



City of Berkeley  
2014 Local Hazard Mitigation Plan

First Draft

October 21, 2013

*Full First Draft Plan Available at [www.CityofBerkeley.info/Mitigation](http://www.CityofBerkeley.info/Mitigation)*

## Executive Summary

Berkeley is a vibrant and unique community. But every aspect of the city – its economic prosperity, social and cultural diversity, and historical character – could be dramatically altered by a serious earthquake or fire. While we cannot predict or protect ourselves against every possible hazard that may strike the community, we can anticipate many impacts and take steps to reduce the harm they will cause. We can make sure that tomorrow’s Berkeley continues to reflect our current values.

The City and community members have been working together for years to address certain aspects of the risk – such as strengthening structures, distributing disaster supply caches, and enforcing vegetation management measures to reduce fire risk. The 2004 Disaster Mitigation Plan formalized this process, ensuring that these activities continued to be explored and improved over time. Over many years, this constant focus on disasters has made Berkeley, its residents and businesses, much safer.

This 2014 Local Hazard Mitigation Plan continues this ongoing process to evaluate the risks that different hazards pose to Berkeley, and to engage the community in dialogue to identify the most important steps that the City and its partners should pursue to reduce these risks.

The federal Disaster Mitigation Act of 2000 called for all communities to prepare mitigation plans. The City adopted a plan that met the requirements of DMA 2000 on June 22, 2004. This is the 2014 update to that plan, which ensures that Berkeley will remain eligible to apply for mitigation grants before disasters, and to receive federal mitigation funding and additional State recovery funding after disasters.

### ***Risks in Berkeley***

A sound disaster resilience program must be founded on reliable information about the types and scale of damage that different hazards could cause. To develop the 2004 Disaster Mitigation plan, the City conducted detailed research on four major natural and two major “manmade” hazards present in Berkeley. These hazards were earthquake, wildland-urban interface fire, landslide, flood, hazardous materials release, and terrorism. Since that time, new maps and data depicting the extent and possible impacts from tsunami and climate change have become available. In 2011, the City added these hazards to the list.

As in 2004, earthquake and wildland-urban interface fire are the two hazards of greatest concern. These hazards have the potential for catastrophic impacts Berkeley.

### **Hazards of Greatest Concern**

#### ***Earthquake***

We do not know when the next major earthquake will strike Berkeley, the United States Geological Survey calculated that there is a 63 percent chance that a 6.7 magnitude earthquake will strike the Bay Area by 2038, and a 31 percent chance that that earthquake will occur on the Hayward/Rogers Creek Fault system, which runs directly through Berkeley.<sup>1</sup> The 1994 Northridge earthquake was also magnitude 6.7, and caused \$28 billion in losses.

A catastrophic earthquake on the Hayward Fault would cause very violent shaking and three types of ground failure in Berkeley. Liquefaction is likely in the westernmost parts of the city.

Liquefaction can destroy pavements and dislodge foundations. Surface fault rupture could occur along the Fault, causing displacements of up to several feet. Landslides are expected in the Berkeley hills during the next earthquake, particularly if the earthquake occurs during the rainy winter months. Landslide movement could range from a few inches to tens of feet; ground surface displacements as small as a few inches are enough to break typical foundations.

In a 6.9 magnitude earthquake on the Hayward Fault, the City estimates that over 600 housing units in Berkeley will be completely destroyed and 20,000 more will be damaged. One thousand to 4,000 families may need temporary shelter. Depending on the disaster scenario, one hundred people could be killed in Berkeley alone, and many more would be injured. Commercial buildings, utilities, and public roads will be disabled or destroyed. The earthquake could also spark numerous fires at a time when water systems may not be functioning. This plan estimates that building damage in Berkeley alone could exceed \$1.8 billion, out of a multi-billion dollar regional loss, with losses to business activities and infrastructure adding to this figure. Low-income housing units are expected to be damaged at a higher rate than other residences. Other types of housing, such as condominiums, may replace them when land owners rebuild. This could lead to profound demographic shifts in Berkeley.

### ***Wildland-Urban Interface Fire***

Berkeley is vulnerable to a wind-driven fire starting along the city's eastern border. The fire risk facing the people and properties in the eastern hills is compounded by the area's mountainous topography, limited water supply, minimal access and egress routes, and location, overlaid upon the Hayward Fault. Berkeley's flatlands are also exposed to a fire that spreads west from the hills. The flatlands are densely-covered with old wooden buildings housing low-income and vulnerable populations, including isolated seniors, persons with disabilities and students.

The high risk of wildland-urban interface (WUI) fire in Berkeley was clearly demonstrated in the 1991 Tunnel Fire, which destroyed 62 homes in Berkeley and more than 3,000 in Oakland. In 1923, an even more devastating fire burned through Berkeley. It began in the open lands of Wildcat Canyon to the northeast and, swept by a hot September wind, penetrated residential north Berkeley and destroyed nearly 600 structures, including homes, apartments, fraternities and sororities, a church, a fire station and a library. The fire burned downhill all the way to Shattuck Avenue in central Berkeley<sup>ii</sup>. If a fire today burned that same area, 3,000 structures would be destroyed, with losses for buildings alone exceeding \$3 billion. Destruction of contents in all of the homes and businesses burned could increase the losses by another \$600 million. Depending on the speed of the fire spread, lives of Berkeley residents could also be lost. Many established small businesses, homes, and multi-family apartment buildings, particularly student housing, would be completely destroyed, changing the character of Berkeley forever.

### **Natural Hazards of Concern**

This plan identified three additional natural hazards of concern: rainfall-induced landslide, flood, and tsunami. These hazards could cause significant damage and losses in Berkeley. However, unlike earthquake and WUI fire, their impacts are likely to be smaller, and confined to specific areas.

Berkeley has a number of deep-seated landslides that continuously move, with the rate of movement affected by rainfall and groundwater conditions. Significant localized areas of the

Berkeley hills face risk from landslide, and a major slide could endanger lives and impact scores of properties, utilities and infrastructure.

Floods also could damage property and cause significant losses in Berkeley. Flooding can occur when stormwater exceeds the capacity of a creek channel, or the capacity of the storm drain system. Creek flooding in Berkeley has the potential to affect about 675 structures, mainly in the western, industrial area of the city. It is unlikely that floodwaters will reach higher than three feet, but damages to homes, businesses, and their contents could total almost \$150 million. With few properties covered by flood insurance, these costs would be borne primarily by Berkeley residents and businesses.

Tsunamis, though rare inside the San Francisco Bay, can occur from large offshore Subduction style earthquakes around the Pacific Rim. Small, local tsunamis can also result from offshore strike-slip Faults such as parts of the San Andreas Fault of the Peninsula and the Hayward Fault through San Pablo Bay. The March 2011 Japan earthquake generated a devastating tsunami, which reached the Bay Area and caused minor damage to docks and floats in the Berkeley Marina. A larger tsunami could impact much more of Berkeley's western shores. Buildings, infrastructure, and roadways could be damaged, and debris and hazardous materials could cause post-tsunami fires. Deaths are possible if individuals choose not to evacuate hazardous areas, do not understand tsunami warnings, or are unable to evacuate.

### **Manmade Hazards of Concern**

This plan addresses climate change, hazardous materials release, and terrorism as Berkeley's three manmade hazards of concern.

Like regions across the globe, the San Francisco Bay Area is experiencing and will continue to increasingly experience the impacts of the changing climate. By 2100, average temperatures in the San Francisco Bay Area will increase up to 11° F. In 2100, Berkeley will have 6-10 additional heat waves each year, which will disproportionately impact the elderly, children under five, and the low-income community members.

Climate change will also cause additional extreme rainfall events, which will lead to more flooding. San Francisco Bay sea-levels will rise up to 55" by 2100, impacting infrastructure and community members in west Berkeley. Climate change impacts will also exacerbate the natural hazards of concern outlined in this plan. Rising sea levels will increase Berkeley's exposure to earthquake liquefaction, tsunami inundation, and flooding. Increases in precipitation and severe storms will make flooding more frequent, and will increase the landslide risk in the hills. California's water security will be reduced, and drought will become a more persistent issue.

Over the last twenty years, Berkeley has seen a more than 90 percent reduction in the number of facilities with extremely hazardous materials. The City carefully tracks hazardous materials within its borders, and works closely with companies using large amounts of potentially dangerous materials. The City has identified fifteen facilities in Berkeley with sufficiently large quantities of toxic chemicals to pose a high risk to the community. Hazardous materials also travel through Berkeley by truck and rail. Natural hazards identified in the plan could trigger the release of hazardous materials.

It is not possible to estimate the probability of a terrorist attack. Experts prioritize terrorism readiness efforts by identifying critical sites and assessing these sites' vulnerability to terrorist

attack. City officials are currently working with State and regional groups to prevent and prepare for terrorist attacks.

## ***Disaster Resilience***

Managing risk requires government and its partners to identify and evaluate risks, and implement and maintain policies, practices and projects to reduce those risks. Many innovative Berkeley initiatives are increasing our community's disaster resilience:

- The City has strengthened its ability to serve the community during and after disasters by seismically upgrading or replacing buildings that house critical City functions. Since 2004, Berkeley has strengthened or replaced its City Hall, all seven fire stations, all five libraries, its public works maintenance building, and its animal shelter.
- The Berkeley Unified School District, supported by voter-approved bonds, has strengthened all public schools.
- Over 90% of Berkeley's 700 unreinforced masonry buildings have been retrofitted or demolished since a City mandate began in 1991.
- Berkeley was the first city in the nation to inventory the community's soft-story buildings. The City Council has directed staff to prepare an ordinance mandating retrofit of all of these buildings.
- Berkeley has also developed innovative programs to encourage building owners to strengthen their own structures. The City has distributed over \$9 million through the Transfer Tax Rebate Program, which reduces the real estate transfer tax to building owners who perform seismic safety work.
- Four different programs contribute to vegetation management citywide, removing thousands of tons of potential fire fuels each year.
- The City enforces several programs to reduce Berkeley's fire hazard in the hills. These include strict building and fire code provisions, as well as more restrictive local amendments for new and renovated construction, along with vegetation control inspections in high-risk properties.
- The Disaster Cache Program incentivizes community-building for disaster readiness. To date, the City has awarded 87 caches of disaster response equipment to neighborhoods, congregations, and UC Berkeley Panhellenic groups that have undertaken disaster readiness activities.
- The City recently hired two positions tasked specifically with increasing disaster readiness in Berkeley's vulnerable and underserved populations.
- Berkeley's 2009 Climate Action Plan has served as a model for jurisdictions across the nation. The Climate Action Plan also guides the City's new climate adaptation strategy.

These programs, and many others, place Berkeley as a leader in disaster management. Long-term maintenance and improvements to these programs will help to protect the Berkeley community in our next disaster.

## ***Mitigation Strategy***

Berkeley aims to be a resilient community that can survive, recover from, and thrive after a disaster, while maintaining its unique character and way of life. Berkeley envisions a community in which the people, buildings, and infrastructure, in and serving Berkeley, are resilient to disasters; City government provides critical services in the immediate aftermath of a devastating event of any kind; and basic government and commercial functions resume within thirty days of a damaging earthquake or other significant event.

For many years, the City has pursued initiatives to identify and mitigate Berkeley's hazard vulnerabilities. In 2014, the City is continuing this effort: this plan outlines a five-year strategic plan to bring Berkeley closer to that vision. This plan identifies three disaster mitigation approaches to increase Berkeley's resilience:

1. The City will evaluate and strengthen all City-owned structures, particularly those needed for critical services, to ensure that the community can be served adequately after a disaster.
2. The City will establish and maintain incentive programs and standards to encourage local residents and businesses to upgrade the hazard-resistance of their own properties.
3. The City will actively engage other local and regional groups to collaboratively work towards mitigation actions that help maintain Berkeley's way of life and its ability to be fully functional after a disaster event.

This plan has four objectives for reducing disaster risk in Berkeley:

- A. Reduce the potential for loss of life, injury and economic damage to Berkeley residents and businesses from earthquakes, wildfires, landslides, floods, tsunamis, climate change, and their secondary impacts.
- B. Increase the ability of the City government to serve the community during and after hazard events by mitigating risk to key city functions such as response, recovery and rebuilding.
- C. Protect Berkeley's unique character and values from being compromised by hazard events.
- D. Encourage mitigation activities to increase the disaster resilience of institutions, private companies and lifeline systems that are essential to Berkeley's functioning.

Actions specified in the 2014 mitigation strategy were inspired by multiple elements of the City's General Plan, and specified through collaborative planning processes among City staff and key institutional partners. 2014 mitigation actions are presented in *high*, *medium*, and *low* priority categories. Generally, *high* and *medium* priority actions address Berkeley's hazards of greatest concern—earthquake and wildland-urban interface fire. *High* and *medium* priority actions can be completed in the five-year time frame covered by this strategy. Implementation of *medium* and *low* actions is dependent on outside sources of funding becoming available. Resource availability will strongly influence the pace of achievements.

**High Priority Actions:**

- Perform appropriate seismic and fire safety analysis based on current and future use for all City-owned facilities and structures.
- Implement Phase Two of the Soft-Story Retrofit Program, mandating retrofit of soft-story residences.
- Complete the ongoing program to retrofit all remaining non-complying Unreinforced Masonry (URM) buildings.
- Reduce hazard vulnerabilities in Berkeley buildings.
- Reduce fire risk in existing development through fire code updates and enforcement.
- Collect, analyze and share information with the Berkeley community about Berkeley hazards and associated risk reduction techniques.
- Ensure that the City provides leadership and coordination of the private sector, public institutions, and other public bodies in disaster mitigation.
- Work with EBMUD to ensure an adequate water supply during emergencies and disaster recovery.
- Manage and promote pedestrian evacuation routes in Fire Zones 2 and 3.
- Mitigate climate change impacts by integrating climate change research and adaptation planning into City operations and services.

**Medium Priority Actions:**

- Strengthen or replace City buildings in the identified prioritized order as funding is available.
- Develop an Energy Assurance Plan for City operations.
- Improve the disaster-resistance of the natural gas delivery system to increase public safety and to minimize damage and service disruption following a disaster.
- Rehabilitate the City's stormwater system to reduce local flooding caused by inadequate storm drainage.
- Reduce fire risk in existing development through vegetation management.
- Define and mitigate Berkeley's tsunami hazard.
- Reduce Berkeley's vulnerability to extreme heat events and associated hazards.
- Reduce Berkeley's vulnerability to severe storms and associated hazards.
- Collaborate with local, State, regional and federal partners to increase the security of Berkeley's water supply from climate change impacts.
- Maintain City participation in the National Flood Insurance Program.
- Streamline the zoning permitting process to rebuild residential and commercial structures following disasters.

**Low Priority Actions:**

- Mitigate the impacts of sea-level rise in Berkeley.
- Explore legislation to require hazardous materials stored in the flood zones to be elevated or otherwise protected from floodwaters.

Berkeley has developed effective processes to implement, track and update the status of its disaster mitigation activities. The City Manager's Office directs implementation and tracking of mitigation activities; funded actions will be inserted into departmental work plans each year.

Department heads task staff members with projects. Lead staff identified in each action will meet together at the beginning of each calendar year to address their progress on the actions that comprise Berkeley's mitigation strategy. Staff will also present progress on mitigation strategy implementation to the Disaster and Fire Safety Commission on an annual basis. Staff will conduct a complete review and update of the plan, including the hazard analysis and mitigation strategy, once every five years.

***Summary of Changes to Section 3: Hazard Analysis***

As part of the 2004 plan update, this 2014 plan includes an updated analysis of Berkeley's hazards and their potential impacts. Hazard vulnerabilities identified in Section 3 guide the mitigation strategy presented in Section 1.

**General Changes and Updates**

The 2014 plan contains numerous updates to facts, figures and descriptions. The City has incorporated the newest-available hazard data, including impact maps for particular scenarios. The City and its partners have provided additional descriptions, details and definitions to explain the science of these hazards and their potential impacts.

Advances in GIS mapping technology have enabled the City to present maps that help to visualize information. The City has overlaid multiple related hazards with Berkeley's buildings and infrastructure to demonstrate structural hazard exposure and vulnerabilities.

Institutional community partners have updated information regarding their vulnerabilities to the described hazards, as well as significant mitigation activities that they have completed, in progress, or planned for the coming five years.

Within the historical section for each hazard, the City has added information about any instances of the hazard affecting Berkeley since 2004. Throughout the plan, the City has updated 2004 financial loss estimates for inflation.

Appendix A describes Berkeley's progress on the hazard mitigation actions identified in 2004. It also identifies where and how the City incorporated select 2004 actions and activities into this 2014 plan.

**Hazards Described in the 2014 Plan**

The 2014 plan now specifically highlights Berkeley's two hazards of greatest concern as earthquake and wildland-urban interface (WUI) fire. These two hazards are underscored because of their history in Berkeley, our community's extensive exposure and many vulnerabilities to these hazards, and the cascading impacts that could result from one of these hazards.

For the first time, the plan identifies tsunami and climate change as hazards of concern.

Significant changes and updates to the analysis of each hazard are described below:

#### Earthquakes (Section 3.3)

- Three new Hayward Fault earthquake scenario maps illustrate the Bay Area's exposure to seismic shaking, and Berkeley's exposure to liquefaction and seismically-triggered landslides.
- A new map overlays the areas of Berkeley potentially exposed to liquefaction, fault rupture and earthquake-induced landslides. The City has overlaid Berkeley's vulnerable structures on this base map, demonstrating where vulnerable buildings have been constructed on ground that could possibly liquefy, rupture or slide in an earthquake.
- The City addresses seismically-triggered landslides, their cause and their potential impacts in additional detail. The 2014 plan also contains a new scenario map for seismically-triggered landslide.
- The 2014 plan addresses fire following earthquake in greater detail: the plan describes significant fires resulting from past earthquakes, causes of fire following earthquake, and how earthquake impacts can impede firefighting efforts and promote fire spread. The estimated number of fires following a scenario earthquake has been updated based on new scientific research, from five ignitions to 6-12 ignitions in the first day.
- The seismic stability of City-owned and leased buildings has been updated to reflect significant retrofit efforts since 2004. (This information is provided in greater detail in *Appendix B: List of City Owned and Leased Buildings.*)
- The City has updated the plan to describe Berkeley's progress on mitigating earthquake vulnerabilities in soft-story buildings. Data gathered through the City's 2005 soft-story ordinance are used to describe the ordinance's impacts on retrofit activities, as well as the current number and locations of soft-story buildings in Berkeley.
- The City describes locations and seismic vulnerabilities to gas systems in greater detail. Pacific Gas & Electric natural gas transmission lines, and Kinder Morgan's jet fuel/diesel pipelines are overlaid on the seismic hazard planning zone map to illustrate their potential earthquake liquefaction exposure.
- Earthquake risk and loss estimates have been updated to include data from a 2008 catastrophic earthquake incident scenario. The 2008 report uses a more severe scenario earthquake than the City used to establish risk and loss estimates in 2004. The 2008 scenario also includes additional information about potential impacts to partner systems at a greater level of detail than was available for the 2004 plan.

#### Wildland-Urban Interface Fire (Section 3.4)

- This plan redefines Berkeley's 2004 "wildfire" hazard as the "wildland-urban interface" fire hazard. The "WUI" term more specifically describes the fire hazard present in the Berkeley hills, in which natural and built environments meet and intermix. This change of perspective and associated terminology aligns Berkeley's 2014 plan with the State of California Hazard Mitigation Plan.

- The 2014 plan describes the potential for a WUI fire to spread to Berkeley's flatlands, clarifying that WUI fire is a citywide concern. The 2014 plan provides additional detail on the particular vulnerabilities of Panoramic Hill residents and visitors.
- The City has provided information about Berkeley's four vegetation management programs reducing Berkeley's fire risk, and its partnership with the Berkeley Path Wanderers Association to maintain and improve the rustic paths in the hills, which also serve as pedestrian evacuation routes.

#### Rainfall-Triggered Landslide (Section 3.5)

- Rainfall-triggered landslide is addressed separately of earthquake-induced landslide. Additional information has been provided to describe rainfall-triggered landslide and debris flow, and Berkeley's exposure and vulnerabilities to historic or recent deep-seated landslides.

#### Floods (Section 3.6)

- The floods section has been rewritten for clarity. The 2014 plan also provides additional information about floods caused by storm drain overflow. Hydraulic models created in 2011 identify key intersections in Berkeley that are exposed to flooding from storm drain overflow.

#### Tsunami (Section 3.7)

- Tsunami is a newly-introduced hazard of concern for the 2014 plan. The tsunami section describes recent tsunami events and their impacts on Berkeley. It outlines the latest information about the tsunami hazard within the San Francisco Bay, and provides an inundation map showing Berkeley's tsunami exposure. The City identifies populations, businesses, roadways, City buildings and other infrastructure within the tsunami inundation zone, and discusses potential evacuation challenges.

#### Climate Change (Section 3.8)

- Climate change is a newly-introduced hazard of concern for the 2014 plan. The climate change section describes the anticipated impacts to Berkeley from climate change. It also outlines how climate change exacerbates other hazards identified in this plan. The City discusses potential impacts from sea-level rise on Berkeley's western coast, and maps areas in Berkeley that are vulnerable in 55-inch sea-level rise.

#### Hazardous Materials Release (Section 3.9)

- This plan provides greater detail regarding Berkeley's exposure and vulnerability to hazardous materials release. The City's classification system for Berkeley's hazardous materials sites is described.
- This section includes a map that visualizes sites with sufficiently large quantities of toxic chemicals to pose a high risk to the community, along with key transportation routes used for hazardous materials in Berkeley. This map also includes areas of Berkeley exposed to earthquake-induced ground failure and flooding. By layering this information, readers can visualize how Berkeley's natural hazards could cause a hazardous materials release.

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**Executive Summary**

<sup>1</sup> Analyses by the US Geologic Survey (USGS) and California Earthquake Prediction Evaluation Council: <http://pubs.usgs.gov/fs/2008/3027/fs2008-3027.pdf>

<sup>ii</sup> City of Berkeley. *Fire Hazard Mitigation Plan*. February 25, 1992.