severe weather events. Figure 19 indicates how the frequency and strength of windstorms impacts the United States and the general location of the most wind activity. Hercules is located in FEMA's Wind Zone I, where wind speeds can reach up to 130 mph.

Figure 19. Wind Zones in the United States



Source: FEMA, 2010

Frequency

Predicting the frequency of severe weather events in a constantly changing climate is a difficult task. Hercules can expect to experience exposure to and adverse impacts from some type of severe weather event at least annually.

Severity

The most common problems associated with severe storms are immobility and loss of utilities. Fatalities are uncommon, but can occur. Community members should pay close attention to changing weather conditions when there is a severe thunderstorm watch or warning. Lightning strikes are a danger during thunderstorms and can cause death or injury to one or several persons. Long-term injuries from lightning strike can include memory and attention loss, chronic numbness, muscle spasm, stiffness, depression, hearing loss and sleep disturbance. Seventy percent of all lightning injuries and fatalities occur in the afternoon; 85 percent of victims are children and young men (age 10 to 35) engaged in outdoor recreation and work activities. Hikers, campers, backpackers, skiers, fishermen, and hunters are especially vulnerable.

Roads may become impassable due to flooding, downed trees, or a landslide. Power lines may be downed due to high winds, and services such as water or phone may not be able to operate without power.

During periods of very high temperatures in the summer, those susceptible to extreme heat may suffer heat-related illnesses:

- **Heat Exhaustion**—Heat exhaustion is a mild form of heat-related illness that can develop after several days of exposure to high temperatures and inadequate or unbalanced replacement of fluids. It is the body's response to an excessive loss of the water and salt contained in sweat. Those most prone to heat exhaustion are elderly people, people with high blood pressure, and people working or exercising in a hot environment.
- **Heat Cramps**—Heat cramps usually affect people who sweat a lot during strenuous activity. This sweating depletes the body's salt and moisture. The low salt level in the muscles may be the cause of heat cramps. Heat cramps may also be a symptom of heat exhaustion.
- **Heat Stroke**—Heat stroke is a severe, dangerous form of heat-related illness. It occurs when the body's temperature rises rapidly, the sweating mechanism fails, and the body is unable to cool down. Body temperature may rise to 106°F or higher within 10 to 15 minutes. Heat stroke can cause death or permanent disability if emergency treatment is not provided. This is a medical emergency.

Heat has caused more than 9,000 deaths in the United States since 1979. Air-conditioning is the number one protective factor against heat-related illness and death. If a home is not air-conditioned, people can reduce their risk for heat-related illness by spending time in public facilities that are air-conditioned.

Windstorms can be a frequent problem in Hercules and have been known to cause damage to utilities. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one-minute average; gusts may be 25 to 30 percent higher.

Tornadoes are potentially the most dangerous of local storms, but they are not common in Hercules. If a major tornado were to strike within the populated areas of the planning area, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings may be damaged or destroyed. California ranks 32nd among states for frequency of tornadoes, 44th for the frequency of tornados per square mile, 36th for injuries, and 31st for cost of damage. The state has no reported deaths from tornadoes.

Heavy rain can have significant impacts, including flash flooding, mudslides and landslides. Stormwater runoff from heavy rains can also impair water quality by washing pollutants into water bodies (EPA, 2003).

Warning Time

Meteorologists can often predict the likelihood of a severe weather event. This can give several days of warning time. However, meteorologists cannot predict the exact time of onset or severity of the storm. Some storms may come on more quickly and have only a few hours of warning time. The San Francisco Bay Area Weather Forecast Office of the NWS monitors weather stations and issues watches and warnings when appropriate to alert government agencies and the public of possible or impending weather events. The watches and warnings are broadcast over NOAA weather radio and are forwarded to the local media for retransmission using the Emergency Alert System.

Secondary Hazards

The most significant secondary hazards associated with severe local storms are floods, falling and downed trees, mudslides, landslides and downed power lines. Landslides occur when the soil on slopes becomes oversaturated and fails.

Exposure

Population

A lack of clearly defined extent and location mapping for the severe weather hazards profiled in this chapter prevented a detailed analysis for exposure and vulnerability. However, it can be assumed that the entire planning area is exposed to some extent to the severe weather hazards profiled in this assessment. Certain areas are more exposed due to geographic location and local weather patterns. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and black out, while populations in low-lying areas are at risk for possible flooding.

Property

According to the Contra Costa County tax assessor data from January 2017, there are 8,284 buildings within the census tracts that define the planning area. Most of these buildings are residential All of these buildings are considered to be exposed to the severe weather hazard, but structures in poor condition or in particularly vulnerable locations (located on hilltops or exposed open areas) may risk the most damage. The frequency and degree of damage will depend on specific locations.

Critical Facilities and Infrastructure

All critical facilities such as bridges over creeks are likely exposed to all flooding due to severe weather hazards profiled in this assessment. Additional facilities on higher ground may also be exposed to wind damage or damage from falling trees. The most common problems associated with severe weather are loss of utilities. Prolonged periods of extreme heat could result in power outages caused by increased demand for power for cooling. Downed power lines associated with wind and/or thunderstorm events can cause blackouts, leaving large areas isolated. Phone, water and sewer systems may not function. Roads may become impassable due to secondary hazards such as mudslides and landslides.

Environment

The environment is highly exposed to severe weather events profiled in this assessment. Natural habitats such as streams and trees are exposed to the elements during a severe storm and risk major damage and destruction.

Prolonged rains can saturate soils and lead to slope failure. Flood events caused by severe weather or snowmelt can produce river channel migration or damage riparian habitat. Storm surges can erode beachfront bluffs and redistribute sediment loads. Vegetation can die as a result of prolonged periods of extreme heat.

Vulnerability

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:

- **Thunderstorms**—Nationally, lightning is one of the leading causes of weather-related fatalities (CDC, 2014). Lightning strikes are far more common in other areas of the country than they are in the west. The majority of injuries and deaths associated with lighting strikes occur when people are outdoors; however, almost one-third of lightning-related injuries occur indoors. Males are five times more likely than females to be struck by lighting and people between the ages of 15 and 34 account for 41 percent of all lightning strike victims (CDC, 2014).
- **Extreme Temperatures**—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.

Property

All property is vulnerable during the severe weather events profiled in this chapter, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Those in higher elevations and on ridges may be more prone to wind damage. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse. Extreme heat events are not known for causing direct damage to buildings, but may damage building systems such as heating, ventilation and air-conditioning (HVAC) systems.

Loss estimations for the severe weather hazards profiled in this assessment 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 41 lists the loss estimates.

Table 41. Loss Potential for Severe Weather

	Estimated Loss Potential from Severe Weather		
Exposed Value	10% Damage	30% Damage	50% Damage
$4,178,980,493	$417,898,049	$1,253,694,148	$2,089,490,247

Critical Facilities and Infrastructure

Incapacity and loss of roads are the primary transportation failures resulting from severe weather, mostly associated with secondary hazards. Landslides caused by heavy prolonged rains can block roads. High winds can cause significant damage to trees and power lines, blocking roads with debris, incapacitating transportation, isolating population, and disrupting ingress and egress. Of particular concern are roads providing access to isolated areas and to the elderly.

Prolonged obstruction of major routes due to landslides, debris or floodwaters can disrupt the shipment of goods and other commerce. Large, prolonged storms can have negative economic impacts for an entire region.

Severe windstorms, downed trees, and ice can create serious impacts on overhead power lines and infrastructure and above-ground communication lines. Freezing of power and communication lines can cause them to break, disrupting electricity and communication. Loss of electricity and phone connection would leave certain populations isolated because residents would be unable to call for assistance.

Extreme heat is not known for causing direct impacts on critical facilities and infrastructure, but some impacts may occur in extreme cases, such as loss of power due to brownouts.

Electric power losses for severe weather hazards can be estimated using standard values for loss of service for utilities published in FEMA's 2009 Benefit Cost Analysis Reference Guide. These figures provide estimated costs associated with the loss of power in relation to the populations in Hercules Table 42. The loss of use estimates for power failure associated with severe weather are presented as a cost per person per day of loss. The estimated loss of use provided represents the loss of service of the indicated utility for one day for 10 percent of the population. These figures do not take into account physical damage to utility equipment and infrastructure.

Table 42. Loss of Use Estimates for Power Failure

	2018 American Community Survey 5-Year Population Estimates	Estimated Affected Population 10%	Electric Loss of Use Estimate ($126 per person per day)
Hercules	25,343	2,534	$319,321

Environment

The vulnerability of the environment to severe weather is the same as the exposure.

Future Development Trends

All future development will be affected by severe storms, extreme heat, and high winds. The ability to withstand impacts lies in sound land use practices and consistent enforcement of codes and regulations for new construction. The City of Hercules has adopted the International Building Code in response to California mandates. This code is equipped to deal with the impacts of severe weather events. Land use policies identified in the general plan also address many of the secondary impacts (flood and landslide) of the severe weather hazard. With these tools, the Hercules is well equipped to deal with future growth and the associated impacts of severe weather.

Scenario

Although severe local storms are infrequent, impacts can be significant, particularly when secondary hazards of flood and landslide occur. A worst-case event would involve prolonged high winds during a winter storm accompanied by an atmospheric river event. Such an event would have both short-term and longer-term effects. Initially, schools and roads would be closed due to power outages caused by high winds and downed tree obstructions. In more rural areas, some subdivisions could experience limited ingress and egress. Prolonged rain could produce flooding, overtopped culverts with ponded water on roads, mud over roadways, and landslides on steep slopes. Floods and landslides could further obstruct roads and bridges, further isolating residents.

Issues

Important issues associated with a severe weather in the planning area include the following:

- Older building stock in Hercules is built to low code standards or none at all. These structures could be highly vulnerable to severe weather events such as windstorms.
- The city may need to open cooling centers during extreme heat events.
- Redundancy of power supply must be evaluated.

- The capacity for backup power generation is limited.
- Dead or dying trees as a result of drought conditions are more susceptible to falling during severe storm events.
- Public education on dealing with the impacts of severe weather needs to continue to be provided so that citizens can be better informed and prepared for severe weather events. In particular, fog should be considered, since fog may be downplayed despite its potential for transportation accidents.
- Debris management (downed trees, etc.) must be addressed, because debris can impact the severity of severe weather events, requires coordination efforts, and may require additional funding.
- The effects of climate change may result in an increase of heavy rain or more atmospheric storm events, and will likely lead to increased temperatures and changes in overall precipitation amounts.

WILDFIRE

A wildfire is any uncontrolled fire occurring on undeveloped land that requires fire suppression. Wildfires can be ignited by lightning or by human activity such as smoking, campfires, equipment use, and arson.

Fire 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. Vulnerability to flooding increases due to the destruction of watersheds. The potential for significant damage to life and property exists in areas designated as “wildland urban interface areas,” where development is adjacent to densely vegetated areas.

The Mediterranean climate with cold/wet winters and warm/dry summers, productive plant communities, and rugged terrain contribute to one of the most fire-prone and fire-adapted landscapes in the world. The unique combination of weather, fuel, and topography in California combine to produce extreme wildfire behavior. The influences of climate change such as longer periods of drought and hotter and longer fall and extreme weather have increased the occurrences of wildfire.

Wildfire Protection Responsibility

- **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 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 and/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 and

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. LRAs may include flammable vegetation and wildland-urban interface areas where the financial and jurisdictional responsibility for improvement and wildfire protection is that of a local government agency.

The State Responsibility Area map shows fire hazard severity zones. Land adjacent to the City limits and some land located within the City's Sphere of Influence are designated with a high fire hazard severity zone in the State Responsibility Area (SRA). No land within the incorporated areas of the City has been identified within Local or State Responsibility Areas for fire hazards

The number and severity of wildfires in California are projected to increase in the coming years. The two largest fires in California history have happened over the last three years, with 16 of the top 20 most destructive fires having occurred between 1999 and 2019. Contra Costa County is made up of Wildland Urban Interface (WUI) areas, including suburban populated areas such as Hercules bordered by hill terrain covered with vegetation. Large portions of the City of Hercules are within the WUI (Figure 20), where homesteads are adjacent to the county open space. The open space includes brush and grass covered hills and forested area, including non-native blue gum Eucalyptus trees which are particularly flammable.

Wildfire Hazard Profile

Past Events

Fire is an integral part of the California landscape. With climate change and drought conditions in recent years, wildfires have occurred more frequently. None of the fires have caused sufficient damage to trigger a state or federal disaster declaration. Table 43 shows wildfires over 40 acres from January 2013 through August 2020 in Contra Costa County (CAL FIRE, 2020):

Table 43. Wildfires in Contra Costa County from 2013 through 2020

Start Date	Name	Acres Burned	Area
7/20/2020	Holland Fire	75	Delta Rd and Holland Tract Rd, northeast of Brentwood
7/6/2020	California Fire	298	California Street and Springwood Street. East of Rodeo
7/6/2020	Willow Fire	100	Willow Pass Court and Evora Road, Northeast of Concord
5/23/2020	Creek Fire	60	Round Valley Regional Park, southwest of Brentwood in Contra Costa County
4/27/2020	Byron Fire	47	Byron Highway and Bruns Ave, southeast of Byron
10/27/2019	Forest Fire	50	Alhambra Ave and Alhambra Hills Dr, Martinez in Contra Costa County
10/27/2019	Sky Fire	150	Commings Skyway and I-80, south of Crockett
10/27/2019	Cypress Complex	200	East Cypress Rd and Bethel Island Road, Knightsen
10/9/2019	Merrille Fire	40	Merrill Circle N and Merrill Dr, Moraga
8/7/2019	Sellers Fire	58	Sellers Ave and Delta Rd, 2 miles northeast of Brentwood
8/2/2019	Marsh Complex	757	Marsh Creek Rd and Morgan Territory Rd, southwest of Brentwood
7/25/2018	Marsh Fire	247	Marsh Creek Rd and Bragdon way, east of Mount Diablo
7/8/2018	Bruce Fire	56	Bruce Lane and Joseph Lane, east of San Ramon
7/2/2018	Buckingham Fire	45	Buckingham Dr and Moraga Rd, southwest of Walnut Creek

6/29/2018	Valley Fire	268	Ygnaciao Valley Road and Cowell Road, Concord
6/19/2018	Iron Fire	40	Montbretia Way and Ironwood, East of San Ramon
7/8/2017	Willow Fire	370	Springwood Ct. and California St, Rodeo.
7/7/2017	Deer Complex	231	Deer Valley Road and Marsh Creek Road west of Brentwood
7/24/2016	Franklin Fire	40	Cummings Skyway and Franklin Canyon, 6 miles southeast of Rodeo
7/30/2015	Vasco Fire	195	Vasco Road, 3 miles southwest of Byron
6/24/2015	Loma Fire	533	Contra Loma Regional Park in Antioch
7/11/2014	Marsh Fire	80	Clayton, off Marsh Creek Road and Aspara Drive
9/8/2013	Morgan Fire	3,111	Clayton, off Morgan Territory Road
7/1/2013	Concord Fire	274	Brentwood, near Concord Avenue and Vineyard Parkway
7/1/2013	Kirker Fire	492	South of Pittsburg along Kirker Pass Road

Location

CAL FIRE's Fire and Resource Assessment Program has modeled and mapped wildfire hazard zones using a science-based and field-tested computer model that designates moderate, high or very high fire hazard severity zones (FHSZ). There is no mapped areas in fire hazard severity zones the city; however, the Steering Committee found that the risk to the community needed to be revised due to neighborhoods in the eastern portion of the city being adjacent to High Severity Zones in Local Responsibility areas and the increase of wildfire activity due to climate change. The FHSZ model is built from existing CAL FIRE data and hazard information based on factors such as the following (CAL FIRE, 2017a):

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. Of particular importance for wildfire activity are wind and thunderstorms:

- Strong, dry winds produce extreme fire conditions. Such winds generally reach peak velocities during the night and early morning hours.
- The thunderstorm season typically begins in June with wet storms, and turns dry with little or no precipitation reaching the ground as the season progresses into July and August.

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. Figure 21 shows the FHSZ mapping for Contra Costa County. Most of the mapped zones are in the unincorporated county.

Local Conditions Related to Wildfire

The geography, weather patterns and vegetation in the East Bay area provide ideal conditions for recurring wildfires. The natural vegetation in the open space surrounding the Eastern part of the City 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.

Frequency

Wildfire frequency can be assessed through review of the percent of a given area that has been burned in previous wildfire events (see Table 43).

Severity

Potential losses from wildfire include human life, structures and other improvements, and natural resources. There are no recorded incidents of loss of life from wildfires in Hercules. However, the most destructive wildfire in the region to date—the October 1991 Oakland/Berkeley Hills “Tunnel Fire”—occurred close to Contra Costa County and resulted in 25 lives lost, including a fire battalion chief and an Oakland police officer, 148 people injured, and 3,500 homes destroyed. The blaze started from a grass fire in the Berkeley Hills and burned 1,600 acres. The estimated private property loss was $1.7 billion at the time, according to the Insurance Information Institute.

Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal. 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. 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

Warning Time

Wildfires are often 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.

Figure 20. Hercules Wildfire Severity Zones

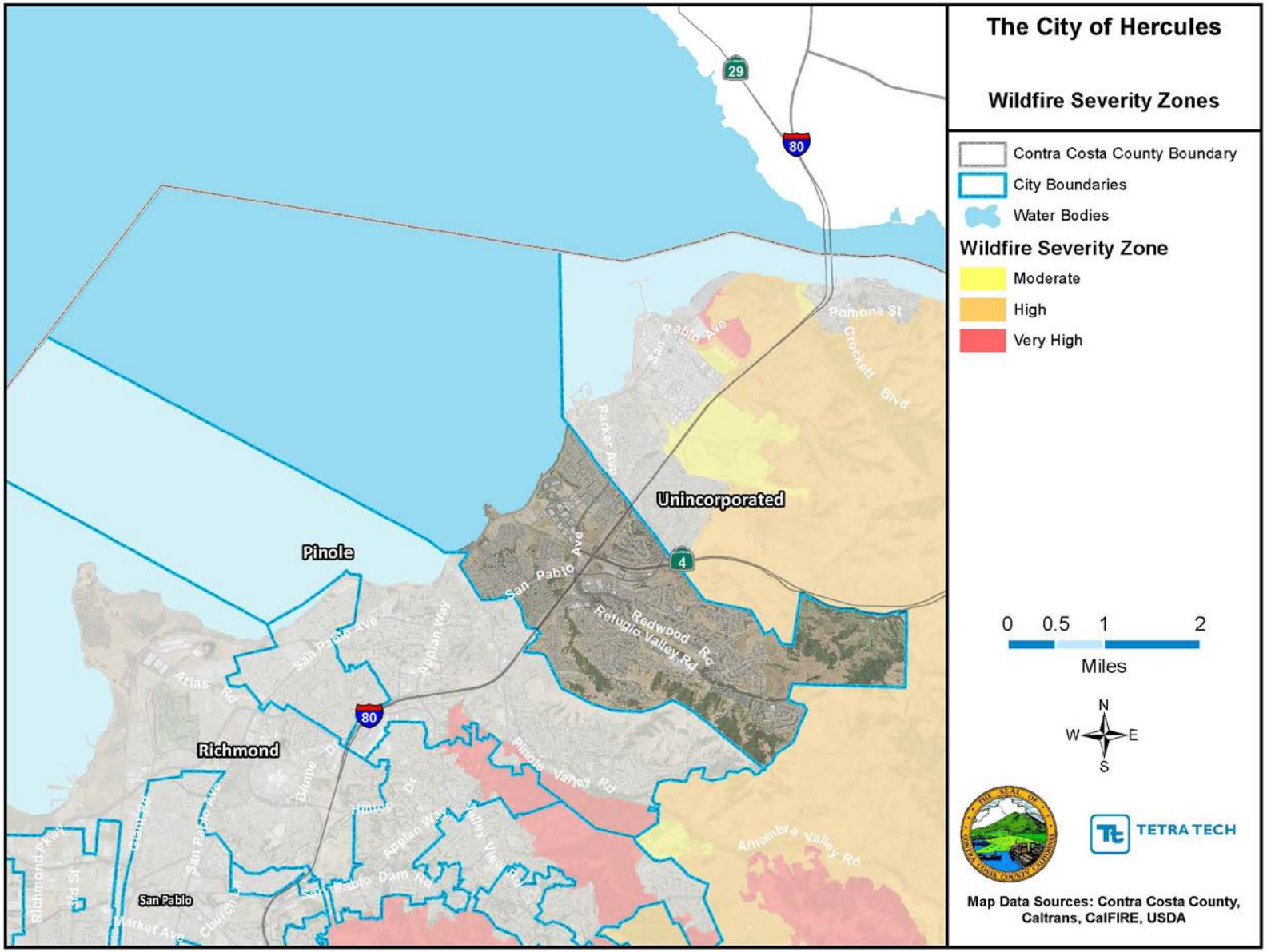
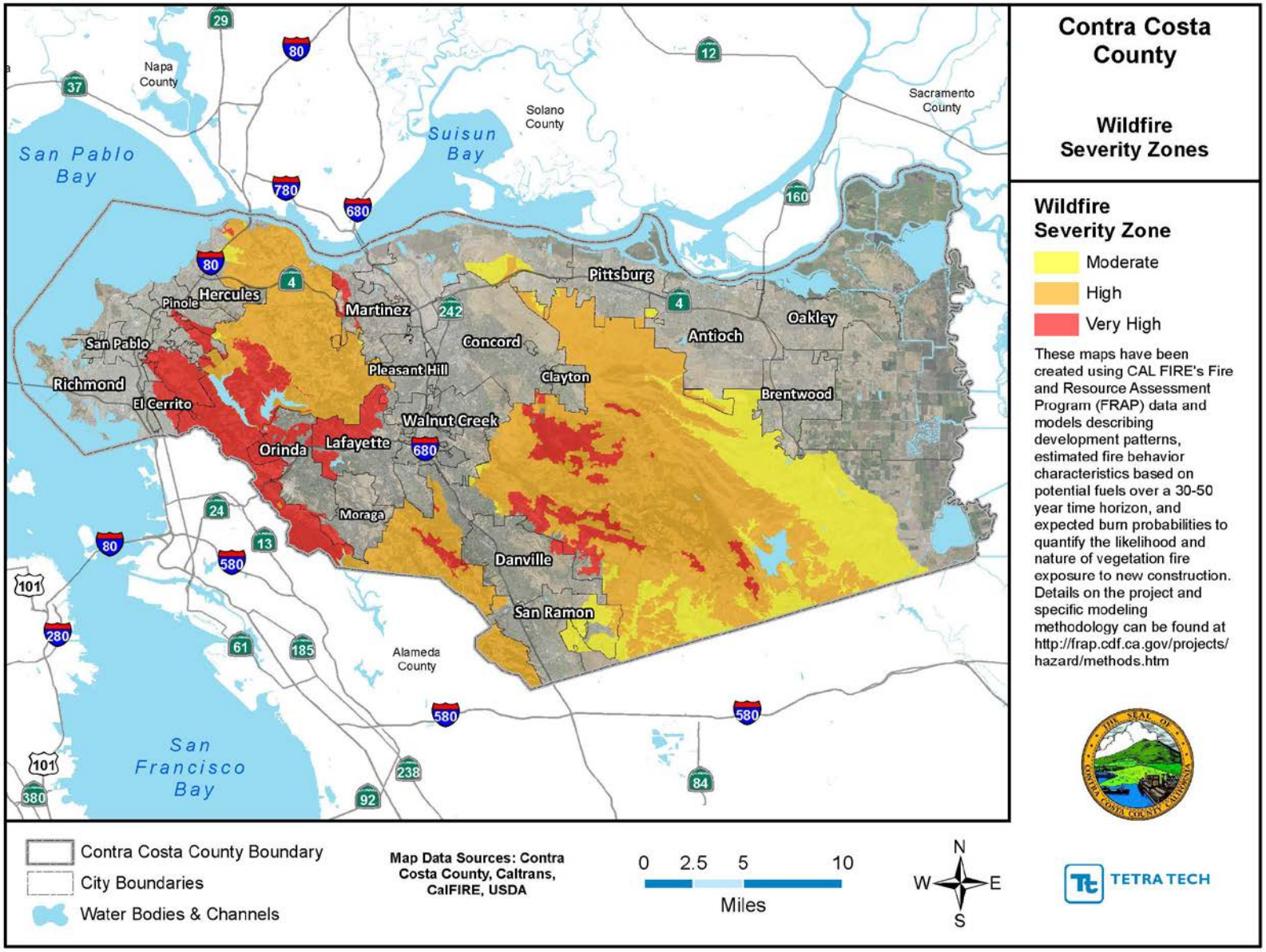


Figure 21. Contra Costa County Wildfire Severity Zones



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 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. 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 increases the runoff generated by storm events, thus increasing the chance of flooding.

Exposure

Hercules does not have any mapped wildfire areas in Federal, State or Local Responsibility Zones which limits the planning teams ability to make an accurate count of exposure in the city. However the Steering Committee believe there is sufficient risk to population, property, critical facilities and the environment which should be included in this plan. Additionally, during a community-wide survey conducted in December 2019 next to earthquake, the second highest concern for the public was wildfire.

According to the Rodeo–Hercules Fire District Wildland Fire Action Guide, homes within one mile of a natural area are considered part of an ember zone, where wind-driven embers can be a risk to property. Most of the eastern portion of the city are located within the ember zone with large areas of the city directly adjacent to high wildfire severity zones.

Population

Population could not be examined by FHSZ because Hercules does not have any mapped areas in FHSZ and census block groups do not coincide with zone boundaries. However the population exposed to wildfire was estimated to be 8,885 using the population count within the high and very high landslide susceptibility zones as both hazards effect approximately the same areas in the city.

Property

Property damage from wildfires can be severe and can significantly alter entire communities. Table 44 shows the estimated number of homes exposed to wildfire using the same method as used to estimate population exposure.

Table 44. Structure Exposure to Wildfire

Total Number of Structures	Structure Value	Contents Value	Total Value
2,866	$928,430,952	$553,081,968	$1,481,512,920

Critical Facilities and Infrastructure

Critical facilities and infrastructure exposed to the wildfire hazard in the planning area are summarized in Table 45 through Table 46.

Table 45. Critical Facilities Exposed to Wildfire

Facility Name	Address	Facility/ Infrastructure Type
Rodeo Hercules Fire Station	1680 Refugio Valley Rd.	Protective Functions
Hanna Ranch Elementary School	2482 Refugio Valley Rd.	School and Educational
Hercules High School	1900 Refugio Valley Rd.	School and Educational

Franklin Substation	1213 Willow Ave.	Power

In the event of wildfire, there would likely be little damage to the majority of infrastructure. Most road and railroads would be without damage except in the worst scenarios. Power lines are the most at risk to wildfire because most are made of wood and susceptible to burning. In the event of a wildfire, pipelines could provide a source of fuel and lead to a catastrophic explosion.

Table 46. Critical Infrastructure Exposed to Wildfire

Facility Name	Address	Facility/ Infrastructure Type
AT&T Switching Office / Facility	1540 Sycamore Avenue	Communication
City of Hercules EOC	111 Civic Drive.	Government
San Pablo Ave.		Bridge
Hercules Police Department	1213 Willow Ave.	Protective Functions
Mendocino Reservoir	1100 Block Turquoise Drive	Water Supply
Ohlone Elementary School	1616 Pheasant Dr.	School and Educational
Junior High School (Future site)	Refugio Valley Rd.	School and Educational
City of Hercules		Wastewater

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—Fire 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 or even centuries for ecosystems to recover from a fire. Some fires burn so hot that they can sterilize the soil.

Many ecosystems are adapted to historical patterns of fire. 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.

Vulnerability

Structures, above-ground infrastructure, critical facilities and natural environments are all vulnerable to the wildfire hazard. There is currently no validated damage function available to support wildfire mitigation planning.

Except as discussed in this section, vulnerable populations, property, infrastructure and environment are assumed to be the same as described in the section on exposure.

Population

There are no recorded incidents of loss of life from wildfires within the city. Given the immediate response times to reported fires, the likelihood of injuries and casualties is minimal; therefore, injuries and casualties were not estimated for the wildfire hazard.

Smoke and air pollution from wildfires can be a severe 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. Public health impacts associated with wildfire include difficulty in breathing, odor, and reduction in visibility.

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.

Property

Property damage from wildfires can be severe and can significantly alter entire communities Loss estimations for the wildfire hazard are not based on damage functions, because no such damage functions have been generated.

Critical Facilities and Infrastructure

Critical facilities of wood frame construction are especially vulnerable during wildfire events. In the event of wildfire, there would likely be little damage to most infrastructure. Most roads and railroads would be without damage except in the worst scenarios. Power lines are the most at risk from wildfire because most poles are made of wood and susceptible to burning. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers. Wildfire typically does not have a major direct impact on bridges, but it can create conditions in which bridges are obstructed.

Future Development Trends

The highly urbanized portions of the planning area have little or no wildfire risk exposure. Urbanization tends to alter the natural fire regime, and can create the potential for the expansion of urbanized areas into wildland areas. The expansion of the wildland urban interface can be managed with strong land use and building codes. The planning area is well equipped with these tools and this planning process has assessed capabilities with regards to the tools. As the planning area experiences future growth, it is anticipated that the exposure to this hazard will remain as assessed or even decrease over time due to these capabilities.

Scenario

A major wildfire in the planning area might begin with a wet winter, adding to fuels already present on the forest floor. Flashy fuels would build throughout the spring and early summer. The summer could see the onset of insect infestation. A dry summer could follow the wet winter, exacerbated by dry hot winds. Carelessness with combustible materials or a tossed lit cigarette, or a sudden lighting 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 would be deep in the forests and interface zones. 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.

Issues

The major issues for wildfire are the following:

- Public education and outreach to people living in or near 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.
- Climate change could affect the wildfire hazard.
- Future housing growth into interface areas should continue to be managed.
- Area fire districts need to continue to train on wildland-urban interface events.
- Vegetation management activities. This would include enhancement through expansion of the target areas as well as additional resources.
- Regional consistency of higher building code standards such as residential sprinkler requirements and prohibitive combustible roof standards.
- Fire department water supply in high risk wildfire areas.
- Expand certifications and qualifications for fire department personnel. Ensure that all firefighters are trained in basic wildfire behavior, basic fire weather, and that all company officers and chief level officers are trained in the wildland command and strike team leader level.

GOALS AND OBJECTIVES

44CFR requires hazard mitigation plans to identify goals for reducing long-term vulnerabilities to identified hazards. As part of the planning process the city incorporated the concerns of the community and aligned their goals and objectives with Contra Costa County's Multi-Jurisdictional Hazard Mitigation Plan to provide consistency. The following are the five mitigation goals and sixteen objectives from Contra Costa County's plan which the City of Hercules has adopted:

- Goal 1—Save (or protect) lives and reduce injury
- Goal 2—Increase resilience of infrastructure and critical facilities
- Goal 3—Avoid (minimize, or reduce) damage to property
- Goal 4—Encourage the development and implementation of long-term, cost-effective and environmentally sound mitigation projects
- Goal 5—Build and support capacity to enable local government and the public to prepare for, respond to and recover from the impact of natural hazards.

Table 47. Objectives

Objective Number	Objective Statement	Goals for Which It Can Be Applied
O-1	Increase resilience of (or protect and maintain) infrastructure and critical facilities.	2, 3, 5
O-2	Sustain reliable local emergency operations and facilities during and after a disaster.	1, 5
O-3	Educate the public on the risk from natural hazards and increase awareness, preparation, mitigation, response, and recovery activities.	1, 3, 5
O-4	Minimize the impacts of natural hazards on current and future land uses by providing incentives for hazard mitigation.	1, 3, 5
O-5	Prevent (or discourage) new development in hazardous areas or ensure that if building occurs in high-risk areas that it is done in such a way as to minimize risk.	1, 3, 5
O-6	At the local government level, continually improve understanding of the location and potential impacts of natural hazards, utilizing the best available data and science.	1, 2, 3, 4, 5
O-7	Ensure all structures meet minimum standards for life safety.	1, 2, 3, 5
O-8	Monitor plan progress annually to integrate local hazard mitigation plans and the results of disaster- and hazard-specific planning efforts.	1, 2, 3, 5
O-9	Lower cost of flood insurance premiums through CRS program	3, 4, 5
O-10	Provide/improve flood protection with flood control structures, and drainage maintenance plans.	2, 3, 4
O-11	Strengthen codes, and their enforcement, so that new construction can withstand the impacts of natural hazards and lessen the impact of that development on the environment's ability to absorb the impact of natural hazards.	1, 3
O-12	Consider the impacts of natural hazards in all planning mechanisms that address current and future land uses within the planning area.	1, 3

O-13	Eliminate or minimize disruption of local government operations caused by natural hazards.	1, 3, 4
O-14	Consider open space land uses within identified high-hazard risk zones.	1, 2, 3, 4, 5
O-15	Retrofit, acquire or relocate identified high risk structures, including those known to experience repetitive losses.	1, 3, 4
O-16	Establish a partnership among all levels of government and the business community to improve and implement methods to protect property.	1, 2, 3, 4, 5

HAZARD MITIGATION ACTION PLAN AND EVALUATION OF RECOMMENDED ACTIONS

The Steering Committee reviewed and selected area-wide actions to be included in a hazard mitigation action plan. The selection of area-wide actions was based on the risk assessment of identified hazards of concern and the defined hazard mitigation goals and objectives. Table 33 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.

Benefit-Cost Review

The action plan must be prioritized according to a benefit/cost analysis of the proposed projects (44 CFR, Section 201.6(c)(3)(iii)). The benefits of proposed projects were weighed against estimated costs as part of the project prioritization process. The benefit/cost analysis was not of the detailed variety required by FEMA for project grant eligibility under the Hazard Mitigation Grant Program (HMGP) and Pre-Disaster Mitigation (PDM) grant program. A less formal approach was used because some projects may not be implemented for up to 10 years, and associated costs and benefits could change dramatically in that time. Therefore, a review of the apparent benefits versus the apparent cost of each project was performed. Parameters were established for assigning subjective ratings (high, medium, and low) to the costs and benefits of these projects.

Cost ratings were defined as follows:

- **High**—Existing funding levels are not adequate to cover the costs of the proposed action; implementation would require an increase in 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 ratings were defined as follows:

- **High—**The action will provide an immediate reduction of risk exposure for life and property.
- **Medium—**The action will have a long-term impact on the reduction of risk exposure for life and property, or project 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.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low, etc.) are considered cost-beneficial and are prioritized accordingly

Table 48 lists the actions that make up the City of Hercules hazard mitigation action plan. Table 49 identifies the priority for each action. Table 50 summarizes the mitigation actions by hazard of concern and mitigation type.

Table 48. Hazard Mitigation Action Plan Matrix

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
H-1 — Where appropriate, support retrofitting or relocation of structures in hazard prone areas to protect structures from future damage focusing on repetitive loss and sever repetitive loss properties.						
Existing	Earthquake, Landslide, Severe Weather, Wildfire	1, 4, 7, 11, 12, 14, 15, 17	Community Development Department	High	HMGP, PDM, FMA, BRIC	Long-term
H-2 — Integrate the hazard mitigation plan into other plans, ordinances, and programs that dictate land use decisions in the community, including the General Plan, and Zoning Ordinance.						
New and Existing	Earthquake, Landslide, Severe Weather, Wildfire	1, 3, 4, 5, 7, 11, 12, 14, 17, 18	Community Development Department	Medium	Staff Time, department funds	Ongoing
H-3 — Actively participate in the plan maintenance protocols outlined in the Plan Maintenance Strategy in the Hazard Mitigation Plan						
New and Existing	Earthquake, Landslide, Severe Weather, Wildfire	3, 8,16	Community Development Department	Low	Staff time, General funds	Ongoing
H-4 — Continue to maintain 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						
New and Existing	Sever Weather	3, 5, 6, 9, 10, 11, 15	Public Works	Low	Staff Time, General Funds	Ongoing
H-5 — Dredge Refugio Lake & Replace Aerator Fountains –The fountains aerate the water, reducing algae and dredging will restore the lake to its original depth, as part of the City's storm water program.						
Existing	Sever Weather	1, 2,10,17	Public Works	$392,000	LLAD Zone 10	Short-term
H-6 — Develop and implement a program to capture perishable data after significant events (e.g. high water marks, preliminary damage estimates, damage photos) to support future mitigation efforts including the implementation and maintenance of the hazard mitigation plan.						
Existing	Earthquake, Landslide, Severe Weather, Wildfire	6,8,18	Community Development Department	Low	Staff Time, General Funds	Short-term
H-7 — Support the County-wide initiatives identified in Volume I of the Multi-Juristically Contra Costa County Hazard Mitigation Plan.						
New and Existing	Earthquake, Landslide, Severe Weather, Wildfire	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17 ,18	Community Development Department	Low	Staff Time, General Funds	Short-term

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
H-8 — Explore participating in community readiness programs such as Firewise, Read Set Go, and StormReady.						
New and Existing	Severe Weather, Wildfire	3, 6, 9,17	Public Works	Low	Staff Time, Grant	Short-term
H-9 — Partner with Rodeo-Hercules Fire District to form a Community Emergency Response Team (CERT).						
Existing	Earthquake, Landslide, Severe Weather, Wildfire	2, 3, 6, 13, 16	Emergency Management	Low	Rodeo-Hercules Fire District, Staff Time, Grant	Short-term
H-10 — Maintain an accessible online GIS portal to store and share the multi-agency maps and data developed throughout the LHMP process.						
New and Existing	Earthquake, Landslide, Severe Weather, Wildfire	3, 5, 6	Community Development Department	Low	Staff Time, General Funds	Ongoing
H-11 — Continue pursuing funding to Restore Chelsea Wetlands- The goal is to restore Chelsea Wetlands to its original tidal wetland state to reduce flooding and improve wildlife habitat.						
Existing	Severe Weather	17,18	Community Development Department	High	Grant administered by Ducks Unlimited, BRIC	Long-term
H-12 — Consider developing a Climate Action Plan to incorporate relevant research, and maps which might impact hazard planning and policy setting in the City of Hercules.						
New and Existing	Earthquake, Landslide, Severe Weather, Wildfire	3, 6, 12, 16, 17, 18	Community Development Department	Medium	Staff time for investigation of grant options.	Short-term
H-13 — Partner with the community, non-profits, Police Department, and the Fire District to conduct community trainings on emergency preparedness, and response including evacuation routes and shelters.						
Existing	Earthquake, Landslide, Severe Weather, Wildfire	2, 3, 6, 16,	Emergency Management	Medium	Staff Time, General Funds	Ongoing
H-14 — Review the Adapting to Rising Tides policy and program recommendations when updating the Housing Element, and completing the next Capital Improvement Program.						
New and Existing	Severe Weather	1, 4, 5, 6, 8, 10,11, 16	Community Development Department	Low	Staff time, General Funds	Ongoing
H-15 — Install Green Infrastructure where feasible throughout the City in order to promote climate resiliency through the reduction of urban heat, recharging the aquifer, and reducing runoff to the floodplain.						
New and Existing	Severe Weather	1, 4, 7, 10, 12, 13, 15, 17	Public Works	High	HMGP, General Funds, BRIC	Long-term
H-16 — Adopt and enforce updated building code provisions to reduce damage risk from natural hazard.						
New and Existing	Earthquake, Landslide, Severe Weather, Wildfire	1, 7, 11,	Community Development Department	Low	Staff Time, General Funds	Short-tern
H-17 — Partner with the Contra Costa County Department of Conservation and Development, and surrounding municipalities on grant opportunities for climate resiliency efforts.						

Applies to new or existing assets	Hazards Mitigated	Objectives Met	Lead Agency	Estimated Cost	Sources of Funding	Timeline
New and Existing	Earthquake, Landslide, Severe Weather, Wildfire	1, 2, 3, 4, 8, 10, 13, 15, 15, 17, 18	Community Development Department	Low	Staff Time, General Funds	Long-term
H-18 — Require development proposed in landslide mapped area to provide a geo-technical analysis to ensure site is build-able; and any construction requirements.						
New	Landslide	1, 4, 5, 6, 7, 11, 12,	Public Works	Low	Staff Time, General Funds	Ongoing

Note: * = Identified lead agency

For many of the strategies identified in this action plan, financial assistance may be available through the HMGP or PDM programs, both of which require detailed benefit/cost analyses. These analyses will be performed on projects at the time of application using the FEMA benefit-cost model. For projects not seeking financial assistance from grant programs that require detailed analysis, "benefits" can be defined according to parameters that meet the goals and objectives of this plan.

Action Plan Prioritization

Table 49 lists the priority of each area-wide action. A qualitative benefit-cost review was performed for each of these actions. The priorities are defined as follows:

- **High Priority**—Action that meets multiple objectives (i.e., multiple hazards), has benefits that exceed cost, has funding secured or is an ongoing project and meets eligibility requirements for the HMGP or PDM grant program. High priority projects can be completed in the short term (1 to 5 years).
- **Medium Priority**—Action that meets goals and objectives, that has benefits that exceed costs, and for which funding has not been secured but that is grant eligible under HMGP, PDM or other grant programs. Project can be completed in the short term, once funding is secured. Medium priority projects will become high priority projects once funding is secured.
- **Low Priority**—Action that will mitigate the risk of a hazard, that has benefits that do not exceed the costs or are difficult to quantify, for which funding has not been secured, that is not eligible for HMGP or PDM grant funding, and for which the time line for completion is long term (1 to 10 years). Low priority projects may be eligible for other sources of grant funding from other programs.

These priority definitions are dynamic and can change from one category to another based on changes to a parameter such as availability of funding. For example, a project might be assigned a medium priority because of the uncertainty of a funding source, but be changed to high priority once a funding source has been identified. The prioritization schedule for this plan will be reviewed and updated as needed annually through the plan maintenance strategy.

Table 49. Mitigation Action Priority

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 Pursuit Priority
H-1	8	High	High	Yes	Yes	No	Medium	High
H-2	10	Medium	Medium	Yes	No	Yes	High	Low
H-3	3	Low	Low	Yes	No	Yes	High	Low
H-4	7	Medium	Low	Yes	No	Yes	High	Low
H-5	4	Medium	$392,000	Yes	No	Yes	Medium	Low
H-6	3	Low	Low	Yes	No	Yes	Low	Low
H-7	18	Medium	Low	Yes	No	Yes	High	Low
H-8	4	Medium	Low	Yes	No	Yes	Medium	Low
H-9	5	Low	Low	Yes	No	Yes	Medium	Low
H-10	3	Low	Low	Yes	Yes	No	Low	High
H-11	2	Medium	High	Yes	No	Yes	Medium	Low
H-12	6	Medium	Medium	Yes	Yes	No	Low	High
H-13	4	High	Medium	Yes	Yes	Yes	High	Medium
H-14	8	Low	Low	Yes	No	Yes	High	Low
H-15	8	High	High	Yes	Yes	No	Medium	High
H-16	3	High	Low	Yes	No	Yes	High	Low
H-17	11	Medium	Low	Yes	Yes	No	Medium	Medium
H-18	7	Low	Low	Yes	No	Yes	Low	Low

Analysis of Area-Wide Mitigation Actions

Each recommended action was classified based on the hazard it addresses and the type of mitigation it involves. Table 50 shows these classifications. Mitigation types used for this categorization 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 citizens 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, and wetland restoration and preservation.
- **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 Resilient**—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 50. Analysis of Mitigation Actions

Hazard Type	Action Addressing Hazard, by Mitigation Type							
	Prevention	Property Protection	Public Education and Awareness	Natural Resource Protection	Emergency Services	Structural Projects	Climate Resilient	Community Capacity Building
Earthquake	H1, H2 ,H3, H7, H10, H16, H17	H1, H2, H3, H7, H16	H2, H3, H6, H7, H9, H10, H13	H2, H3, H7, H12, H17	H2, H7, H9, H13	H1, H2, H3, H16	H1, H2, H3, H6, H7, H9, H12, H17	H1, H2, H3, H6, H7, H9, H10, H12, H13, H17
Landslide	H1, H2 ,H3, H7, H10, H16, H17, H18	H1, H2, H3, H7, H16, H18	H2, H3, H6, H7, H9, H10, H13	H2, H3, H7, H12, H17	H2, H7, H9, H13	H1, H2, H3, H16	H1, H2, H3, H6, H7, H9, H12, H17	H1, H2, H3, H6, H7, H9, H10, H12, H13, H17
Severe weather	H1, H2 ,H3, H4, H7, H10, H15, H16, H17	H1, H2, H3, H4, H7, H8, H15, H16	H2, H3, H6, H7, H8, H9, H10, H13	H2, H3, H7, H8, H12, H15, H17	H2, H7, H8, H9, H13	H1, H2, H3, H15, H16	H1, H2, H3, H6, H7, H9, H11, H12, H15, H17	H1, H2, H3, H6, H7, H9, H10, H12, H13, H17
Wildfire	H1, H2 ,H3, H7, H10, H16, H17	H1, H2, H3, H7, H8, H16	H2, H3, H6, H7, H8, H9, H10, H13	H2, H3, H7, H8, H12, H17	H2, H7, H9, H13	H1, H2, H3, H16	H1, H2, H3, H6, H7, H9, H12, H17	H1, H2, H3, H6, H7, H9, H10, H12, H13, H17

PLAN MAINTENANCE STRATEGY

A hazard mitigation plan must present a plan maintenance process that includes the following (44 CFR Section 201.6(c)(4)):

- A section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan over a 5-year cycle
- 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
- A discussion on how the community will continue public participation in the plan maintenance process.

This section details the formal process that will ensure that the Hazard Mitigation Plan remains an active and relevant document. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. This chapter also describes how public participation will be integrated throughout the plan maintenance and implementation process. It also explains how the mitigation strategies outlined in this Plan will be incorporated into existing planning mechanisms and programs, such as comprehensive land-use planning processes, capital improvement planning, and building code enforcement and implementation.

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 planning partners 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 plan will be evaluated by how successfully the implementation of identified actions have moved toward reaching the goals and objectives identified in this plan. This will be assessed at the next update by a review of the changes in risk that occurred over the performance period and by the degree to which mitigation goals and objectives were incorporated into existing plans, policies and programs.

Steering Committee

The Steering Committee is a total volunteer body that oversaw the development of the Plan and made recommendations on key elements of the plan, including the maintenance strategy. The Steering Committee will remain a viable body involved in key elements of the plan maintenance strategy.

The principal role of the steering committee in this plan maintenance strategy will be to provide a review forum to and provide feedback to be considered at the next update. Future plan updates will be overseen by a steering committee similar to the one that participated in this update process, so keeping a steering committee intact will provide a head start on future updates. It will be the steering committee's role to serve as a resource to the planning partners as needed to review the progress report in an effort to identify issues needing to be addressed by future plan updates.

Annual Progress Report

The minimum task of planning team will be the evaluation of the progress of its individual action plan during a 12-month performance period. This review will include the following:

- Summary of any hazard events that occurred during the performance period and the impact these events had on the planning area
- Review of mitigation success stories
- Review of continuing public involvement
- Brief discussion about why targeted strategies were not completed
- Re-evaluation of the action plan to determine if the timeline for identified projects needs to be amended (such as changing a long-term project to a short-term one because of new funding)
- Recommendations for new projects
- Changes in or potential for new funding options (grant opportunities)
- Impact of any other planning programs or actions that involve hazard mitigation.

The Community Development Department will oversee progress reporting and will have the discretionary authority on how to capture this information at least annually over the performance period of the plan. This information may be captured by various means available to the planning partners. This report should be used as follows:

- Posted on the City of Hercules website page dedicated to the hazard mitigation plan
- Provided to the local media through a press release
- Presented to planning partner governing bodies to inform them of the progress of actions implemented during the reporting period

Uses of the progress report will be at the discretion of planning partners. Annual progress reporting is not a requirement specified under 44 CFR.

Plan Update

Local hazard mitigation plans must be reviewed, revised if appropriate, and resubmitted for approval in order to remain eligible for benefits under the DMA (44 CFR, Section 201.6(d)(3)). The Steering Committee has two options when updating the Local Hazard Mitigation Plan. The City has the option to Annex to the Contra Costa County Multi-Jurisdictional Hazard Mitigation Update. The last County plan was adopted in 2019 and the update process will begin in 2020 or 2021. If the Steering Committee decides to join with Contra Costa County the update will be done sooner than the 5-years required. The second option is for the City to update this stand-alone LHMP within the planning timeframe of 5-years and update the plan by 2025. Both update options would result in Hercules being eligible under code (44 CFR, Section 201.6(d)(3)). The decision will be made by the Steering Committee at a future date.

Continuing Public Involvement

The public will continue to be apprised of the plan's progress through the City of Hercules website and by providing copies of annual progress reports to the public. The City of Hercules will maintain the hazard mitigation plan webpage, and record any submitted comments from the public to the steering committee. This site will not only house the final plan, it will become the one-stop shop for information regarding the plan, the partnership and plan implementation. Copies of the plan will be distributed to local libraries. 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 planning partnership at the time of the update. At a minimum, this strategy will include the use of local media outlets within the planning area.

REVIEW AND INCORPORATION OF RESOURCES FOR THIS ANNEX

The following technical reports, plans, and regulatory mechanisms were reviewed to provide information for this annex.

- **Contra Costa County Hazard Mitigation Plan Volume 1 and 2 –** The county multijurisdictional local hazard mitigation plan was reviewed to identify county wide goals and polices.
- **City of Hercules Municipal Code –** The municipal code was reviewed for the full capability assessment and for identifying opportunities for action plan integration.
- **City of Hercules General Plan** – The general plan was reviewed to see where hazard mitigation strategies were currently being integrated and where they could be integrated in the future.
- **City of Hercules Emergency Operations Plan 2014–** The Emergency Operations Plan was reviewed to identify the level of preparedness to an extraordinary emergency situation associated with natural disasters.
- **City of Hercules Threat Assessment / Emergency Action Plan 2008-** As part of the Emergency Operations Plan the City of Hercules underwent a threat assessment which provided information regarding potential hazards and threats to the city.
- **City of Hercules Budget Plan 2017-** The budget plan allocates resources to enhance the community and provide services in a thoughtful and sustainable way.
- **Technical Reports and Information –** The following **o**utside resources and references were reviewed:
    - **Hazard Mitigation Plan Annex Development Tool-kit**—The tool-kit was used to support the development of this annex including past hazard events, noted vulnerabilities, risk ranking and action development.

- **Community Wildfire Protection Plan Contra Costa County -** Provided an analysis of wildfire hazards and risk in the wildland-urban interface (WUI) in Contra Costa County.
- **FEMA Local Mitigation Planning Handbook**- Provided guidance in developing the Local Hazard Mitigation Plan