

## Chapter 3 - Housing (HSNG)

COMMITMENT: Bay Area residents need to have safe and disaster-resistant housing that is architecturally diverse and serves a variety of household sizes and incomes.

### Damage to housing in a disaster has implications beyond just housing damage.

Residents are the foundation of any vibrant community, and a key to keeping the region strong during the disaster recovery process. Residents are the fuel of an economy, providing the labor and consumption required for productivity. One of the most important aspects in a person's life is his or her home. The loss of a home can lead to job loss, as moving from one place to another and searching for a home is likely to detract from one's work. Home loss can also lead to poor medical and mental health.

In a large scale disaster, many homes can become uninhabitable. A sharp and sustained reduction in available housing during a disaster may result in a mass exodus from the area, as occurred in New Orleans after Hurricane Katrina. The Bay Area's large immigrant population compounds this issue, as they have fewer lasting ties to the area and are less likely to stay and wait for the region to recover. The 1994 Northridge earthquake demonstrated that neighborhoods with large numbers of damaged multifamily homes can become "ghost towns," allowing for increased criminal activity that, in turn, can spiral out of control. Finally, rebuilt housing is likely to be more expensive, leading to gentrification, changes in neighborhood character, and loss of affordable housing.

For these reasons, it is essential that steps be taken to mitigate the impact of a large scale disaster on the Bay Area's housing stock.



Soft-story apartment collapsed due to the Northridge earthquake

### A key aspect of any hazard mitigation plan is protecting the housing stock from excessive damage in disasters.

The Bay Area currently has **2,686,148** housing units spread across **557,664** acres of residential land in nine counties. These residential lands are covered by a variety of different use densities, ranging from single-unit rural areas to multi-unit urban areas.

Just as diverse as the housing stock of the Bay Area is the variety of hazards facing it. In addition to being in the heart of "Earthquake Country," communities all around the Bay are faced with the threats of flooding, wildfire, and landslides.

As quantified in Appendices C and E, the exposure of Bay Area housing to earthquake hazards is the greatest hazard, with **93%** of the housing exposed to high shaking levels (peak accelerations of greater than 40% of gravity [g] with a 10% chance of being exceeded in the next 50 years), and **53%** being exposed to **extremely** high shaking levels (60% g). Thus, most of the hazard mitigation strategies that follow deal with this hazard.

Wildland-urban-interface fire threat exposure is less than earthquake exposure. Over half (**58%**) of the residential land is located in these hazard areas. While only **4.5%** of these hazard areas burned in the past 130 years, this indicates a build-up in fuel loads. While global warming may result in more fires in the next 50 years, the exposure is still less than that of earthquake shaking. Areas of extreme and very high wildfire threat only account for **0%** and **9%** of the residential areas; **23%** of these areas have burned in the past 130 years.

The exposure of residential land to other weather-related hazards is less. Only **4%** of residential land is located in the 100-year flood plain, and only **10%** is located in areas of significant past landslides.

In summary, while floods and fires occur more frequently, earthquakes are rarer but will damage far more houses in the region. Thus, the focus of this chapter will be to assess the potential impacts of various disasters on the Bay Area's housing stock, to outline priorities for preserving and rehabilitating the housing stock prior to a disaster, and to present steps that have already been made toward mitigating the impact of various disasters on that housing stock.

## Certain Mitigation Strategies Apply to All Hazards

There are various steps that local jurisdictions can take to mitigate the hazards posed by multiple disasters. For example, all large-scale disasters pose a risk to home occupancy, so plans for interim sheltering and re-occupancy must be developed.

Similarly, public education on the general importance of hazard mitigation is not specific to one particular disaster, and a hazard mitigation plan regarding public education can and should include general hazard mitigation strategies.

## ACTIONS APPLYING TO MULTIPLE HAZARDS AND PUBLIC EDUCATION

Bay Area residents should be made aware of the significant threats posed by various natural disasters. As such, jurisdictions should work to make sure that residents are well-prepared for the broad spectrum of potential hazards. Preparation for hazards includes full disclosure to residents in hazard-prone areas such as flood plains and fire-susceptible areas, as well as education of proper hazard mitigation and disaster preparedness. Public education and disclosure strategies are essential.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1–(Strategy HSNB a-1):</b> Assist in ensuring adequate hazard disclosure by working with real estate agents to improve enforcement of real estate disclosure requirements for residential properties with regard to seven official natural hazard zones: 1) Special Flood Hazard Areas (designated by FEMA), 2) Areas of Potential Flooding from dam failure inundation, 3) Very High Fire Hazard Severity Zones, 4) Wildland Fire Zones, 5) Earthquake Fault Zones (designated under the Alquist-Priolo Earthquake Fault Zoning Act), and the 6) Liquefaction and Landslide Hazard Zones (designated under the Seismic Hazard Mapping Act).	Existing program	Cities and counties
<b>2–(k-1):</b> Provide information to residents of your community on the availability of interactive hazard maps showing your community on ABAG’s web site.	Existing program	Cities and counties
<b>3–(k-2):</b> Develop printed materials, utilize existing materials (such as developed by FEMA and the American Red Cross), conduct workshops, and/or provide outreach encouraging residents to have family disaster plans that include drop-cover-hold earthquake drills, fire and storm evacuation procedures, and shelter-in-place emergency guidelines.	Existing program, underfunded	Cities and counties
<b>4–(k-3):</b> Inform residents of comprehensive mitigation activities, including elevation of appliances above expected flood levels, use of fire-resistant roofing and defensible space in high wildfire threat and wildfire-urban-interface areas, structural retrofitting techniques for older homes, and use of intelligent grading practices through workshops, publications, and media announcements and events.	Existing program, underfunded	Cities and counties
<b>5–(k-4):</b> Develop a public education campaign on the cost, risk, and benefits of earthquake, flood, and other hazard insurance as compared to mitigation.	Not yet considered	Cities and counties
<b>6–(k-5):</b> Use disaster anniversaries, such as April (the 1906 earthquake), September (9/11), and October (Loma Prieta earthquake and Oakland Hills fire), to remind the public of safety and security mitigation activities.	Existing program	Cities and counties
<b>7–(k-6):</b> Sponsor the formation and training of Community Emergency Response Teams (CERT) for residents in your community. [Note – these programs go by a variety of names in various cities and areas.]	Existing program, underfunded	Cities and counties

<b>8–(k-8):</b> Institute the neighborhood watch block captain and team programs outlined in the Citizen Corps program guide.	Existing program, underfunded	Cities and counties
<b>9–(k-10):</b> Train homeowners to locate and shut off gas valves if they smell or hear gas leaking.	Existing program	Cities and counties
<b>10–(k-16):</b> Distribute appropriate materials related to disaster mitigation and preparedness to residents. Appropriate materials are (1) culturally appropriate and (2) suitable for special needs populations. For example, such materials are available on the <a href="http://www.preparenow.org">http://www.preparenow.org</a> website and from non-governmental organizations that work with these communities on an on-going basis.	Existing program	Cities and counties

## ACTIONS APPLYING TO MULTIPLE HAZARDS AND REOCCUPANCY

In the event of a large-scale disaster, hundreds or even thousands of Bay Area housing units will become uninhabitable. Should this occur, jurisdictions must have a plan for temporarily housing displaced residents. Some will only need shelter for a short period as their homes are prepared for reoccupancy. Others will have longer-term interim shelter needs, especially those in larger-scale apartment complexes and soft-story buildings. Once temporary shelter needs are met, cities and counties must have plans in place to expedite the repair of damaged homes for reoccupancy. A longer reoccupancy process means longer interim housing needs, which place a significant burden on local jurisdictions. The following strategies are related to interim sheltering and speeding reoccupancy.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1–(a-2):</b> Create incentives for private owners of historic or architecturally significant residential buildings to undertake mitigation to levels that will minimize the likelihood that these buildings will need to be demolished after a disaster, particularly if those alterations conform to the federal Secretary of the Interior’s <i>Guidelines for Rehabilitation</i> .	Existing program, underfunded	Cities and counties
<b>2–(a-3):</b> Develop a plan for short-term sheltering of residents of your community in conjunction with the American Red Cross.	Existing program	Cities and counties
<b>3–(a-4):</b> Develop a plan for interim housing for those displaced by working with the Regional Catastrophic Planning Grant Program (CPGP) that funded this effort in 2009. (Estimated completion is 2011.)	Under Study	Major cities in conjunction with the UASI program
<b>4–(j-1):</b> Develop and enforce a repair and reconstruction ordinance to ensure that damaged buildings are repaired in an appropriate and timely manner and retrofitted concurrently. This repair and reconstruction ordinance should apply to all public and private buildings, and also apply to repair of all damage, regardless of cause. See <a href="http://quake.abag.ca.gov/recovery/info-repair-ord.html">http://quake.abag.ca.gov/recovery/info-repair-ord.html</a> .	Existing program	Cities and counties
<b>5–(j-2):</b> Establish preservation-sensitive measures for the repair and reoccupancy of historically significant privately-owned structures, including requirements for temporary shoring or stabilization where needed, arrangements for consulting with preservationists, and expedited permit procedures for suitable repair or rebuilding of historically or architecturally valuable structures.	Existing program, underfunded	Cities and counties

## Living in Earthquake Country

The most pressing and potentially dangerous hazard facing the Bay Area is the constant threat of earthquakes. With many area faults overdue for major seismic activity, it is essential that the potential impact of a major earthquake on the region's housing stock be emphasized.

Structural damage to housing is most commonly caused by ground shaking. Although ground shaking can be felt for as many as hundreds of miles away in a major earthquake, shaking is most violent near fault segments that moved, causing the earthquake, as well as on soils that can amplify that shaking and make the shaking last longer.

For example, the Hayward fault has experienced major earthquakes, on average, every 140 years. As of 2009, it has been 141 years since the 1868 Hayward earthquake on the southern segment of the Hayward fault. Because this fault runs through one of the densest part of the Bay Area, and the housing in this area is older, ABAG has estimated that such an earthquake would create over 150,000 uninhabitable housing units.

The amount of damage to housing varies greatly across building construction types and building age. Two adjacent buildings can suffer dramatically different amounts of damage due to shaking. Buildings with "soft stories" (multi-story buildings with open or mostly open lower floors with parking or commercial space built prior to about 1990), unreinforced masonry buildings (built before the building code changed in 1933), and older single-family homes (typically built before about 1970) are extremely susceptible to severe shaking damage. In addition to sustaining substantial property damage, these buildings are more likely to be uninhabitable after earthquakes, resulting in large numbers of displaced residents.

In addition to shaking, earthquakes also can cause soil liquefaction, landslides, and surface rupture. However, these related hazards are typically handled through land use controls on new development described in Chapter 8.

The following section will discuss strategies for mitigating the hazards posed by earthquake shaking to various housing types.

## ACTIONS APPLYING TO EXISTING SINGLE-FAMILY HOMES VULNERABLE TO EARTHQUAKES

Single-family homes are the cornerstone of most Bay Area communities. Over half (54%) of the Bay Area housing stock is in single-family homes. As such, it is essential that damage to these homes be minimized to the greatest extent possible. Structural damage is the largest earthquake-related risk facing single-family homes. The amount and type of potential structural damage that a home faces depends upon the type of construction, its age and condition, and its location. The highest risk homes include unretrofitted homes built before 1978 (prior to the adoption of the most important earthquake-resistant building code changes), homes on hillsides, and homes with living space above a garage (these are subject to collapse due to structural weaknesses due to the garage door openings), but all homes are at risk.

**Conducting a proper retrofit using a standard plan set:** For a typical older house with a crawl space underneath the home, a retrofit consists of **no less** than three separate actions.

- (1) The base of the house (mudsill) is secured to the foundation using bolts to prevent the house from slipping off of the foundation.
- (2) If the house has a cripple wall (which forms the perimeter of the crawl space below the first floor), it is strengthened by adding plywood panels (shear walls) along the interior surface of all perimeter walls. Unbraced crawl space walls are the most likely part of the home to collapse in an earthquake.
- (3) The floor framing is secured to these walls to prevent the floor from slipping off them. (If the home does not have cripple walls, then the floor framing is secured directly to the mudsills.)

If any one of these actions does not occur, then there remains a large risk that the house will still suffer significant structural damage.

Unfortunately, just because a house has been retrofitted does not necessarily mean that it has been retrofitted properly or that all three actions have been taken. In a 1999 survey of 341 homes, ABAG found that anywhere from 1/3 to 2/3 of retrofitted homes were not adequately prepared for a future quake (the percentage varied by city). In a 2006 survey of 35 homes published in the *Contra Costa Times* on March 5, 2006, 2/3 of **retrofitted** homes were not adequately retrofitted to prevent collapse and limit damage.

Anecdotal evidence suggests that there are two primary reasons for this problem: lack of knowledge and lack of funds. Doing something is not always better than doing nothing.

*Contractors* may be untrained in retrofits and may therefore be unaware of proper retrofit procedure. The work they do may therefore be inadequate (for example, they may only add bolts to the foundation and not perform the other two actions). In addition, some unscrupulous contractors may intentionally deceive clients even if they are aware of proper retrofit procedure, as few homeowners would know how to inspect the work.

*Home inspectors* may be untrained in retrofits and therefore unable to judge whether the contractor has performed a proper retrofit. In addition home inspectors may be unable to judge whether a home needs a retrofit in the first place.

*Licensed professionals (engineers or architects with seismic retrofit experience)* are required for homes on hillsides or with living spaces above garages. If these professionals are not included in the design process when retrofitting these homes, it is unlikely that the home will be protected against collapse.

A retrofit standard clearly establishes the requirements for a retrofit, and gives local governments the power to enforce the standard. The standard applies not only to what is done in the retrofit, but also who is involved in the retrofit. Local governments can also require that engineers be involved in complex retrofits of homes on hillsides or on split-level homes with living spaces above a garage.

In order to simplify and make more uniform retrofit standards, ABAG, three chapters of the International Code Council (ICC), the California Building Officials (CALBO), the Structural Engineers Association of Northern California (EERI-NC), the Northern California Chapter of the Earthquake Engineering Research Institute, and retrofit contractors jointly developed a standard plan set to cover one type of single-family home. This standard “Plan Set A” applies to 1- or 2-family light construction wood-frame homes that are two stories or less in height, have a continuous perimeter concrete foundation, and crawl space walls no higher than four feet. This plan set greatly simplifies the retrofit process, as homeowners do not have to hire engineers to design retrofit plans, and city building departments do not have to individually review custom plans for each home.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<p><b>1–(b-1):</b> Utilize or recommend adoption of a retrofit standard that includes standard plan sets and construction details for voluntary bolting of homes to their foundations and bracing of outside walls of crawl spaces (“cripple” walls), such as Plan Set A developed by a committee representing the East Bay-Peninsula-Monterey Chapters of the International Code Council (ICC), California Building Officials (CALBO), the Structural Engineers Association of Northern California (SEAONC), the Northern California Chapter of the Earthquake Engineering Research Institute (EERI-NC), and ABAG’s Earthquake Program.</p>	Existing program, underfunded	City and county building departments
<p><b>2–(b-4):</b> Encourage local government building inspectors to take classes on a periodic basis (such as the FEMA-developed training classes offered by ABAG) on retrofitting of single-family homes, including application of Plan Set A.</p>	Existing program	City and county building departments
<p><b>3–(b-5):</b> Encourage private retrofit contractors and home inspectors doing work in your area to take retrofit classes on a periodic basis (such as the FEMA-developed training classes offered by ABAG or additional classes that might be offered by the CALBO Training Institute) on retrofitting of single-family homes.</p>	Existing program	City and county building departments
<p><b>4–(b-9):</b> Provide financial incentives to owners of single-family homes to retrofit if those retrofits comply with Plan Set A or IEBC 2006 in addition to that provided by existing State law that makes such retrofits exempt from increases in property taxes.</p>	Existing program, underfunded	Cities and counties

**Retrofitting homes not covered by a standard plan set:** Unfortunately, not all homes can be covered by one standard plan set. These homes include those more than two stories in height, homes on hillsides, homes with living spaces over garages, split-level homes, crawl space walls over four feet, and other common single-family home types. Although ABAG and the other organizations involved in the development of Plan Set A are looking into developing more standard plan sets to apply to a wider range of homes, local jurisdictions can and should still take steps to encourage proper retrofits of these homes.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1–(b-2):</b> Require engineered plan sets for seismic retrofitting of heavy two-story homes with living areas over garages, as well as for split level homes (that is, homes not covered by Plan Set A), until standard plan sets and construction details become available.	Existing program	City and county building departments
<b>2–(b-3):</b> Require engineered plan sets for seismic retrofitting of homes on steep hillsides (because these homes are not covered by Plan Set A).	Existing program	City and county building departments

**Public education related to retrofitting homes:** Although most residents are aware that both structural and non-structural earthquake damage can be severe, many are unaware of specific measures that should be taken to mitigate the impact to their homes. Local jurisdictions should develop a comprehensive plan to inform residents of specific mitigation procedures that can and should be undertaken.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1–(b-6):</b> Conduct demonstration projects on common existing housing types demonstrating structural and nonstructural mitigation techniques as community models for earthquake mitigation.	Moderate	City and county building departments
<b>2–(b-7):</b> Provide retrofit classes or workshops for homeowners in your community, or help promote utilization of sub regional workshops in the South Bay, East Bay, Peninsula, and North Bay as such workshops become available through outreach using existing community education programs.	Existing program, underfunded	City and county building departments
<b>3–(b-8):</b> Establish tool-lending libraries with common tools needed for retrofitting for use by homeowners with appropriate training.	Moderate	City and county building departments
<b>4–(g-18):</b> Create a mechanism to require the bracing of water heaters and flexible couplings on gas appliances, and/or (as specified under “b. Single-family homes vulnerable to earthquakes” above) the bolting of homes to their foundations and strengthening of cripple walls to reduce fire ignitions due to earthquakes.	Existing program	City and county building departments
<b>5–(k-12):</b> Make use of the materials on the ABAG web site at <a href="http://quake.abag.ca.gov/fixit">http://quake.abag.ca.gov/fixit</a> and other web sites to increase residential mitigation activities related to earthquakes. (ABAG plans to continue to improve the quality of those materials over time.)	Existing program	Cities and counties

## **ACTIONS APPLYING TO EXISTING SOFT-STORY MULTIFAMILY RESIDENTIAL BUILDINGS VULNERABLE TO EARTHQUAKES**

Some of the most susceptible structures to shaking damage are “soft-story” apartments and condominiums. A soft story residential building is one that has open parking or commercial space on the first floor and housing on higher floors built prior to modern codes. In an earthquake, ground shaking causes such structures to sway and sometimes collapse.

A soft-story collapse can have particularly disastrous consequences considering that they can crush cars and kill people

occupying the open areas.

A large portion of the Bay Area housing stock is in soft-story multifamily residences. A magnitude 7 earthquake on the Hayward fault could cause as many as 26,000 housing units in the City of Oakland alone to become uninhabitable, and over half of those failures would be of soft-story buildings. In addition to the obvious risk of shaking creating uninhabitable homes, soft-story buildings can also suffer gas main breaks, which can cause fires that will be particularly difficult to fight due to the other damage in an earthquake disaster.

Historically, multi-family housing is particularly slow to rebuild, as is low-income housing. Thus, the most vulnerable populations and the most vulnerable housing types are hit hardest and longest.

**Conducting an inventory of soft-story buildings:** An initial step to developing a soft-story earthquake hazard mitigation plan is to conduct an inventory of soft-story buildings. Without a comprehensive list, mitigating the hazards posed by soft-story buildings in an earthquake becomes difficult.

While potential soft-story multifamily residential buildings occur throughout the Bay Area, they predominate in areas where densities make parking within a building more common. For example, as housing densities increase and apartments replace single-family homes, these *initial* multifamily residential buildings constructed tend to have parking external to the building (in carports or in separate structures). But as housing densities continue to increase, that parking tends to be located within the building.

San Francisco itself has the largest number of soft-story buildings in the Bay Area. The San Francisco Department of Building Inspection for San Francisco worked with volunteers to inventory multifamily buildings containing 5 or more units, with three or more stories, and built prior to 1973. It identified approximately 4,400 buildings with parking or commercial on the first floor, of which about 2,800 buildings (containing 29,000 housing units), had openings spanning 80% of one side or 50% or more of two or more sides of that first floor. San Francisco has also estimated that there are an additional 4,600 4-unit buildings and 3,400 3-unit buildings in the City three stories or taller (Applied Technology Council, 2009).

However, the East Bay cities of Oakland, Berkeley, Alameda, Fremont, and San Leandro also have a significant number of potential soft-story buildings. In Oakland alone there are 1,479 potential soft-story multifamily buildings containing 24,273 housing units based on an inventory conducted by ABAG. This inventory defines such a building as having 2 or more stories, containing 5 or more units, and built prior to 1990. ABAG also has estimated, based on a statistical sample, that there are about 1,060 4-unit buildings and 370 3-unit buildings with parking on the first floor that were built prior to 1990 in Oakland (Perkins and others, 2009). Berkeley inventoried multifamily buildings containing 5 or more units, with 2 or more stories, and built prior to 1995. The City identified approximately 400 buildings containing about 5,000 units (D. Lambert, City of Berkeley, personal communication, 2009).

San Jose has the largest number of potential soft-story buildings in the South Bay, accounting for 10,923 units in 1,093 buildings (as compared to a total of 33,119 units in 2,630 potential soft-story buildings in that county). This inventory defines a multifamily building as one containing 4 or more units (Selvaduray and others, 2003).

Cities on the San Francisco Bay side of the Peninsula between San Francisco and San Jose also tend to have large number of these buildings. However, no specific numbers are available. Finally, these buildings are more common in the denser portions of Marin County than in the other North Bay counties. Again, no specific numbers are available.

An inventory can be expensive and time consuming. The effort by ABAG in the City of Oakland has worked to develop techniques that can be used to simplify and speed up the inventory process in other vulnerable Bay Area cities.

Once an inventory has been conducted, it can be used to develop and enforce retrofit programs and notify residents and landlords of the dangers of shaking damage to soft-story buildings. Although development of a comprehensive strategy for soft-story retrofits may take time, these inventories can be used immediately to inform residents that their homes are structurally suspect.

The process of conducting a soft-story inventory and disclosing information to the public about soft-story buildings is captured by the following strategies. While they focus on privately-owned buildings rather than government-owned office space (covered in Chapter 5-Government), *it is not the intent of these strategies to ignore housing owned by city housing authorities and non-profit groups.*

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1-(c-4):</b> Conduct an inventory of privately-owned existing or suspected soft-story residential structures as a first step in establishing voluntary or mandatory programs for retrofitting these buildings.	Existing program, underfunded	Cities and counties with ABAG
<b>2-(c-5):</b> Use the soft-story inventory to require private owners to inform all existing tenants (and prospective tenants prior to signing a lease agreement) that they may live in this type of building.	High	Cities and counties
<b>3-(c-6):</b> Use the soft-story inventory to require private owners to inform all existing and prospective tenants that they may need to be prepared to live elsewhere following an earthquake if the building has not been retrofitted.	Moderate	Cities and counties

**Retrofit standards:** Another step in mitigating the soft-story earthquake hazard is to develop and enforce specific retrofit standards. Since the range of soft-story buildings is wide, there is no easy way to develop the soft-story building equivalent of Plan Set A for single-family homes. Thus, use of a qualified engineer with seismic design experience is essential before undertaking major alternations of these buildings.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1-(c-1):</b> Require engineered plan sets for voluntary or mandatory soft-story seismic retrofits by private owners until a standard plan set and construction details become available.	Existing program	City and county building departments
<b>2-(c-2):</b> Adopt the 2009 International Existing Building Code or the latest applicable standard for the design of voluntary or mandatory soft-story building retrofits for use in city/county building department regulations. In addition, allow use of changes to that standard recommended by SEAOC for the 2012 IEBC.	Existing program	City and county building departments

**Retrofit incentives:** Unless cities and counties offer strong effective incentives and remove disincentives, many soft-story buildings will not get retrofitted. Different incentives may be appropriate for residential buildings of 5 or more units, since these buildings may be defined as commercial, whereas 3- or 4- unit apartments may be classified as residential. Many jurisdictions view building departments as logical leads for all activities associated with earthquake retrofits. However, incentive programs work best if a variety of departments are involved. Planning and community development can also encourage retrofits though the imaginative use of financial, procedural, and land use incentives. Examples of such incentives include parking, zoning, and density tradeoffs; use of redevelopment and CDBG funds to encourage retrofits; tax credits; transfer of development rights; reducing setbacks; coordination with rent control boards; and waiving or reducing building permit fees.

While the following strategies refer to existing materials available through ABAG and the City of San Jose, there remains a need to upgrade and update those materials.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1-(c-3):</b> Work to educate building owners, local government staff, engineers, and contractors on privately-owned soft-story retrofit procedures and incentives using materials such as those developed by ABAG and the City of San Jose (see <a href="http://quake.abag.ca.gov/eqhouse.html">http://quake.abag.ca.gov/eqhouse.html</a> ).	High	Cities and counties and ABAG
<b>2-(c-7):</b> Investigate and adopt appropriate financial, procedural, and land use incentives (such as parking waivers) for private owners of soft-story buildings to facilitate retrofit such as those described by ABAG (see <a href="http://quake.abag.ca.gov/fixit">http://quake.abag.ca.gov/fixit</a> ).	High	Cities and counties and ABAG

<b>3-(c-8):</b> Explore development of State regulations or legislation to require or encourage private owners of soft-story structures to strengthen them.	Moderate	Cities and counties and ABAG
<b>4-(c-9):</b> Provide technical assistance in seismically strengthening privately-owned soft-story structures.	Under study	Cities and counties and ABAG

## ACTIONS APPLYING TO UNREINFORCED MASONRY HOUSING STOCK

Unreinforced masonry buildings comprised of brick or stone are also vulnerable to collapse in an earthquake. **Un**reinforced **m**asonry structures, or URM) consist of a wood roof and floor with unreinforced brick walls. The walls are often not properly anchored to the floor and roof, often resulting in complete collapse when shaken violently. They were built largely before the 1930s when changes in the building code after the 1933 Long Beach Earthquake prevented further construction of URM. Although URM made up only 1% of the Bay Area housing stock in 1989, they accounted for over 15% of destroyed or significantly damaged housing units. According to ABAG projections, URM building failures could account for as many as 13,000 of the projected 156,000 uninhabitable housing units in a magnitude 7 event on the Hayward fault. While the most severe damage is experienced closest to the epicenter, earthquakes can cause damage to URM miles away. For example, in the Loma Prieta earthquake, URM over 80 miles away in Martinez suffered damage.

Given the severity of URM collapses, local jurisdictions must take positive steps to make sure that these homes are structurally sound and that residents know the potential dangers of living in one. For example, as explained further in Chapter 4-Economy, the common “*bolts-plus*” standard for retrofit in San Francisco and Oakland will mean that people will confront the risk of falling masonry when evacuating them after a damaging earthquake and many of these buildings will need to be torn down. Thus, disclosure programs, including installation of placards, become important.

While the following strategies focus on privately-owned buildings rather than government-owned office space (covered in Chapter 5-Government), ***it is not the intent of these strategies to ignore housing owned by city housing authorities and non-profit groups.***

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1-(d-1):</b> Continue to actively implement existing State law that requires cities and counties to maintain lists of the addresses of unreinforced masonry buildings and inform private property owners that they own this type of hazardous structure.	Existing program	Cities and counties
<b>2-(d-2):</b> Accelerate retrofitting of privately-owned unreinforced masonry structures that have not been retrofitted, for example, by (a) actively working with owners to obtain structural analyses of their buildings, (b) helping owners obtain retrofit funding, (c) adopting a mandatory versus voluntary, retrofit program, and/or (d) applying penalties to owners who show inadequate efforts to upgrade these buildings.	Existing program, underfunded	Cities and counties
<b>3-(d-3):</b> Require private owners to inform all existing tenants (and prospective tenants prior to signing a lease agreement) that they live in an unreinforced masonry building and the standard to which it may have been retrofitted.	Existing program, underfunded	Cities and counties
<b>4-(d-4):</b> As required by State law, require private owners to inform all existing tenants that they may need to be prepared to live elsewhere following an earthquake even if the building has been retrofitted, because it has probably been retrofitted to a life-safety standard, not to a standard that will allow occupancy following major earthquakes.	Existing program	Cities and counties

## ACTIONS APPLYING TO OTHER PRIVATELY-OWNED STRUCTURALLY VULNERABLE RESIDENTIAL BUILDINGS AND EARTHQUAKES

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In addition to soft-story buildings and unreinforced masonry structures, there are various other housing types that can be particularly vulnerable to shaking damage during an earthquake, including mobile homes, non-ductile concrete, and tilt-up concrete structures.

The most prevalent type of construction is mobile homes. As of 2005, ABAG had identified 5,458 acres of mobile home parks in the Bay Area, or 1% of the residential land in the region. In addition, mobile homes can be located areas outside of mobile home parks, particularly in rural areas. Their exposure to violent shaking is equivalent to that of residential land as a whole. Based on data from the 2000 Census, there are an estimated 57,129 mobile homes in the region, accounting for 2.2% of the housing stock. In September, 1985, regulations became effective requiring the Department of Housing and Community Development to certify earthquake resistant bracing systems for mobile homes. The sale or installation of systems not certified by the Department is unlawful. All certified bracing systems are required to bear a label indicating the manufacturer's name, the product name, the model number, and a statement that indicates "This system complies with the California Administrative Code, Title 25, Chapter 2, Article 7.5."

Local jurisdictions should have a plan for ensuring that these homes remain safe during earthquakes. While the following strategies focus on privately-owned buildings rather than government-owned office space (covered in Chapter 5-Government), *it is not the intent of these strategies to ignore housing owned by city housing authorities and non-profit groups.*

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1-(e-1):</b> Identify and work toward tying down mobile homes used as year-round permanent residences using an appropriate cost-sharing basis (for example, 75% grant, 25% owner).	Existing program, underfunded	Cities and counties
<b>2-(e-2):</b> Inventory non-ductile concrete, tilt-up concrete (such as converted lofts), and other privately-owned potentially structurally vulnerable residential buildings.	Existing program, underfunded	Cities and counties
<b>3-(e-3):</b> Adopt the 2009 International Existing Building Code or the latest applicable standard for the design of voluntary or mandatory retrofit of privately-owned seismically vulnerable buildings.	Existing program	Cities and counties
<b>4-(e-4):</b> Adopt one or more of the following strategies as incentives to encourage retrofitting of privately-owned seismically vulnerable residential buildings: (a) waivers or reductions of permit fees, (b) below-market loans, (c) local tax breaks, (d) grants to cover the cost of retrofitting or of a structural analysis, (e) land use (such as parking requirement waivers) and procedural incentives, or (f) technical assistance.	Existing program, underfunded	Cities and counties

## ACTIONS APPLYING TO NEW CONSTRUCTION AND EARTHQUAKES

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As the Bay Area continues to grow, local jurisdictions must remain vigilant about hazard mitigation. As more new residents settle in the region, we must ensure that the housing that is built will withstand the earthquakes we know will happen. Cities and counties must enforce building codes to ensure that the Bay Area's new homes are structurally sound. The following strategies relate to new construction and earthquakes. In addition, the requirements need to be combined with public education to ensure that alterations, additions, and repairs of existing buildings, when those changes exceed 50% of the value of the building, are enforced.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1–(f-1):</b> Continue to require that all new housing be constructed in compliance with requirements of the most recently adopted version of the <i>California Building Code</i> .	Existing program	Cities and counties
<b>2–(f-2):</b> Conduct appropriate employee training and support continued education to ensure enforcement of building codes and construction standards, as well as identification of typical design inadequacies of housing and recommended improvements.	Existing program	Cities and counties

## Wildfire Threat and Wildland-Urban-Interface Threat and Housing

During the past 50 years, the Bay Area has experienced wildfire disasters in 1961, 1962, 1964, 1965, 1970, 1981, 1985, 1988, and 1991. By far the most damaging was the 1991 fire in the East Bay Hills, which resulted in \$1.7 billion in losses. In that fire, 3,354 family dwellings and 456 apartments were destroyed, while 25 people were killed and 150 people were injured.

While it is unlikely that any single fire disaster in the Bay Area would exceed the 1991 East Bay Hills Fire in total homes lost, increases in the value and size of homes in hillside areas can make the total losses greater.

The California Department of Forestry maps wildfire hazard in two ways – wildland-urban-interface (WUI) fire threat for areas where local fire agencies have jurisdiction, and wildfire threat for areas that the State has jurisdiction. Based on an analysis of data on wildfires during the past 130 years, **0.2%** of the areas mapped as an extreme wildfire threat have burned, **22.8%** of those mapped as very high, and **18.5%** of those mapped as high. While, only **4.5%** of the areas in WUI fire threat areas have burned in the past 50 years, this past experience is not an indicator of risk for the next 50 years due to the availability of increased fuel loads and the potential impact of global climate change.

Wildfires remain a pervasive and continuing concern. As noted in Chapter 8-Land Use, while **18.5%** of the region’s land is in a wildland-urban-interface (WUI) fire threat area, amazingly, **51.8%** of the land newly developed or redeveloped from 2000-2005 is in these areas.

The following strategies do not cover all of the mitigation needed for residential development in these areas.

Additional strategies related to access, for example, are covered in Chapter 1-Infrastructure. In addition, while a fire can offer the opportunity to rebuild in a more sustainable manner, such a result is not guaranteed. For example, new housing built in the Oakland Hills after the 1991 fire now have more fire-resistant roofs and siding, but access issues were not solved.

One of the largest concerns for local governments is the risk of fire following an earthquake, whether that fire is triggered by downed power lines or broken gas lines. Problems will be exasperated by broken water lines and lack of available emergency response vehicles. Thus, while the following strategies target mitigation of hazards posed to housing by wildfires and structural fires, they are also mitigation for fire following earthquakes.

## ACTIONS APPLYING TO WILDFIRES AND STRUCTURAL FIRES

**Existing construction:** Local jurisdictions can take various steps to mitigate the hazards posed to existing homes by wildfire in their areas.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1–(g-1):</b> Increase efforts to reduce hazards in existing private development in wildland-urban-interface fire-threatened communities or in areas exposed to high-to-extreme fire threat through improving engineering design and vegetation management for mitigation, appropriate code enforcement, and public education on defensible space mitigation strategies.	Existing program	Cities and counties

**New construction or significant remodeling:** As the Bay Area continues to grow, homes will inevitably be built in areas that are susceptible to wildfires. Local governments must take steps to ensure that this new construction does not become a liability that will devastate Bay Area communities in the event of a wildfire. New communities must be planned in a way that structures are built of fire-retardant materials and with fire suppression mechanisms. In addition, residents should have easy evacuation routes. Finally, the requirements need to be combined with public education to ensure that alterations, additions, and repairs of existing buildings, when those changes exceed 50% of the value of the building, are enforced.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1-(g-3):</b> Require that new homes in wildland-urban-interface fire-threatened communities or in areas exposed to high-to-extreme fire threat be constructed of fire-resistant building materials (including roofing and exterior walls) and incorporate fire-resistant design features (such as minimal use of eaves, internal corners, and open first floors) to increase structural survivability and reduce ignitability. <b>Note</b> - See Structural Fire Prevention Field Guide for Mitigation of Wildfires at <a href="http://cdfdata.fire.ca.gov/fire_er/fpp_engineering_view?guide_id=11">http://cdfdata.fire.ca.gov/fire_er/fpp_engineering_view?guide_id=11</a> .	Existing program	Cities and counties
<b>2-(g-5):</b> Consider fire safety, evacuation, and emergency vehicle access when reviewing proposals to add secondary units or additional residential units in wildland-urban-interface fire-threatened communities or in areas exposed to high-to-extreme fire threat.	Existing program	Cities and counties
<b>3-(g-6):</b> Adopt and amend as needed updated versions of the <i>California Building and Fire Codes</i> so that optimal fire-protection standards are used in construction and renovation projects of private buildings.	Existing program	Cities and counties
<b>4-(g-12):</b> Require fire sprinklers in new homes located more than 1.5 miles or a 5-minute response time from a fire station or in an identified high hazard wildland-urban-interface wildfire area.	Existing program	Cities and counties
<b>5-(g-13):</b> Require fire sprinklers in all new or substantially remodeled multifamily housing, regardless of distance from a fire station.	Existing program	Cities and counties
<b>6-(g-14):</b> Require sprinklers in all mixed use development to protect residential uses from fires started in non-residential areas.	Existing program	Cities and counties

**Vegetation management:** One of the simplest, yet most important aspects of a wildfire hazard mitigation strategy is vegetation management. Fires without volatile fuel are less likely to spread, and homes with defensible space are more likely to survive a wildfire. A number of non-native plant species in wildfire-susceptible areas, namely eucalyptus trees, significantly raise the threat to homes in wooded areas. As such, local jurisdictions can take steps to encourage proper vegetation management and defensible space clearing as explained by the following strategies.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1-(g-9):</b> Expand vegetation management programs in wildland-urban-interface fire-threatened communities or in areas exposed to high-to-extreme fire threat to more effectively manage the fuel load through roadside collection and chipping, mechanical fuel reduction equipment, selected harvesting, use of goats or other organic methods of fuel reduction, and selected use of controlled burning.	Existing program, underfunded	Cities and counties
<b>2-(g-10):</b> Establish special funding mechanisms (such as Fire Hazard Abatement Districts or regional bond funding) to fund reduction in fire risk of existing properties through vegetation management that includes reduction of fuel loads, use of defensible space, and fuel breaks.	Existing program, underfunded	Cities and counties

<p><b>3–(g-17):</b> Ensure that city/county-initiated fire-preventive vegetation-management techniques and practices for creek sides and high-slope areas do not contribute to the landslide and erosion hazard. For example, vegetation in these sensitive areas could be thinned, rather than removed, or replanted with less flammable materials. When thinning, the non-native species should be removed first. Other options would be to use structural mitigation, rather than vegetation management in the most sensitive areas.</p>	<p>Existing program, underfunded</p>	<p>Cities and counties</p>
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<p><b>4–(k-9):</b> Assist residents in the development of defensible space through the use of, for example, “tool libraries” for weed abatement tools, roadside collection and/or chipping services (for brush, weeds, and tree branches) in wildland-urban-interface fire-threatened communities or in areas exposed to high-to-extreme fire threat.</p>	<p>Existing program, underfunded</p>	<p>Cities and counties</p>
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**Public education:** Residents must be made aware of the significant hazard posed by wildfires. While necessary, government vegetation management programs will not be sufficient if private citizens are not shown the importance of proper mitigation techniques. For example, a new deck may meet existing requirements for setbacks from existing trees on an individual’s own property, but not from the trees on a neighbor’s property.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<p><b>1–(g-2):</b> Tie public education on defensible space and a comprehensive defensible space ordinance to a field program of enforcement.</p>	<p>Existing program</p>	<p>Cities and counties</p>
<p><b>2–(g-4):</b> Create or identify “model” properties showing defensible space and structural survivability in neighborhoods that are wildland-urban-interface fire-threatened communities or in areas exposed to high-to-extreme fire threat.</p>	<p>Moderate</p>	<p>Cities and counties</p>
<p><b>3–(g-11):</b> Work with residents in rural-residential areas to ensure adequate plans are developed for appropriate access and evacuation in wildland-urban-interface fire-threatened communities or in areas exposed to high-to-extreme fire threat. For example, in some areas, additional roads can be created, and in other areas, the communities will need to focus on early warning and evacuation because additional roads are not feasible.</p>	<p>Existing program, underfunded</p>	<p>Cities and counties</p>
<p><b>4–(k-14):</b> Encourage the formation of a community- and neighborhood-based approach to wildfire education and action through local Fire Safe Councils and the <i>Fire Wise Program</i>. This effort is important because grant funds are currently available to offset costs of specific council-supported projects.</p>	<p>Existing program, underfunded</p>	<p>Cities and counties</p>

**Multi-agency coordination:** Many necessary functions in fire hazard mitigation planning cannot be handled by local jurisdictions acting alone. Some mitigation strategies require that local jurisdictions work with one another, as well as with state and private agencies to reduce the risk of serious damage to the Bay Area housing stock. Mutual aid agreements and multi-agency coordination and communication become particularly important when the number of fires exceeds the number of fire trucks. In particular, the issue of fires triggered in an earthquake can be particularly problematic. As local governments struggle with decisions on reducing those ignitions, it is important that they work with PG&E and understand that electrical shorts, not gas leaks, are responsible for most earthquake-triggered fires.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<p><b>1–(g-8):</b> Work to ensure a reliable source of water for fire suppression in rural-residential areas through the cooperative efforts of water districts, fire districts, and residents.</p>	<p>Existing program, underfunded</p>	<p>Cities and counties and water agencies</p>

<p><b>2-(g-19):</b> Work with the State Fire Marshall, the California Seismic Safety Commission, Pacific Earthquake Engineering Research Center (PEER), and other experts to identify and manage gas-related fire risks of soft-story residential or mixed use buildings that are prone to collapse and occupant entrapment consistent with the natural gas safety recommendations of Seismic Safety Commission Report SSC-02-03. <b>Note</b> - See <a href="http://www.seismic.ca.gov/pub/CSSC_2002-03_Natural%20Gas%20Safety.pdf">http://www.seismic.ca.gov/pub/CSSC_2002-03_Natural%20Gas%20Safety.pdf</a>. <b>Also note</b> - any valves that are installed may need to have both excess flow and seismic triggers (“hybrid” valves).</p>	Moderate	Cities and counties and ABAG
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<p><b>3-(g-20):</b> Work with insurance companies to create a public/private partnership to give a discount on fire insurance premiums to “Forester Certified” <i>Fire Wise</i> landscaping and fire-resistant building materials on private property.</p>	Existing program, underfunded	Cities and counties
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**Enforcement and inspection for fire hazard mitigation:** A fire hazard mitigation plan will not be effective if jurisdictions do not maintain rigorous enforcement of new and existing mitigation practices. For example, they should ensure that alterations, additions, and repairs of existing buildings meet these requirements when those changes exceed 50% of the value of the building.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<p><b>1-(g-7):</b> Create a mechanism to enforce provisions of the <i>California Building and Fire Codes</i> and other local codes that require the installation of smoke detectors and fire-extinguishing systems on existing residential buildings by making installation a condition of (a) finalizing a permit for any work valued at over a fixed amount and/or (b) on any building over 75 feet in height, and/or (b) as a condition for the transfer of property.</p>	Existing program	Cities and counties
<p><b>5-(g-15):</b> Compile a list of privately-owned high-rise and high-occupancy buildings which are deemed, due to their age or construction materials, to be particularly susceptible to fire hazards, and determine an expeditious timeline for the fire-safety inspection of all such structures.</p>	Existing program	Cities and counties
<p><b>6-(g-16):</b> Conduct periodic fire-safety inspections of all multi-family buildings, as required by State law.</p>	Existing program	Cities and counties

<h2>Flooding and Housing</h2>	
<p>Only 4% of the residential land is located in the 100-year flood plain. These homes lie along the various rivers and streams that form the Bay Area watershed, as well as around significant portions of the Bay and Delta. Most of the most vulnerable housing is located along the Russian River in Sonoma County.</p>	<p>Those properties that have had more than one insured flood loss are called repetitive loss properties. Based on the most recent data obtained from FEMA, there are 1,417 repetitive flood properties in the Bay Area. While 1,417 is a large number of properties, it is only 0.1% of the 1,663,498 residential parcels in the Bay Area (as of 2005). These property owners have made 4,269 claims totaling \$98,159,564, of which \$65,454,919 was in Sonoma County.</p>
<p>Sometimes the same homes flood again and again. The Federal Emergency Management Agency (FEMA) insures properties against flooding losses in the Bay Area through the National Flood Insurance Program.</p>	

## ACTIONS APPLYING TO FLOODING

**Existing construction:** Local jurisdictions with significant portions of its housing stock located in flood-prone areas should develop a plan to mitigate the hazard posed by flooding to the Bay Area housing stock. Potential plans can range from such basic activities as providing sandbags and plastic sheeting to area residents, to more in-depth programs for elevation and relocation. Note that activities such as maintenance of creeks and existing drainage infrastructure are covered in Chapter 1-Infrastructure.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1-(h-4):</b> Provide sandbags and plastic sheeting to residents in anticipation of rainstorms, and deliver those materials to vulnerable populations upon request.	Existing program	Cities and counties
<b>2-(h-5):</b> Provide public information on locations for obtaining sandbags and/or deliver those sandbags to those various locations throughout a city and/or county prior to and/or during the rainy season.	Existing program	Cities and counties
<b>3-(h-8):</b> Encourage home and apartment owners to participate in home elevation programs within flood hazard areas.	Moderate	Cities and counties
<b>4-(h-9):</b> As funding opportunities become available, encourage home and apartment owners to participate in acquisition and relocation programs for areas within floodways.	Moderate	Cities and counties

**Role for flood insurance:** Although Federal regulations require flood insurance for those homes in designated high-risk flood zones (those areas with a 1% or greater chance of flooding in any given year), there are still steps local jurisdictions can take to ensure that the financial hazards posed by floods to residents are mitigated. Although flood insurance is not required in moderate- to low-risk flood areas, jurisdictions can encourage residents in these areas to purchase flood insurance, as FEMA estimates that 25% of flood loss claims each year are from homeowners in moderate- to low-risk areas. Jurisdictions can also work to lower the cost of obtaining flood insurance by working with the National Flood Insurance Program.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1-(h-1):</b> To reduce flood risk, thereby reducing the cost of flood insurance to private property owners, work to qualify for the highest-feasible rating under the Community Rating System of the National Flood Insurance Program.	Existing program	Cities and counties
<b>2-(h-10):</b> Encourage owners of properties in a floodplain to consider purchasing flood insurance. For example, point out that most homeowners' insurance policies do not cover a property for flood damage.	Existing program	Cities and counties

**New construction:** As the Bay Area grows, homes may continue to be built in flood hazard areas. While simply not building homes in flood-prone areas would be the easiest solution, it is not practical in a growing urban region. Because construction in flood planes is inevitable, local jurisdictions must ensure that new development in such areas is planned in a way that does not contribute to flood hazards. New development in flood zones must be planned considering storm water and flood management infrastructure, as additional homes without increased water runoff management can cause problems.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1-(h-2):</b> Balance the housing needs of residents against the risk from potential flood-related hazards.	Existing program	Cities and counties

<b>2–(h-3):</b> Ensure that new private development pays its fair share of improvements to the storm drainage system necessary to accommodate increased flows from the development, or does not increase runoff by draining water to pervious areas or detention facilities.	Existing program	Cities and counties
<b>3–(h-6):</b> Apply floodplain management regulations for private development in the floodplain and floodway.	Existing program	Cities and counties
<b>4–(h-7):</b> Ensure that new subdivisions are designed to reduce or eliminate flood damage by requiring lots and rights-of-way be laid out for the provision of approved sewer and drainage facilities, providing on-site detention facilities whenever practicable.	Existing program	Cities and counties

**Public education:** Local jurisdictions can play a key role in informing residents of flood hazards. They can emphasize the importance of proper storm water runoff management, and provide resources to residents regarding flood preparation and notification.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<b>1–(k-7):</b> Include flood fighting technique session based on California Department of Water Resources training to the list of available public training classes offered by CERT.	Existing program, underfunded	Cities and counties
<b>2–(k-11):</b> Develop a program to provide at-cost NOAA weather radios to residents of flood hazard areas that request them, with priority to neighborhood watch captains and others trained in their use.	Moderate	Cities and counties
<b>3–(k-13):</b> Develop a “Maintain-a-Drain” campaign, similar to that of the City of Oakland, encouraging private businesses and residents to keep storm drains in their neighborhood free of debris.	Existing program	Cities and counties
<b>4–(k-15):</b> Inform shoreline-property owners of the possible long-term economic threat posed by rising sea levels.	Under study	Cities and counties and ABAG

## Housing, Landslides, and Erosion

Only 10% of the Bay Area housing stock is located in areas that are exposed to very high risk of future landslides (because they are in areas where many landslides have occurred in the past. However, when a landslide occurs, it can be just as devastating and dangerous as the various other hazards facing the Bay Area housing stock, but to smaller geographic areas.

Intense storms in January of 1982 caused over 18,000 separate landslides in the Bay Area, destroying over 100 homes and causing 25 fatalities. In all, the slides resulted in \$66 million in damage. The hazard posed by landslides is increased when soil becomes eroded.

## ACTIONS APPLYING TO LANDSLIDES AND EROSION

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The following strategies on landslides and erosion relate specifically to housing. However, additional strategies related to landslides are listed in Chapter 8-Land Use, and a discussion of erosion during vegetation management is included above as Strategy g-17. In addition, appropriate vegetation management practices listed in the wildfire section above can also reduce the risk of erosion and shallow landslides. Education of owners is also critical.

<i>Strategy</i>	<i>Regional Priority</i>	<i>Responsible Agency</i>
<p><b>1-(i-1):</b> Increase efforts to reduce landslides and erosion in existing and future development by improving appropriate code enforcement and use of applicable standards for private property, such as those appearing in the <i>California Building Code</i>, California Geological Survey <i>Special Report 117 – Guidelines for Evaluating and Mitigating Seismic Hazards in California</i>, American Society of Civil Engineers (ASCE) report <i>Recommended Procedures for Implementation of DMG Special Publication 117: Guidelines for Analyzing and Mitigating Landslide Hazards in California</i>, and the California Board for Geologists and Geophysicists <i>Guidelines for Engineering Geologic Reports</i>. Such standards should cover excavation, fill placement, cut-fill transitions, slope stability, drainage and erosion control, slope setbacks, expansive soils, collapsible soils, environmental issues, geological and geotechnical investigations, grading plans and specifications, protection of adjacent properties, and review and permit issuance.</p>	Existing program	Cities and counties
<p><b>2-(i-2):</b> Increase efforts to reduce landslides and erosion in existing and future private development through continuing education of design professionals on mitigation strategies.</p>	Existing program, underfunded	Cities and counties