

Here Today—Here Tomorrow:

The Road to Earthquake Resilience in
San Francisco

A Community Action Plan for Seismic Safety

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Report Summary

Earthquakes are in San Francisco's future. The consequences of those future earthquakes could be very different—worse or better—depending on the policy choices and actions City agencies and building owners take now.

The Community Action Plan for Seismic Safety (CAPSS) project studied four probable earthquakes that could strike the City and found that future earthquakes would damage many thousands of buildings to the point where they cannot be occupied. They would devastate the City's housing stock, and could have long-term implications on the City's affordability to middle and low-income residents who would be displaced for years. Hundreds of people could be killed and thousands could be injured. The City would lose irreplaceable historic buildings and rent-controlled apartments. The price tag of the earthquake damage would be many billion dollars. Property owners, the majority of whom do not carry earthquake insurance, would bear the brunt of these economic losses. Many more details appear in a companion report, *Potential Earthquake Impacts* (ATC 52-1, 2010).

Much of the damage from future earthquakes is preventable. This report suggests measures building owners and the City can take to reduce risk to privately owned buildings. It does not consider the risk to publicly owned buildings or infrastructure, though these risks are considerable. Reducing the negative consequences of future earthquakes benefits all San Franciscans: building owners, businesses, residential tenants, and the City government. These recommendations were developed with advice from an Advisory Committee of citizens representing all of these groups. Taking action before an earthquake strikes is less costly than repairing damage after an earthquake, both in terms of the dollars required and the social impacts associated with housing losses, business closures, and damaged property.

The top priority actions that San Francisco's City government leaders should take now to reduce the consequences of future earthquakes are:

- **Inform the public of risks and ways to reduce risk.** The City should conduct focused education and outreach campaigns aimed at building owners, tenants, realtors and others to improve their understanding of earthquake risks and measures to manage the risk, and to facilitate a market for retrofitting. On their own, education programs motivate only a limited number of people to take action. However, they are an essential part of making other risk reduction programs work.
- **Adopt updated code standards for seismic evaluation and retrofit of all common buildings.** As the City moves forward with programs to encourage and require more retrofits of vulnerable buildings, it is critical for DBI to adopt updated code standards applicable to all of the common building types that reflect both the City's earthquake resilience objectives and technical advances in structural engineering. It must be clear to building owners what building seismic performance is acceptable to the City, and what requirements of future mandates will be.

- **Require all buildings to be evaluated for seismic risk.** Owners of all buildings should evaluate the seismic performance of their buildings upon sale relative to standards adopted by the City. If no sale occurs, they should evaluate their buildings by a deadline established based on the building use and structural type. The result would be shared with tenants and prospective buyers and tenants, and be made a part of public City records. This information allows prospective buyers and tenants to consider seismic issues when making decisions about purchasing or renting space. It provides information needed to incorporate seismic issues in market pricing of real estate. It would also provide owners with the information needed to decide whether to seismically retrofit vulnerable buildings.
- **Require retrofits of vulnerable buildings.** Owners of vulnerable buildings should be required to seismically retrofit their buildings for structural, fire, usability and falling hazards by specific deadlines, varying by building category. It is likely that most owners will not retrofit their buildings unless they are required to do so. Ultimately, the City will need to require owners of vulnerable buildings to retrofit to improve San Francisco's earthquake resilience. Deadlines for mandatory retrofits show that the City believes this issue is serious, allows the market to consider seismic safety in its pricing, and provides certainty for owners of vulnerable buildings to plan for the future.
- **Adopt improved post-earthquake repair standards.** The City should enact updated post-earthquake repair and retrofit standards developed by CAPSS and expand this approach to other building types. In a companion report (ATC 52-4, *Postearthquake Repair and Retrofit Requirements*), CAPSS clarified technical recommendations to improve this policy and to improve the way this process builds the City's resilience over time.
- **Clarify responsibility for preparing for and reducing risk from earthquakes.** The City should identify a single official, the "Earthquake Czar", to be responsible for achieving earthquake resilience through mitigation, response and recovery. Implementing earthquake mitigation measures needs to become an ongoing concern of the City with standing equal to other programs.
- **Offer incentives for retrofit of buildings.** The City should enact a range of meaningful programs to help building owners afford retrofits. Owners ultimately are responsible for the earthquake performance of their buildings: they have the most to gain from improved performance, and the most to lose because of damage and liability. However, the City has a strong interest in reducing the amount of damage that occurs to privately-owned buildings in future earthquakes. Therefore, it makes sense for the City to invest in encouraging building owners to make their buildings safer.

This plan is a call to action to invest in the City's future. San Francisco will always have earthquakes in its future, but with the proper foresight and effort, the consequences of those earthquakes can be reduced so that the City can rebound quickly and maintain its unique character.

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1. Introduction

San Francisco faces a daunting earthquake threat given its proximity to active faults, buildings that are older than those in other Western cities, steep hillsides, areas with poor soils prone to liquefaction and amplification of shaking, and dense, wooden buildings with a proclivity to burn. However, there are many things that can be done to minimize the consequences of future earthquakes and make San Francisco more earthquake resilient. Actions taken to improve buildings before earthquakes strike will reduce damage and casualties, speed recovery, lessen economic losses from business interruption, reduce housing and jobs losses, and protect community values and the unique character of the City. San Franciscans need to understand the risk from earthquakes and steps they can take to improve the situation.

This report identifies measures that could be taken before earthquakes strike to reduce damage to privately-owned buildings. It recommends a comprehensive, long-term mitigation program to lead the City toward earthquake resilience and identifies steps needed to carry out the program. The program begins with building public awareness among specific groups of San Franciscans and builds over time to stronger measures to make the City's building stock more robust.

Earthquake risk creates a dilemma for building owners. Most owners understand that intense earthquakes would damage their buildings and that the cost to repair their buildings and income lost while the building is repaired or replaced can amount to significant losses. They also sense that they bear a duty to others who could be harmed by damage to their buildings and the ensuing disruption, but they are faced with uncertainty. The lack of community standards about the appropriate actions to take leads to misleading and inconsistent opinions about what needs to be done. Acting now appears to leave them open to requirements adopted later. If they retrofit their building now, will it comply with code requirements put in place in a few years? Will they need to re-do the work? Some owners, especially homeowners, have tried to improve their buildings without advice from qualified design professionals, but the lack of standards leads them to overspend or carryout projects that might be ineffective. This report calls for measures to provide owners with the information and standards that would help them decide on the right course of action. It recommends giving owners of some types of vulnerable buildings about 20 years to voluntarily to protect their own interests before adopting requirements.

However, the course of action cannot be only voluntary because too much is at stake. Therefore, this report recommends, ultimately, setting mandatory deadlines for meeting buildings to be retrofit. The report reiterates an earlier recommendation for a mandatory retrofit program addressing wood frame buildings with five or more residential units and three or more stories. A task force created by the Mayor currently is considering this recommendation. Improving San Francisco's earthquake resilience will take persistent effort and government intervention over several decades. However, as the recommended measures are implemented, the San Francisco community would weather earthquakes with fewer casualties and less damage, be able to more rapidly recover economically, and preserve for

future generations the exciting, dynamic, culturally diverse, historic and livable city residents enjoy today. In a word, San Francisco would become more resilient.

The recommended mitigation program is presented in the following chapters:

- Chapter 2 summarizes the likely impacts of future earthquakes in San Francisco as it exists today. These impacts are described in detail in the companion report, *Potential Earthquake Impacts* (ATC 52-1, 2010).
- Chapter 3 recommends objectives to guide the City's mitigation activities.
- Chapter 4 recommends actions building owners and the City should take, and explains why these actions make sense for the City.
- Chapter 5 presents a plan of action for the next few years, 2011 to 2015, to launch the recommendations in this report.

This plan is a call to action to invest in the City's future. San Francisco will always have earthquakes in its future, but with the proper foresight and effort, those earthquakes do not need to be unmitigated disasters.

2. San Francisco's Earthquake Risk

Future large earthquakes will have severe consequences to San Francisco if the City does not act to improve the seismic performance of its older buildings. These consequences are discussed exhaustively in a companion report, *Potential Earthquake Impacts* (ATC 52-1, 2010), and they include deaths and injuries; damaged and destroyed buildings; loss of housing, particularly affordable and rent-controlled units; economic losses; job losses; businesses closures; reductions in City revenues at a time of increasing need; loss of historic resources; and increased difficulties for low and middle income residents.

Knowing the risk the City faces today is important because it defines the starting point for reducing those risks. The San Francisco community can compare where its risk is today with where it would like it to be, and identify the risks that are least acceptable. San Francisco can learn from New Orleans, where the risk of hurricane flooding was well known, but the importance of acting on that knowledge became widely accepted only after Katrina struck.

This chapter briefly reviews selected impacts of four possible earthquakes that could strike the City, highlighting impacts that point towards mitigation priorities and steps the City could take to become more resilient. The earthquakes studied are magnitude 6.5, 7.2 and 7.9 earthquakes on the San Andreas fault at the City's western coast, and a magnitude 6.9 earthquake on the Hayward fault across the Bay. The CAPSS project analyzed the damage these earthquakes and fires ignited by the shaking could cause, and the impacts of that damage on various aspects of San Francisco. Selected findings are discussed below¹. These findings are estimates, not predictions, and any number of circumstances could cause impacts after future earthquakes to be much lower or higher.

Loss of Life

Buildings damaged by earthquakes can kill people. Some loss of life may be unavoidable in large earthquakes, but measures can reduce the danger. In fact, San Francisco already has taken many steps to reduce casualties in earthquakes by enforcing building design and construction standards and requiring seismic retrofits of unreinforced masonry buildings and bracing of parapets. San Francisco can expect fewer casualties after a large earthquake than seen in less developed countries, but deaths are still expected and significant risk remains.

The study of four scenario earthquakes found the following²:

- Depending on the magnitude, location and time of day of an earthquake, deaths could range from 70 to nearly 1,000, and injuries requiring medical care could number from 1,900 to more than 14,000.

¹ Detailed loss estimates are available in the report *Potential Earthquake Risk* (ATC 52-1, 2010). A discussion of the technical methods behind the estimates appears in *Potential Earthquake Impacts: Technical Documentation* (ATC 52-1A, 2010).

² These estimates only include casualties caused by building damage. They do not include casualties caused by infrastructure damage (e.g., collapse of overpasses) or casualties due to fires sparked by the earthquake.

- Casualties could be much higher than these estimates if even one large, densely occupied office or apartment building collapses. There are some large, multi-story concrete buildings in the City built before 1980 that have the potential to collapse catastrophically and kill many people.

Specific types of buildings are most likely to cause casualties in future earthquakes. As shown in Figure 2-1, stiff and brittle concrete buildings built before the 1980's have the highest potential to cause casualties. Falling items, such as heavy shelves, plaster ceilings, or exterior veneer, even in buildings that are structurally robust, also can cause casualties. For example, studies following the 1999 Kocaeli earthquake near Istanbul found that nearly half of the casualties were caused by falling hazards³. Casualties caused by such damage are included in these estimates but are not reported separately.

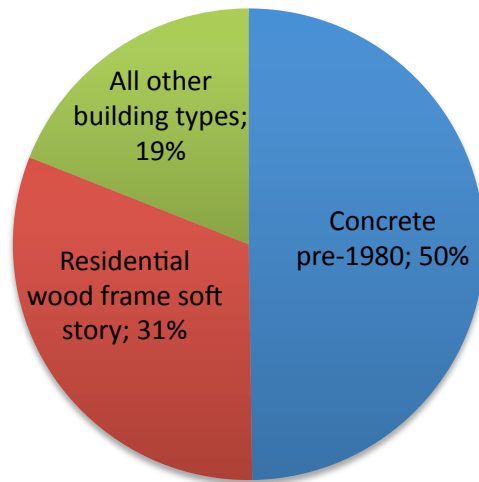


Figure 2-1. Estimated percent of deaths caused by various structure types in a Magnitude 7.2 San Andreas scenario, averaged over different times of day.

Implications for risk mitigation activities:

- Structural improvements to concrete buildings built before 1980 and residential wood frame soft-story buildings would do the most to reduce expected casualties in future earthquakes.
- Casualties could be further reduced by making sure falling hazards are properly secured so that they do not fall on occupants during shaking. This is a relatively simple, low-cost effort.

Loss of Housing and Displaced Residents

Housing, which is a critical part of San Francisco's recovery from future earthquakes, will be hard hit. Damage will threaten the availability and affordability of housing and displace residents for years. The

³ Petal, 2004.

loss study found the following damage to housing after a magnitude 7.2 scenario earthquake on the San Andreas:

- 85,000 of the City’s 330,000 housing units could not be occupied due to damage caused by shaking. This is more than a quarter of the City’s housing units.
- 11,000 of those damaged housing units would need to be demolished. It is likely that many of the lost units would be rent-controlled apartments, which, due to state law, could not be replaced by apartments covered by rent control.
- Fires that follow the earthquake could destroy more than 5,800 additional housing units.

Rebuilding is a slow process. After the Loma Prieta and Northridge earthquakes, both of which were much smaller in size than the earthquakes studied by this project, it took an average of two to three years before most heavily damaged residences were repaired or replaced. San Francisco can expect it will take much longer for its damaged and destroyed housing units to be usable after larger earthquakes.

Housing loss due to shaking damage is linked to particular types of structures. Figure 2-2 shows the types of structures responsible for unusable housing units after a Magnitude 7.2 San Andreas scenario earthquake.

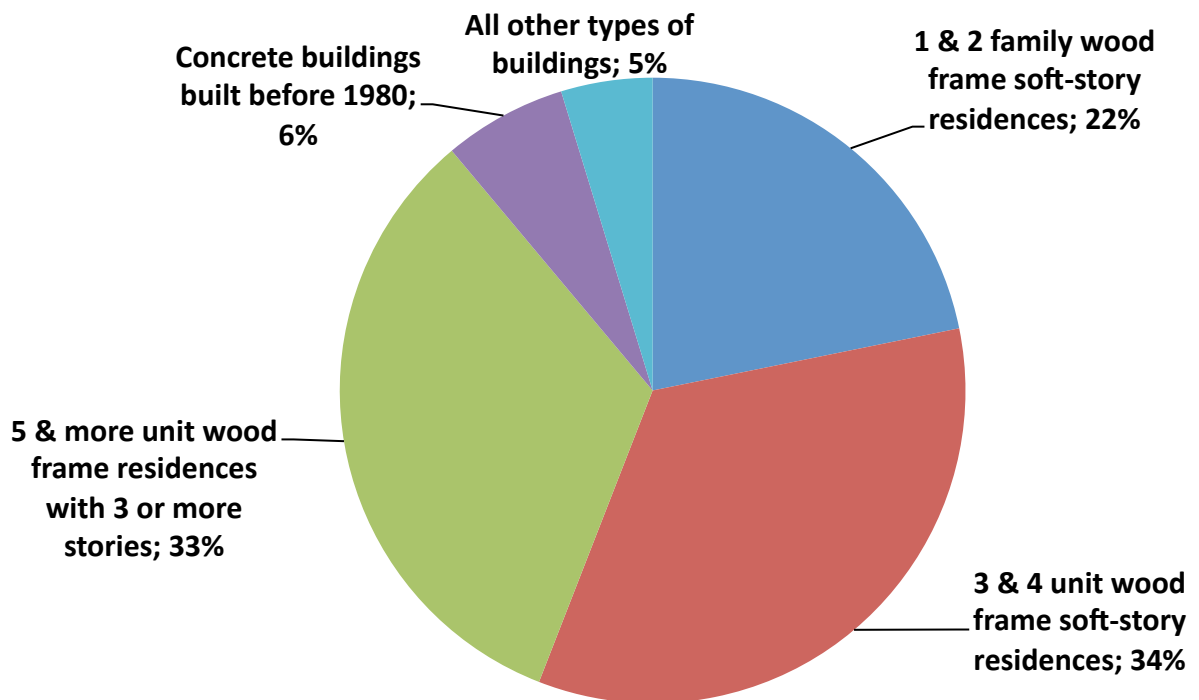


Figure 2-2. The estimated share of housing units that cannot be occupied found in various structural types, for a Magnitude 7.2 San Andreas scenario earthquake.

Implications for risk mitigation activities:

- Wood frame residences with three or more units account for about two-thirds of the housing units that would not be usable after a Magnitude 7.2 San Andreas scenario earthquake. These structures are vulnerable largely because of weak or “soft-story” conditions. Retrofitting these types of structures would have a significant impact to improve post-earthquake housing availability. These retrofits are relatively straightforward and are less expensive than retrofits to other types of structures.
- Rebuilding after an earthquake will take a long time. There are steps the City agencies and building owners can take prior to an earthquake to facilitate rapid and efficient repair and rebuilding, but reducing the amount of expected damage is the most effective way to speed post-earthquake recovery.

Economic and Business Impacts

The damage from earthquake shaking and fires sparked by the earthquake will be costly to households and businesses. Home and business owners will face an immediate need for funds to pay for repairs or relocate. Businesses will fail and jobs will be lost. CAPSS found the following expected impacts:

- Damage to buildings due to shaking and fire could cost \$17 to \$54 billion⁴, depending on which earthquake scenario occurs. These losses can be compared to the annual city budget of approximately \$5 billion.
- Additional types of losses (such as damage to building contents and inventory, lost business income, lost wages, relocation expenses, etc.) could add another \$5 to \$15 billion in losses, again varying by scenario earthquake.
- On top of the previously stated losses, reduced spending between businesses and by workers could shrink the City’s economy by more than two percent after a Magnitude 7.2 scenario earthquake, equivalent to or greater than the impacts of a recession.

In addition, a number of commercial and industrial buildings would be damaged. After the Magnitude 7.2 San Andreas scenario, it is estimated that more than 900 commercial buildings and 200 industrial buildings, out of a total of about 7,000 such buildings in the City, would not be safe for occupancy.

All of these impacts will affect the City’s economy, businesses and jobs. The economy relies greatly on tourism and knowledge-based businesses. Many of the businesses and residents in San Francisco today do not need to be located here. They are in San Francisco because of its urban amenities and attractiveness to creative workers. If those attractions change after an earthquake, these businesses could relocate and residents could move. The success of the City’s tourism industry is directly linked to people wanting to visit San Francisco. Tourism will drop off after a major earthquake, and how quickly it rebounds is closely linked to how extensive the damage is and how quickly and how well the City as whole recovers and rebuilds.

San Francisco is privileged to have many small and local businesses; firms with 25 or fewer employees make up over 90 percent of the City’s businesses. These face the highest failure risk after an earthquake. These businesses often have limited capital, depend entirely on revenues from one or few locations,

⁴ All dollar figures are in 2009 dollars.

carry limited insurance, and face difficulties repairing facilities, replacing damaged equipment and inventory, and weathering an economic downturn. Maintaining neighborhood business operations and speeding recovery are key to avoiding blighted neighborhoods. Vacant storefronts mean that both property values and neighborhood livability decline.

Certain businesses are critical to helping the City recover quickly and it is desirable to have them operational as soon as possible. San Franciscans need pharmacies, grocery stores, and similar retail establishments that provide the items required for daily living. Many of these important businesses may be located in weak buildings that would not be usable after a large earthquake.

Implications of business and economic losses for risk mitigation activities:

- The cost of building damage and the economic ripple effects of this damage are daunting, and will increase with time as San Franciscans complete repairs. Retrofitting buildings and reducing post-earthquake fire risk before an earthquake would reduce these costs and keep the City's economy on stronger footing.
- Small and local businesses are particularly vulnerable to post-earthquake impacts. These businesses might be tenants in buildings with a limited ability to address seismic safety concerns and rely on nearby residents as customers. There are steps the City can take to minimize earthquake impacts to small and local businesses.
- There are particular retailers, such as large grocery stores and pharmacies that are critical to the City's residents following earthquakes. The City has a particular interest in making sure these retailers can serve the community quickly after a disaster.

Impacts on Building Owners

Building owners stand to lose the most. Almost every building would be damaged by an intense earthquake to degrees that vary by building weaknesses, ground conditions, proximity to the fault and whether there are fires. Building owners bear the costs of repairs, as well as costs to relocate while damage is repaired. Commercial owners lose income from rents. Existing lenders continue to expect payments. Owners' ability to repair their buildings depends on their ability to continue making payments on existing debt and to fund repairs from savings, liquidating other assets, or borrowing additional sums. Those without sufficient assets and with limited income might not qualify for additional loans. In contracts, retrofitting before earthquakes strike allows owners the opportunity to plan and finance measures to protect their assets and improve the chances that they will be able to afford repairs and recover quickly after future earthquakes.

Private building owners cannot rely on outside sources of funds to help them recover. FEMA's Individual and Family Grant program would cover some of the cost of minor repairs and temporary housing, but does not deal sufficiently with the magnitude of costs that will face San Franciscans. Fewer than ten percent of San Franciscan homeowners carry earthquake insurance. The cost of insurance premiums is high relative to the coverage offered. Many argue that it is better to invest in retrofitting to reduce losses than to spend similar sums over time for insurance.

Implications for mitigation activities

- Owners should know the risks they face and measures they can take to manage the risks so they can make informed decisions;
- Building owners' investments should not be jeopardized by other owners who, by failing to address earthquake and fire risks, allow damage that affects entire neighborhoods.

Impacts on Vulnerable City Residents

Some privately-owned buildings that serve the City's most vulnerable populations may not be safe during or usable after future earthquakes. The following types of important services are often located in privately-owned buildings:

- Private schools—K through 12 and colleges
- Preschools and childcare centers
- Assisted living facilities for the elderly or disabled
- Medical offices and clinics, dialysis centers, medical suppliers, etc.
- Non profits that serve vulnerable populations (e.g., meal delivery and public kitchens)
- Single room occupancy hotels in older buildings

The buildings that house these services are no better than the general building stock and would suffer similar degrees of damage, if not more, in earthquakes. Many of these organizations rent space in older buildings where rents are lower and near the population they serve. Some of these buildings might be unsafe. Extensive damage will interrupt critical support for those dependent on the services these organizations provide. Community service organizations have little leverage to cause owners to retrofit weak buildings.

Implications for risk mitigation activities:

- Organizations serving the City's most vulnerable residents may be located in buildings that will not be safe during or usable after future earthquakes. This City's elderly, disabled, children and poor will need the services these organizations provide in the aftermath of an earthquake. It makes sense for the City to help financially challenged organizations to become more resilient.

Loss of Community Character or "Sense of Place"

San Francisco's character could be defined in many ways, but surely it is partly captured by the distinctive flavor of the neighborhoods and the diversity of the City's residents. A major earthquake would affect both.

Earthquake damage and damage from fires sparked by earthquake shaking could destroy many buildings that define San Francisco's look and feel, including historic buildings. Demolished buildings would be replaced with buildings having modern construction materials that would look and function differently. Many of them would be larger, taking advantage of current height and density limits.

Earthquake damage to housing would have big impacts on the City's lowest income residents, senior citizens, people with fixed incomes and those with disabilities. Due to a variety of factors—including, but not limited to, few vacancies, expensive repairs, and loss of rent-controlled units—rents for apartments are likely to increase after an earthquake. Combined with short and medium term impacts on the City's

businesses and job market, this could drive demographic changes that reduce San Francisco's socioeconomic diversity.

Implications for risk mitigation activities:

- Architecturally attractive private buildings, including historic buildings and districts, are at risk from earthquake and fire, and programs to limit building damage and earthquake triggered fires would protect these irreplaceable resources.
- Risk reduction measures targeted at housing for low, middle and fixed income households would help keep San Francisco's population diverse.

Loss of City Government Revenue

Damage to privately owned buildings affects the City government's bottom line. An earthquake would reduce revenue at a time when expenses are increasing because City-owned facilities need repair and residents need assistance to recover from the earthquake. The City can expect short and medium term declines in property tax, business tax, hotel room tax, sales tax, and other income sources. Federal funds will only cover a fraction of the City government's rebuilding and recovery expenses.

Implications for risk mitigation activities:

- Limiting damage to privately owned buildings and the ensuing financial impacts would improve post-earthquake government revenues from property, sales and hotel taxes.

Conclusion

The analysis of four possible earthquakes to strike the City makes it clear that, as it is today, the City should expect a lot of damage from future earthquakes. As described above, wide ranging consequences will flow from that damage, causing recovery challenges for all residents, especially building owners. San Francisco will recover, but it will be forever changed by losing workers and businesses that relocate rather than for recovery. Taking steps to mitigate earthquake damage before the next earthquake strikes can avoid many of these consequences. In the following chapters, this report recommends a comprehensive program for the City to improve its earthquake resiliency.

3. Objectives

Earthquakes are in San Francisco's future. The consequences of those future earthquakes could be very different—worse or better—depending on the policy choices and actions City departments and building owners take now. It is up to San Franciscans to join in an informed and open process to decide what level and types of consequences they are willing to accept. San Franciscans should consider three fundamental questions: How many casualties are acceptable? How much damage and disruption are acceptable from shaking and fires sparked by that shaking? How quickly should the City return to a “new normal” following earthquakes? The citizens committee that advised the preparation of this study concluded that the expected casualties are too many, the damage and destruction too great, and the time to recover too long. Many of the attributes San Franciscans value are at risk. San Francisco, its neighborhoods and people, would be changed in regrettable ways by a large earthquake. This need not be the case.

Objectives are needed to guide the efforts to improve earthquake safety and post-disaster resiliency in San Francisco. This chapter recommends mitigation objectives, and the following chapters provide recommendations and a long-term plan to meet the objectives.

Objectives are important because they shape the policies the City needs to pursue. The objectives indicate priorities for which categories of buildings should be evaluated first, and how quickly weak buildings should be strengthened. They guide development of the standards used for identifying unacceptably weak buildings and the measures needed to strengthen them to achieve the desired performance. The objectives justify incentives that help building owners take actions that benefit the wider community.

This report proposes the following objectives to guide mitigation actions and priorities:

After expected earthquakes⁵

- a) Residents will be able to stay in their own homes
- b) Residents will quickly have access to important privately-run community services
- c) No building will collapse catastrophically
- d) Businesses and the economy will quickly return to functionality
- e) The City's *sense of place* will be preserved

These objectives are not new to the City. They respond to existing policies provided in the San Francisco General Plan. For over two decades, the City has clearly stated that earthquake safety, housing,

⁵ The damage the City experiences in future earthquakes depends a lot on the intensity of earthquake shaking. Shaking intensity depends on a number of factors including the location of the fault where an earthquake occurs, magnitude of the earthquake, the manner that the fault rupture propagates, and the character of the ground underlying the City. The recommendations in this report are based on the intensity of shaking used by the building code for the design of new buildings. In its Resilient City report (SPUR, 2009), San Francisco Planning and Urban Research (SPUR) called this the “expected earthquake” because shaking of this intensity is likely to occur during the lifetime of the City's existing buildings.

neighborhood character and neighborhood-serving businesses are priorities. (See sidebar for a discussion of how the objectives link to existing City policy.)

Meeting these objectives will require many San Franciscans to improve their buildings so that they experience less damage from earthquake shaking and resulting fires. It will require City government to develop new programs and rethink existing ones. There are many ways to structure objectives. This report proposes general objectives in terms of visualizing hopes for how the City will look after future large earthquakes. These objectives are long-term and ideal, and when reached would result in a more earthquake-resilient San Francisco.

Looking at each of the proposed objectives in more detail provides insights into why each is important:

a) Residents will be able to stay in their own homes

Keeping San Franciscans in San Francisco after an earthquake is critical to the City's recovery. Residents will help revive their neighborhoods and the City's economy. It makes sense for owners to invest in, and the City government to encourage, making the existing housing stock robust, rather than coping with a major homelessness crisis, providing long-term temporary housing, and rebuilding a large part of the City's housing after an earthquake. Retrofitting residential buildings known to be vulnerable would save lives and money, and speed recovery.

b) Residents will quickly have access to important privately-run community services

San Franciscans depend on numerous private entities for essential aspects of their daily lives. These entities range from non-profits that provide housing, food and care to disabled, elderly or low-income residents, to medical clinics and suppliers, to grocery stores and pharmacies, to day care centers, schools and assisted living facilities. Residents need these services to be operational shortly after an earthquake. Many of the buildings that house these services need to be strengthened so they can withstand future earthquakes.

c) No building will collapse catastrophically

Today, many buildings in the City used as residences and offices every day have the potential for dramatic and lethal collapses. These buildings can and must be made safer.

d) Businesses and the economy will quickly return to functionality

The City's recovery depends on a functional economy. Particular businesses are especially vulnerable to earthquake impacts, such as small, local businesses, knowledge-based businesses and visitor serving businesses. If recovery is slow, many businesses would fail and others could easily relocate to other communities. Retrofit of vulnerable buildings would help assure businesses stay afloat and in San Francisco after an earthquake.

e) The City's sense of place will be preserved

Keeping San Francisco diverse and maintaining its architectural character is important to preserving the City's soul. Retrofitting vulnerable buildings would prevent future earthquake damage from making the City unaffordable to low and middle income residents and maintain

the cultural and architectural character of the neighborhoods. Many of the City's older historic buildings and cultural resources need to be preserved and protected.

The objectives and recommendations in this report are focused in a number of ways:

- This report was developed through a project of the Department of Building Inspection (DBI), therefore, its objectives and recommendations primarily focus on issues that are central to DBI's mission. Earthquakes, however, do not respect departmental boundaries. Therefore, this report also includes recommendations relevant to other City agencies, but many of these ideas are not articulated as specifically as those central to DBI.
- This report focuses on mitigation: steps taken before earthquakes strike to reduce their impacts. It does not focus on emergency response or preparedness planning, nor does it focus on post-earthquake recovery planning, which are all essential ingredients for achieving resilience. However, the lines among all these activities are indistinct; recommendations in this report may contribute to other aspects of earthquake planning.
- This report focuses on reducing damage to privately owned buildings and the consequences that flow from that damage. It does not cover government buildings or infrastructure (roads, bridges, water, sewer, gas, electricity, etc.), although the earthquake resilience of both is of major importance to the City.

The objectives recommended in this report cannot be achieved by the Department of Building Inspection acting alone. Nor is requiring owners to strengthen weak buildings sufficient to achieve them. Achieving the recommended objectives requires actions by other City agencies and private partners joining in a long-term, comprehensive effort. The objectives build on and should be integrated within the policy fabric of the City as expressed in ordinances, the General Plan and its Community Safety Element, and through the policies carried out by the Planning Commission, Historic Building Commission, Fire Department, Rent Stabilization and Arbitration Board, and other bodies responsible for the stewardship and management of the resources at risk.

The objectives proposed in this report are ambitious. Reaching them will take years of sustained effort. It will require using many approaches to tackle the City's risk. It would be an investment in the City's future, a recognition that the City does not want to pass all of the responsibility for earthquakes onto future generations. In the following chapters, this report recommends a long-term and comprehensive program of activities.

SIDE BAR 1: Existing City Policy

The objectives and actions proposed in this report are intended to carry out existing policies of the City and County of San Francisco. The City articulates objectives in the General Plan, shaped by 1986's Proposition M that established eight Priority Policies for the protection, preservation and enhancement of the economic, social cultural and esthetic values that establish the desirable quality and unique character of the city. The objectives and priorities proposed in this report respond to five of these Priority Policies:

- That existing neighborhood-serving retail uses be preserved and enhanced and future opportunities for resident employment in and ownership of such businesses enhanced;

- That existing housing and neighborhood character be conserved and protected in order to preserve the cultural and economic diversity of our neighborhoods;
- That the City's supply of affordable housing be preserved and enhanced;
- That the City achieves the greatest possible preparedness to protect against injury and the loss of life in an earthquake.
- That landmarks and historic buildings be preserved.

The Community Safety Element, an integral part of the General Plan, provides additional City policies. The City is currently updating the existing Community Safety Element. The 2007 draft Community Safety Element recognizes that existing hazardous structures have the greatest potential for loss of life and other serious impacts resulting from an earthquake and that the City should continue to explore ways to reduce this risk. It calls for more detailed plans.

The goals of the pending revisions to the Community Safety Element mirror those of this report. They call for protecting against injury and loss of life; reducing social, cultural and economic dislocations; and encouraging rapid recovery. Some of the many relevant objectives and policies in the Safety Element draft appear below:

OBJECTIVE 1: REDUCE STRUCTURAL AND NON-STRUCTURAL HAZARDS TO LIFE SAFETY AND MINIMIZE PROPERTY DAMAGE RESULTING FROM FUTURE DISASTERS.

POLICY 1.9—Complete remaining upgrades of the Unreinforced Masonry Building Seismic Hazard Reduction Program and the parapet Safety Program.

POLICY 1.10—Assess the risks presented by other types of concrete structures and reduce the risks to the extent possible.

POLICY 1.11—Reduce the earthquake and fire risks posed by older small wood-frame residential buildings through easily accomplished hazard mitigation measures.

POLICY 1.12—Explore incentives for private homeowners to upgrade their buildings.

POLICY 1.14—Preserve, consistent with life safety considerations, the architectural character of buildings and structures important to the unique visual image of San Francisco, and increase the likelihood that architecturally and historically valuable structures will survive future earthquakes.

OBJECTIVE 2: BE PREPARED FOR THE ONSET OF DISASTER BY PROVIDING PUBLIC EDUCATION AND TRAINING ABOUT EARTHQUAKES AND OTHER NATURAL AND MAN-MADE DISASTERS, BY READYING THE CITY'S INFRASTRUCTURE, AND BY ENSURING THE NECESSARY COORDINATION IS IN PLACE FOR A READY RESPONSE.

POLICY 2.2—Encourage businesses and homeowners to evaluate their earthquake risks.

OBJECTIVE 4. ASSURE THE SOUND, EQUITABLE AND EXPEDIENT RECONSTRUCTION OF SAN FRANCISCO FOLLOWING A MAJOR DISASTER.

POLICY 4.7—Develop and adopt a Repair and Reconstruction Ordinance, to facilitate the repair and reconstruction of buildings.

END OF SIDEBAR

SIDEBAR 2: San Francisco Planning and Urban Research (SPUR) Recommendations

The proposed objectives in this report also build on SPUR recommendations. In its Resilient City report⁶, SPUR recommended recovery targets for the City after an earthquake. SPUR’s intent is for the City to require those improvements needed to assure a quick recovery—or the level of resilience desired for each stage of recovery. SPUR defined three stages, or phases, of disaster response and recovery.

Phase 1, from one to seven days, is the period of initial emergency response and staging for reconstruction. Within this timeframe, SPUR proposes these recovery targets:

- Within 24 hours, hotels designated to house emergency response workers are safe and useable, shelters are open, and all occupied households are inspected by their occupants. Fewer than five percent of all dwelling units should be unsafe to occupy. Residents can shelter in place in superficially damaged buildings, even if utility services are not functioning.
- Within 72 hours, the initial recovery and reconstruction efforts will be focused on repairing residences and schools to a usable condition.

Phase 2, from 30 to 60 days, is the timeframe when housing is restored and ongoing social needs are met. Within this timeframe, SPUR proposes these recovery targets:

- Within 30 days, ninety percent of the neighborhood businesses are open and serving the workforce.
- Reconstruction efforts will be focused on repairing residences, schools and medical provider offices to a usable condition.

Phase 3, covering several years, is when long-term reconstruction is completed. Within this timeframe, SPUR proposes these recovery targets:






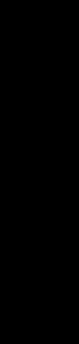




- All displaced households return home or are permanently relocated.
- Ninety-five percent of the community retail services are reopened
- Fifty-percent of non-workforce support businesses are reopened.
- Within three years all business operations are restored to pre-earthquake levels.

SPUR also estimated the expected current status for selected uses following an expected earthquake. The target recovery times and current status applicable to private buildings are summarized in Table 3-1.

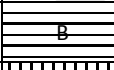


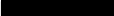
Table 3-1. Target States of Recovery for San Francisco’s Buildings

Infrastructure Cluster Facilities	Phase 1 (Hours)			Phase 2 (Days)		Phase 3 (Months)		
	4	24	72	30	60	4	36	36+
95 percent of residents shelter in place		B						
Emergency Responder Housing		B						
Public Shelters		B						

⁶ SPUR, *Urbanist*, February 2009

Schools								
Medical provider offices								
90 percent neighborhood retail services								
All residences repaired or relocated								
95 percent of neighborhood retail businesses open								
50 percent offices and workplaces open								
All businesses open								

Legend

Performance Measure	Description of Usability after expected event	Symbol
Category B	Safe and useable during repairs	
Category C	Safe and usable after moderate repairs	
Category D	Safe and usable after major repairs	
Expected current status		

END OF SIDE BAR

4. Recommended Actions: The Comprehensive Program

San Franciscans have a choice: either absorb losses from future earthquakes and endure the painful and protracted recovery that follows, or undertake measures to reduce the losses and impacts from those earthquakes. Reaching the objectives proposed in the previous chapter will take years of sustained effort by the City, its departments and residents. This chapter recommends the specific actions needed to reach those objectives, in a comprehensive and phased effort.

Informed decision-making forms the basis of the comprehensive recommended program that follows. All San Franciscans, homeowners, business owners, tenants and officials, need to understand how earthquakes will affect them, and know measures they can take to reduce these impacts. Everyone should be empowered to make risk reduction decisions in their best interests, but not everyone will. Therefore, the recommended approach steps through a series of activities, at first encouraging improvements to buildings, and later requiring such improvements to buildings that threaten the larger community welfare.

This chapter is organized into three sections:

- **A Three-Step Strategy to Better Buildings**
This section provides a discussion of the overall recommended three-step approach the City should use to reach its earthquake mitigation objectives. It begins with facilitating a market in which earthquake performance is valued. Next, building owners would be required to evaluate the seismic vulnerability of their buildings and make the findings public. Last, vulnerable buildings would be required to retrofit by set deadlines, which vary by category of building.
- **Specific Recommended Actions**
This section recommends sixteen specific actions the City should take to carryout the three-step strategy to reduce earthquake risk. Together, these actions combine to form a comprehensive approach that addresses the recommended objectives. Many of the recommended actions contribute to meeting several or all of the objectives.
- **Building Categories and Priorities**
This section recommends a scheme to categorize and prioritize the City's buildings based on both building structure type and use. It presents a recommended schedule for mandatory seismic retrofit of each vulnerable building category.

A Three-Step Strategy to Better Buildings

The recommendations in this report aim to use both market forces and other mechanisms to drive actions to reduce earthquake risks. Public awareness and understanding is essential. Knowledge provides the information needed to give earthquake performance a financial value. Owners and occupants of buildings are empowered to make earthquake risk management decisions in their best interests when they know about the earthquake risk of the buildings they live in or use, understand how the risk affects them, and know what they can do about it. They can address earthquake vulnerability when buying, leasing, financing, insuring, repairing or renovating buildings. Currently, few owners or tenants have any knowledge about how the buildings they own or use are likely to perform in earthquakes, which may contribute to inaction. Misconceptions, both over and underestimating risk, abound.

Market forces have been working well to improve San Francisco's commercial building stock. Lenders and insurers for commercial buildings routinely require an analysis of the expected earthquake performance of a building before they will lend or insure. They generally require that expected building damage be less than 20 percent of the building replacement cost. The result is that the City's commercial building stock has undergone many upgrades over the years and is expected to fare significantly better in future earthquakes than the City's housing stock. Lenders and insurers do not have the same requirements for most residential buildings and, for a variety of reasons, these industries are unlikely to enact such requirements anytime soon. Therefore, it makes sense for the City to step in and help build a market for seismically robust housing.

The goal of the strategy recommended by this report is to increase the number of seismic retrofits voluntarily conducted by owners of the most vulnerable buildings. As more retrofits are conducted, retrofitting techniques will improve, engineering and construction work will grow more efficient and less costly, and the community as a whole will begin to benefit from seismic remediation by building owners. However, experience with the unreinforced masonry law in San Francisco and other California communities indicates that many owners will not evaluate or retrofit their buildings until required to do so. Deadlines requiring evaluations and retrofitting of weak buildings are needed to give market forces a push, even though it may be appropriate to set some of these deadlines for decades in the future. Requirements and deadlines show that earthquake risk is an issue the City government takes seriously; in contrast, a purely voluntary program suggests that this issue is not viewed as important. Deadlines for required action, based on the City's priorities and the capacity of the government and private sectors to do the work, are needed.

The City has a strong interest in making sure owners make informed decisions about their buildings and strengthen those that are most vulnerable. Unsafe and damage prone buildings threaten the safety of City residents, the viability of neighborhoods, the long-term affordability of the City's housing, the socio-economic diversity of the City, and the larger City economy. Individual building failures weaken the fabric of the entire community and can be economically ruinous for the owner, tenants and neighbors. Damaged buildings are prone to fire ignitions that could spread for blocks or consume entire neighborhoods. The cumulative impact of individual failures is devastating; conversely, the cumulative impact of individual retrofits will protect attributes San Franciscans value.

A Three-Step Strategy

This report recommends a three-step strategy to engage market forces to encourage structural retrofits, enact measures to reduce fire damage, and promote non-structural risk reduction measures. The strategy follows the following steps:

- Step 1. Facilitate a market in which earthquake performance is valued;
- Step 2. Nudge the market by requiring evaluation upon sale, or by a deadline; and
- Step 3. Require retrofitting by a deadline.

By applying this three-step program in a phased manner, San Francisco would help buildings owners address their risk and take actions that benefit the broader community. Not all building categories need to pass through each phase. For example, the effort to strengthen weak unreinforced masonry buildings began with step 3, in recognition of their lethal risk.

Each of the steps is described below:

- **Step 1: Facilitate a market in which earthquake performance is valued**

Initially, the City would take steps to encourage building owners to have their buildings evaluated and retrofitted, if vulnerable. This involves the following types of activities:

- Conducting focused education and outreach campaigns that present specific steps that particular types of building owners, tenants, business owners, construction professionals, and others can take to reduce earthquake impacts. Knowing how to reduce risk is a necessary first step to action (see recommendation 1).
- Adopting updated code standards for seismic evaluation and retrofit of all common building types in San Francisco. As the City moves forward with programs to encourage and require more retrofits of vulnerable buildings, it is critical for DBI to adopt updated code standards that reflect both the City's earthquake resilience objectives and technical advances in structural engineering. It must be clear to building owners what building seismic performance is acceptable to the City, and what requirements of future mandates will be (see recommendation 2).
- Offering meaningful incentives to building owners who retrofit voluntarily. Owners ultimately are responsible for the earthquake performance of their buildings: they have the most to gain from improved performance, and the most to lose because of damage and liability. However, the City has a strong interest in reducing the amount of damage that occurs to privately-owned buildings in future earthquakes. Therefore, it makes sense for the City to invest in encouraging building owners to make their buildings safer (see recommendation 8).
- Providing technical assistance to help residents and building professionals to evaluate and seismically retrofit buildings efficiently and in accordance with City codes. Technical assistance

can range from developing standard plan sets to organizing technical training sessions (see recommendation 11).

Many of these activities will require the Department of Building Inspection to work with other departments and private partners. During all stages, existing requirements to evaluate and retrofit buildings when expanding, changing use or repairing damage would remain in place.

- **Step 2: Nudge market by requiring evaluation upon sale or by deadline**

The second step (recommendation 3) would require owners to complete an engineering evaluation prior to selling buildings that compares a building to the code performance standards that DBI has adopted for each type of building. The findings of these evaluations would be shared with tenants and prospective buyers and tenants, and be made a part of public City records. The evaluations would identify structural weaknesses, fire ignition and spread risks, falling hazards that affect safety, vulnerable building elements that affect whether a building could be used after an earthquake, and ground failure hazards. These standards would specify whether it is likely that the occupants would be safe and able to shelter-in-place following the expected earthquake. The evaluation should clearly identify buildings with unsafe weaknesses, or “killer buildings. A potential buyer could then decide on the building’s value and, if it is purchased, whether to retrofit it or not. Buyers and sellers would negotiate sales prices and financing based in part on the findings of the engineering evaluations. The City would supplement this phase by requiring certain categories of buildings, such as those that are infrequently sold, condominiums with multiple owners, and owners of many buildings, such as a university or institutional investor, to complete evaluations according to a schedule. This should include requiring larger buildings to participate in the City’s Building Occupancy Resumption Program (BORP). BORP is a City program that allows building owners to engage an engineer before an earthquake to inspect their building for damage after an earthquake. It can expedite reoccupancy after an earthquake.

- **Step 3: Require retrofit by a deadline**

The third, and last, step would require retrofitting vulnerable buildings by a deadline. This is the approach used to address unreinforced masonry buildings during the 1990s. This step ensures that owners of vulnerable buildings that threaten the broader community’s welfare ultimately improve those buildings. Deadlines for mandatory retrofits show that the City believes this issue is serious, allows the market to consider seismic safety in its pricing, and provides certainty for owners of vulnerable buildings to plan for the future. The requirements of the earlier phases would remain in effect. This step is proposed in recommendation 4.

This report recommends that the City apply the three-step approach to key categories of buildings in the City in a phased manner, which is discussed further later in the report.

Recommended Actions

This chapter presents specific recommended policies to reduce San Francisco’s earthquake risk. The fifteen key recommendations, presented below, are needed to reduce vulnerability from earthquake shaking, falling hazards, ground failure and post-earthquake fire. Some of the recommended actions directly tackle the sources of risk; others are needed to sustain the City’s mitigation efforts over the next few decades. Each of the fifteen recommendations is described in more detail in the pages that follow, including a discussion of what each recommendation entails and why it is a good choice for San Francisco.

Recommended actions to reduce earthquake risk

Additional details

1. **Inform the public of risks and ways to reduce risk.** The City should conduct focused education and outreach campaigns aimed at building owners, tenants, realtors and others to improve their understanding of earthquake risks and measures to manage the risk, and to facilitate a market for retrofitting. page XX
2. **Adopt updated code standards.** The City should adopt code standards for seismic evaluation and retrofit of all common building types in San Francisco. page XX
3. **Require all buildings to be evaluated for seismic risk.** Owners of all buildings should evaluate the seismic performance of their buildings upon sale relative to standards adopted by DBI or, if no sale occurs, by a deadline established based on the building use and structural type. The results would be shared with tenants and prospective buyers and tenants, and be made a part of public City records. page XX
4. **Require retrofits of vulnerable buildings.** Owners of vulnerable buildings should seismically retrofit their building for structural, fire, usability and falling hazards by specific deadlines, varying by building category. page XX
5. **Assist community service groups to reach earthquake resilience.** The City should provide technical and financial assistance for important non-profit organizations, medical clinics, daycares, houses of worship and similar organizations to seismically retrofit their buildings or improve their earthquake resilience in other ways. page XX
6. **Clarify responsibility for preparing for and reducing risk from earthquakes.** The City should identify a single official, the “Earthquake Czar”, to be responsible for achieving earthquake resilience through mitigation, response and recovery. page XX

7. **Adopt improved post-earthquake repair standards.** The City should enact updated post-earthquake repair and retrofit standards developed by CAPSS and expand this approach to other building types. page XX
8. **Offer incentives for retrofit of buildings.** The City should enact a range of meaningful programs to help building owners afford retrofits. page XX
9. **Require gas shut-off valves on select buildings.** The City should require owners of certain vulnerable buildings and buildings in Fire Department designated Post-Earthquake High Fire Hazard Areas to install automatic gas shutoff valves. page XX
10. **Track evaluations and retrofits in a database system.** The City should include information relating to seismic evaluations and retrofits in DBI's updated database system to allow tracking progress of mitigation activities and recording inventories, evaluation reports and retrofit information. page XX
11. **Provide technical assistance for building retrofits.** The City should help residents and building professionals to evaluate and seismically retrofit buildings efficiently and in accordance with City codes. page XX
12. **Enact a façade ordinance,** requiring periodic inspection of façades, parapets and decorative features fixed to building exteriors, and require repair of materials found to be falling hazards. page XX
13. Promote development and implementation of effective ideas on earthquake risk reduction. The City should encourage efforts to improve knowledge about building structural performance and effective ways to reduce earthquake risk that are relevant to San Francisco. page XX
14. **Evaluate measures to reduce post-earthquake fires.** Multiple City Departments should work together to evaluate and implement measures to reduce fire ignitions and spread, and improve fire suppression capacity following earthquakes. page XX
15. **Address the hazards from damage to furnishings, appliances and equipment and non-structural building elements.** DBI should initiate a comprehensive program to encourage, and in some instances, require measures to reduce these hazards. page XX
16. **Periodically evaluate progress and implementation of these recommendations.** page XX

Table 4-1. Recommended actions categorized by mitigation objective.

Recommended mitigation actions	Objective				
	(a)	(b)	(c)	(d)	(e)
1. Inform the public of risks and ways to reduce risk.	X	X	X	X	X
2. Adopt updated code standards.	X	X	X	X	X
3. Require all buildings to be evaluated for seismic risk.	X	X	X	X	X
4. Require retrofits of vulnerable buildings.	X	X	X	X	X
5. Assist community service groups to reach earthquake resilience.		X		X	
6. Clarify responsibility for preparing for and reducing risk from earthquakes.	X	X	X	X	X
7. Adopt improved post-earthquake repair standards.	X	X	X	X	X
8. Offer incentives for retrofit of buildings.	X	X	X	X	X
9. Require gas shut-off valves on select buildings.	X	X	X	X	X
10. Track evaluations and retrofits in a database system.	X	X	X	X	X
11. Provide technical assistance for building retrofits.	X	X	X	X	X
12. Enact a façade ordinance.				X	
13. Promote development and implementation of new effective ideas on earthquake risk reduction.	X	X	X	X	X
14. Evaluate measures to reduce post-earthquake fires.	X	X		X	X
15. Address furnishings and non-structural building elements	X	X		X	
16. Periodically evaluate progress and implementation of these recommendations.	X	X	X	X	X

Mitigation objectives:

- a) Residents will be able to stay in their own homes
- b) Residents will quickly have access to important privately-run community services
- c) No building will collapse catastrophically
- d) Businesses and the economy will quickly return to functionality
- e) The City's *sense of place* will be preserved

Table 4-2. Recommended mitigation actions categorized by three-step approach.

Recommended mitigation actions	Step 1	Step 2	Step 3	Other
	Facilitate market for earthquake performance	Evaluation upon sale or by deadline	Retrofit by deadline	
1. Inform the public of risks and ways to reduce risk.	X			
2. Adopt updated code standards.	X	X		
3. Require all buildings to be evaluated for seismic risk.		X		
4. Require retrofits of vulnerable buildings.			X	
5. Assist community service groups to reach earthquake resilience.				X
6. Clarify responsibility for preparing for and reducing risk from earthquakes.				X
7. Adopt improved post-earthquake repair standards.				X
8. Offer incentives for retrofit of buildings.	X			
9. Require gas shut-off valves on select buildings.				X
10. Track evaluations and retrofits in a database system.	X	X	X	
11. Provide technical assistance for building retrofits.	X			
12. Enact a façade ordinance.				X
13. Promote development and implementation of new effective ideas on earthquake risk reduction.				X
14. Evaluate measures to reduce post-earthquake fires.				X
15. Address furnishings and non-structural building elements.	X	X	X	
16. Periodically evaluate progress and implementation of these recommendations.				X

Recommendation 1. Inform the public of risks and ways to reduce risk. The City should conduct focused education and outreach campaigns aimed at building owners, tenants, realtors and others to improve their understanding of earthquake risks and measures to manage the risk, and to facilitate a market for retrofitting.

The first step in the three-step strategy (see previous section) is to create a deeper understanding of earthquake risk and risk reduction measures, which will underpin a market for retrofitting. San Francisco residents, businesses and building owners need to know specifically what risks they face and what to do to reduce those risks. On their own, education programs motivate only a limited number of people to take action. However, they are an essential part of making other risk reduction programs work. When used in tandem with other programs aimed at reducing risk, education programs can lead to significant action.

Education and outreach campaigns need to be targeted at specific audiences and focused on particular building categories and topics to be effective. Programs should present specific steps that particular types of building owners, tenants, business owners, construction professionals, and others can take to reduce earthquake impacts. San Franciscans need to understand earthquake risk in personal terms. These campaigns need to be long-lasting and the messages frequent, and from multiple sources.

City departments can do some of this, and can get the ball rolling, but it is critical to coordinate with partners in the public and private sectors. Fire and earthquake insurance companies, utilities, contractors, and building materials stores could be particularly effective partners that also would benefit from better community understanding of these issues.

CAPSS recommend the following specific education and outreach programs for San Francisco:

a) Explain the need for and process to evaluate building seismic performance, including structural, fire, and falling hazards.

This report recommends requiring building owners to evaluate the seismic performance of their building upon sale or a scheduled deadline (recommendation 3). Building owners and others that would be involved in this process (realtors, etc.) need to know what they need to do, and how to do it properly. They should also understand why evaluations are important and the goals behind requiring them.

b) Offer courses aimed at single-family homeowners about how to conduct small scale seismic retrofits.

Some single-family homes can improve their seismic safety through relatively simple and affordable steps. The City should develop a course for residents teaching them simple things they can do to upgrade their homes, as well as clarifying when they need to seek professional help.

c) Educate installers, building owners, and others about proper ways to brace water heaters.

Toppled water heaters have fueled earthquake-triggered fire in past earthquakes. State law and the City's building code currently require water heaters be strapped securely whenever they are replaced, or when buildings in the City are sold. However, it appears that many water heaters in San Francisco are strapped improperly, meaning they could still fall and fuel fires during an earthquake. A program to make sure water heater installers, building owners and others know the proper, safe ways to secure water heaters could make a big difference with small cost.

d) Educate residents about simple and cost-effective ways to make their homes safer and habitable following earthquakes by reducing falling hazards.

Falling hazards, such as furniture toppling or ceiling fixtures falling, cause serious problems in every earthquake, including deaths, increased economic losses, and making building space unusable. It is often simple and inexpensive to reduce the risk of casualties and damage from falling hazards. The City should conduct an education campaign informing residents about specific steps they should take, and include details such as types of hardware to purchase and how to install it.

e) Develop a program in coordination with other City agencies to work with small businesses and important community service providers on measures they can take to reduce vulnerability to earthquakes.

Small businesses and important community services, such as non-profit organizations that serve the daily needs of the City's most vulnerable residents, are important to the City's recovery from future earthquakes. By reducing risk and planning in advance, these organizations can greatly improve their ability to stay afloat and continue to function after an earthquake. The City should encourage and help organizations to develop mitigation and recovery plans.

f) Encourage building materials stores, insurance companies and utility companies to supplement education campaigns.

Building materials stores, insurance companies and utility companies regularly contact building owners and managers, and could provide San Francisco specific information about reducing earthquake vulnerability and actions to take after earthquakes. These companies have a direct interest in reducing earthquake damage and post earthquake fire, and should advise building owners accordingly. Multiple, consistent education messages from a variety of public and private entities are far more likely to lead to action than isolated messages only from government agencies.

g) Revise post-earthquake building inspection protocols and train inspectors and owners to identify buildings that can be occupied safely despite damage and loss of utilities.

After an earthquake, it benefits everyone to allow as many residents and businesses to remain in their buildings as possible, while ensuring safety during aftershocks. Displacing residents and businesses makes recovery more difficult. Inspectors who conduct post-earthquake safety tagging should be trained in post-earthquake occupancy concerns particular to San Francisco. Many buildings will be inspected and evaluated by their occupants, which means that public information campaigns about this issue immediately after an earthquake will play an important role.

h) Train preservation engineers and architects knowledgeable about San Francisco’s historic resources in post-earthquake safety tagging.

San Francisco’s building stock is unique and beautiful. To ensure that it stays that way, the City should make sure that engineers and architects that are knowledgeable about preservation issues are involved in post-earthquake building safety evaluations and tagging. The tagging process occurs immediately after an earthquake and influences repair and demolition decisions. Historic resource issues must be considered in these decisions. The City should conduct outreach to the preservation community to make sure that they are trained to assist in this process.

DRAFT

Recommendation 2. Adopt updated code standards. The City should adopt code standards for seismic evaluation and retrofit of all common building types in San Francisco.

DBI should adopt building code standards to be used as a basis for determining vulnerability and seismic retrofitting requirements. As the City moves forward with programs to encourage and require more retrofits of vulnerable buildings, it is critical for DBI to adopt updated code standards that reflect both the City's earthquake resilience objectives and technical advances in structural engineering.

The City should define what performance it expects during earthquakes for all existing and new buildings, considering post-earthquake usability and safety. Retrofit standards should reflect these performance goals. Retrofit standards should relate to both a building's structure type and how it is used, because building use is a key factor in determining what level of damage in earthquakes is deemed acceptable by society. DBI should seek to adopt retrofit standards that take a practical, optimal approach. The standards should optimize performance improvements while minimizing intrusion into occupied spaces and the cost of retrofits. For some types of buildings, achieving "shelter-in-place" performance, or even reparability, might be unacceptably expensive or intrusive, making lower performance expectations reasonable.

During this process, the Department should develop a clear understanding of the performance expected from new buildings constructed to the current building code, and consider whether improvements are necessary. Superior performance is needed from new construction for the City to achieve its resilience objectives for housing and businesses.

The City also should define standards and procedures for engineering evaluations of seismic performance for all building types common in San Francisco. Recommendation 3 in this report recommends requiring building owners to evaluate the seismic vulnerability of their building upon sale or a scheduled deadline. Before this can happen, DBI needs to adapt and adopt clear guidelines and technical standards for professionals to use for evaluations of structures of different types and for communicating the findings in meaningful and objective terms relative to standards. For common building types, it would be ideal if inspectors could use a simple checklist approach that requires a minimum of complex calculations. DBI should also work to develop a scheme, such as a building rating scheme, to explain the findings of the structural evaluations to non-technical building owners and users in a meaningful ways that can help them make decisions about buying, renting or retrofitting⁷. The information provided should be clear that buildings with identified vulnerabilities might be perform better than buildings that have not been evaluated.

⁷ As an example, the Structural Engineers Association of Northern California (SEAONC) is developing a scheme to assign stars to buildings, rating three characteristics: safety, repair cost, and time to reoccupy. After evaluation, buildings would be assigned from zero to five stars, indicating good or bad seismic characteristics (Stillwell, 2010). Other schemes may be available, as well.

CAPSS recommends the following general performance objectives for San Francisco code standards:

- Retrofit standards should result in most residential buildings being safe for use after earthquakes and during their aftershocks (this performance level can be referred to as “shelter-in-place”). Utilities—water, sewer, power, etc.—may not be functional, which would influence whether occupants choose to remain in these buildings. San Francisco Planning and Urban Research (SPUR) has proposed a goal that 95 percent of San Franciscans should be able to shelter-in-place following a large, “expected” earthquake.
- Retrofit standards for buildings that cannot reasonably meet the shelter-in-place standard should result in buildings that can be repaired. Reparability protects San Francisco’s communities, sense-of-place, historic resources and affordable housing.
- Retrofit standards for building types that cannot reasonably meet either the shelter-in-place or reparability standards, as a minimum, must prevent collapse and danger to occupants.

Regardless of the structural performance standard, all retrofit standards should also include measures to address the following issues: building elements such as stairs and elevators that affect the usability of buildings; falling hazards, such as overhead piping, and equipment and furnishings, that affect safety; and fire ignition sources and conditions that could encourage fire spread. Standards should require large buildings to address ground failure risks when undergoing retrofits.

DBI should specify benchmark code dates for all significant building structure types. Buildings constructed or retrofitted after these benchmark dates would be presumed to have adequate earthquake resistance. For buildings constructed or retrofitted to earlier codes, standards designated by DBI would set the basic retrofit standard. Currently, DBI has one benchmark code date for all structure types—May 21, 1973—although it is clear that some building types constructed or retrofitted after that date have seismic vulnerabilities.

DBI should amend Section 3403.5 of the code to improve it as new information and standards become available. In particular, DBI should seek standards that reflect advances in structural engineering approaches and consider building flexibility in addition to strength. Some performance-based national standards are now referenced in building codes and are widely used here and abroad, such as ASCE31 for evaluations and ASCE 41 for retrofits (ASCE, 2007). These standards have known limitations at this time, but should become increasingly practical for use in coming years. These “next generation” code standards potentially allow more effective retrofits at lower costs.

Recommendation 3. Require all buildings to be evaluated for seismic risk. Owners of all buildings should evaluate the seismic performance of their buildings upon sale relative to standards adopted by DBI or, if no sale occurs, by a deadline established based on the building use and structural type. The result would be shared with tenants and prospective buyers and tenants, and be made a part of public City records.

This is the second step in the three-step strategy. People who own and use buildings in San Francisco should know whether their building is likely to be safe during future earthquakes, and repairable and/or usable after those earthquakes. This information allows prospective buyers and tenants to consider seismic issues when making decisions about purchasing or renting space. It provides information needed to incorporate seismic issues in market pricing of real estate. It would also provide owners with the information needed to decide whether to seismically retrofit vulnerable buildings.

This requirement should be enacted only after DBI has adopted updated code standards for seismic evaluation and retrofits (recommendation 2). The information provided should be objective and measured against the established standards. Building owners who choose to voluntarily retrofit to DBI standards after discovering through an evaluation that their building has seismic vulnerabilities, should be exempted from retrofit mandates for a period of 15 years.

Findings of the evaluation should be shared with existing tenants and prospective buyers and tenants and available in public records. The findings should be included in the 3R report for residential buildings and disclosed to interested parties. This evaluation should be conducted by licensed design professionals, along with other inspections typically conducted by licensed personnel at the time of sale.

Evaluation results should be presented in a way that makes it clear that evaluated buildings are not regarded as more vulnerable than buildings that have not been evaluated. Buildings not yet evaluated are potentially hazardous.

The evaluations should cover many aspects of building seismic risk, in addition to assessing whether a building's structure meets the adopted DBI retrofit standards:

- Evaluations should identify buildings with weaknesses that could lead to collapse and life loss.
- Evaluations should explicitly examine building materials for deterioration due to water intrusion or pest infestation and weakness in the attachment of cladding and decorative elements.
- Geotechnical evaluations should be conducted for large buildings located in areas designated as having a high potential for liquefaction-induced ground failure.

- Evaluations should identify fire ignition and spread risks, such as whether water heaters are properly secured; whether electrical wiring, gas piping, appliances and meters are properly installed; the presence of unauthorized perforations in firewalls; and whether a building is located in an area prone to conflagration (defining these areas, designated as Post-Earthquake Fire Hazard Area, is discussed in recommendation 9).
- Evaluations should identify issues that affect post-earthquake usability and safety. There are various “non-structural” aspects of buildings that affect the safety, usability and reparability of buildings. Damaged partition walls, equipment, furnishings, elevators and utilities can hurt people, ignite fires, or prevent occupancy and business resumption.

Deadlines for evaluations should be established for building types that sell rarely, or those divided into multiple parcels that sell at different times (e.g., condominiums), with priority given to buildings that may be unsafe. Owners of many buildings, such as a university or institutional investor, could submit a program to DBI showing how their entire building stock will be addressed, reflecting their internal priorities and facility management needs, and be allowed flexibility within the City’s deadlines by building type. Recommended building categories and associated deadlines appear in the next section Building Categories and Deadlines.

As part of this process, larger buildings could be required to participate in the Building Occupancy Resumption Program (BORP). BORP is a City program that allows building owners to engage an engineer before an earthquake to inspect their building for damage after an earthquake. It can expedite reoccupancy after an earthquake.

Recommendation 4. Require retrofits of vulnerable buildings. Owners of vulnerable buildings should seismically retrofit their building for structural, fire, usability and falling hazards by specific deadlines, varying by building category.

San Francisco is a City prone to earthquakes with an old and vulnerable stock of buildings. As discussed in other recommendations, the City needs to offer strong education and incentive programs and require seismic evaluations of buildings. All of these steps will encourage building owners to seismically retrofit voluntarily. However, it is likely that most owners will not retrofit their buildings unless they are required to do so. Ultimately, the City will need to require owners of vulnerable buildings to retrofit to improve San Francisco's earthquake resilience. This is the third, and last, step in the three-step process (see XXX), and was the approach used to address unreinforced masonry buildings during the 1990's.

Deadlines for mandatory retrofits show that the City believes this issue is serious, allows the market to consider seismic safety in its pricing, and provides certainty for owners of vulnerable buildings to plan for the future. The City should define a number of building categories, based on building use and structural system, and set a series of staggered deadlines for requiring retrofits. Some of these deadlines should be soon; others should be decades away. Deadlines should be assigned to various building categories based on building risk, importance to community resilience, and feasibility and cost of retrofits. Again, owners of many buildings, such as a university or institutional investor, could submit a program to DBI showing how their entire building stock will be addressed, reflecting their internal priorities and facility management needs, and be allowed flexibility within the City's deadlines by building type.

Recommended building categories and associated deadlines appear in the following section Categories and Deadlines). Retrofits should address structural damage, fire risk, falling hazards, usability concerns and, for larger buildings, geotechnical concerns that were identified in evaluations (recommendation 3).

Recommendation 5. Assist community service groups to reach earthquake resilience. The City should provide technical and financial assistance for important non-profit organizations, medical clinics, daycares, houses of worship and similar organizations to seismically retrofit their buildings or improve their earthquake resilience in other ways.

San Francisco is privileged to have many non-profit organizations that serve the daily needs of the City's most vulnerable residents—its poor, elderly, children, disabled, and non-native English speakers. After an earthquake, vulnerable residents will need services from these groups more than ever. Many of these organizations occupy rented space and are not in control of building maintenance issues or seismic safety concerns. The City departments that work with these groups should develop a program to assist them, technically and financially, to evaluate the seismic safety of the buildings they use and to retrofit vulnerable buildings or relocate to better buildings.

The City should provide special assistance to the following types of organizations:

- **Non-profits providing important services to vulnerable populations**
These providers serve the homeless, persons confined to their homes due to health or disabilities, persons with medical or psychological issues, the poor and others. Many City agencies use these organizations to deliver services. Tens of thousands of San Franciscans rely on these organizations for services that keep them alive.
- **Preschools and daycare centers**
Children in preschool and daycare centers should be safe in earthquakes, just as their older siblings are in public schools. Moreover, parents rely on these facilities to care for their children while they work. San Francisco's recovery following earthquakes depends on people returning to work.
- **Clinics and facilities providing urgent and critical medical services**
Neighborhood urgent care and psychological clinics, dialysis centers, medical suppliers, and hospital facilities not regulated by the State of California⁸ provide critical services to San Franciscans. These services would be needed to treat the thousands of injuries that do not require hospitalization immediately after earthquakes, and in the days, weeks and months that follow.
- **Places of worship**

⁸ A state law referred to as SB 1953 requires owners of acute care hospitals to evaluate their facilities and meet specified deadlines to retrofit or replace vulnerable facilities.

Churches, temples, mosques and other religious buildings have large occupancies during services. They also provide critical services to the broader community. These buildings often have earthquake vulnerabilities due to their size, configuration, age and falling hazards. During earthquakes they pose serious threats to the safety of occupants, and the resulting damage would limit their ability to provide services to the community.

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Recommendation 6. Clarify responsibility for preparing for and reducing risk from earthquakes. The City should identify a single official, the “Earthquake Czar”, to be responsible for achieving earthquake resilience through mitigation, response and recovery.

Implementing earthquake mitigation measures needs to become an ongoing concern of the City with standing equal to other programs. The earthquake programs within the City need to be institutionalized and responsibility for implementation clarified so that the long-term effort required will not wane as people retire and other issues emerge. It should be the responsibility of one high level official within the Chief Administrative Officer’s office who has the ability to work with many departments and is accountable for achieving progress. The responsible manager might be called the *Earthquake Czar*.

The official would monitor progress in carrying out the recommendations in this report within the responsible City agencies and would make public quarterly reports to the Disaster Council. Ideally, this function would be established in the City Charter.

Overseeing the interrelated yet autonomous departments responsible for earthquake mitigation, preparedness, response and recovery at the highest administrative level is necessary and the responsibilities should be explicitly described. The measures needed to improve the earthquake performance of the City are physical, involving private and government buildings and utilities, preparation of people and organizations, and many departments, commissions and boards (including the Departments of Building Inspection, Planning, Emergency Management, Public Works and Fire, and functions such as facilities management and capital planning, etc.). The office should seek appointment of a Mayoral task force to investigate a number of the recommended actions and to focus agencies on reducing and managing earthquake risk.

The official should work with an advisory committee, which would meet periodically to review progress implementing the recommendations in this report and to advise on ways to improve the program. The preparation of the recommendations in this report benefited from an active and dedicated advisory committee. The insights and concerns of representatives of various interest and neighborhood groups provide valuable perspective and improve accountability for performance and progress.

This office would also support private sector efforts by providing an ombudsperson to help owners navigate through City requirements and programs relating to retrofitting. Navigating City requirements can be challenging. A dedicated staff could help building owners and construction and design professionals meet all requirements relating to seismic safety and take advantage of all incentive programs. This ombudsperson office should have employees knowledgeable about programs and requirements across the many City departments that address these issues. An ombudsperson who reaches out to owners, provides training and instructions and helps shepherd projects through the entire process could facilitate widespread retrofitting. The ombudsperson should understand both economic and technical issues and be supported administratively and not conflicted with other responsibilities.

Recommendation 7. Adopt improved post-earthquake repair standards. The City should enact updated post-earthquake repair and retrofit standards developed by CAPSS and expand this approach to other building types.

After an earthquake, some damaged buildings can be repaired to the way they were before the earthquake. Other damaged buildings need to incorporate seismic retrofits into their repairs, to ensure that they suffer less damage in future earthquakes. The City's current policy to define which buildings need to retrofit, and which can only repair, needs improvement, as evidenced by problems experienced after the 1989 Loma Prieta earthquake. A post-earthquake repair and retrofit policy is a requirement to receive certain types of post-disaster funding from the Federal Emergency Management Agency.

In a companion report (ATC 52-4, *Postearthquake Repair and Retrofit Requirements*), CAPSS has developed clarified technical recommendations to improve this policy and to improve the way this process builds the City's resilience over time. The City should adopt these revised provisions.

CAPSS has developed detailed recommendations that cover 95 percent of the City's buildings. DBI should use this work as a model to develop detailed improvements for additional structure types identified in the CAPSS report.

Recommendation 8. Offer incentives for retrofit of buildings. The City should enact a range of meaningful programs to help building owners afford retrofits.

Owners ultimately are responsible for the earthquake performance of their buildings: they have the most to gain from improved performance, and the most to lose because of damage and liability. Building owners benefit by retrofitting before earthquakes strike, but the upfront costs are significant and conflict with other expenditure priorities. While retrofitting results in a safer, more reliable building with its value better protected from earthquake damage, often there is no more useable space or operating efficiency achieved, and improved seismic safety may not be reflected in market values or rental incomes. However, the City has a strong interest in reducing the amount of damage that occurs to privately-owned buildings in future earthquakes. Less damage means a quicker and less costly recovery for the entire City, as well as reduced social dislocation. The consequences of cumulative damage to privately-owned buildings for neighborhoods, local businesses, historic character, and post earthquake housing availability and affordability make private damage a public concern. Therefore, it makes sense for the City to invest in encouraging building owners to make their buildings safer.

It is imperative that agencies develop and offer meaningful incentives within the next year. Incentives are an important component of Step 1 of the three-step strategy (see previous section) to encourage owners to retrofit. While incentives will not lead to most buildings owners retrofitting their buildings, they could make the difference for some owners who are already inclined to retrofit and will combine with other programs to lead to more action. They also send a positive signal to building owners that the City does not expect them to solve this problem on their own.

Different incentives are meaningful for different owners, so the City should offer a variety of approaches. Incentives that would encourage and facilitate retrofitting in San Francisco are the following:

a) The Planning Code and other City statutes and regulations should be amended to offer incentives to building owners who voluntarily conduct seismic retrofits to make changes to their buildings that would increase their value.

The City has the ability to offer a number of non-financial incentives that provide real value to building owners. These include allowing additional units or uses (density bonuses), allowing retrofits to encroach into setbacks, increased floor/area ratios, relaxation of parking requirements, change in height limits, transfer of development rights, and priority in the condominium conversion lottery. These issues would allow building owners to make changes to their building to increase their value. While not costing the City anything in terms of dollars, these planning and zoning issues impact other values and can inspire strong feelings among City residents. The City should engage relevant departments, City residents and building owners to discuss which of these potential incentives provide meaningful motivation to building owners to retrofit, and whether their short-term social

implications outweigh the long-term social benefits that come from improved seismic performance. Existing policies protect values important to the City, such as housing affordability and density of uses. However, these values are threatened by inevitable earthquake damage far more than changes made during retrofits. Incentives for earthquake retrofits would protect these values long-term, not erode them.

b) Maintain fee waivers and expedited review for voluntary seismic retrofits of vulnerable wood frame residential buildings.

In 2009, San Francisco began offering expedited plan review and some fee waivers for owners who decide to retrofit vulnerable wood frame residential buildings. Damage to wood frame buildings will be responsible for most of the housing units that cannot be occupied after future large earthquakes. It makes sense to continue this modest program to encourage building owners to invest their own resources to retrofit these vulnerable buildings.

c) Adopt a policy that assures that those who voluntarily retrofit to appropriate standards would not be required to do more work for 15 years, even if standards change.

Owners who undertake retrofitting to the City's standards want some assurance that the City will not require additional retrofit measures as codes change and knowledge of earthquake performance advances. The City has a current policy that applies to retrofitted unreinforced masonry buildings, which should be extended to all types of buildings. Providing a 15-year period in which further retrofits would not be required would encourage owners to retrofit rather than wait, and assure lenders that additional funds would not be needed.

d) Publicize how to use the recently passed transfer tax rebate for seismic safety upgrades.

San Francisco voters passed Proposition N in November 2008. This allows up to a 1/3rd rebate of transfer tax upon sale to owners who have seismically retrofitted. Few residents know about this rebate or how to use it. The City should publicize how to use this existing incentive.

e) Publicize and facilitate the process for building owners to make sure that seismic retrofit work is exempted from property reassessments.

This incentive has been state law for twenty years, but many owners do not know about it or how to apply for this credit when properties are reassessed after renovations. The City should clarify the process to ensure that seismic work is not considered in property reassessments after upgrades.

f) Change the Planning Code to prevent owners of buildings demolished after an earthquake from rebuilding to prior nonconforming conditions, unless the building was seismically retrofitted before the earthquake.

Currently, if a building is demolished following an earthquake, the owner can rebuild incorporating nonconforming conditions that existed in the building previously at that site (e.g., footprint, number of units, parking, etc.). This policy should be changed so that building owners have an incentive to retrofit.

g) Review, extend and document as appropriate designated Historic Districts and historic buildings and conduct earthquake vulnerability assessments.

Owners of designated buildings who invest in rehabilitation projects can qualify for federal income tax incentives. Because earthquakes threaten the preservation of irreplaceable historic resources, the Historic Preservation Commission should encourage vulnerability assessments and measures to improve the earthquake performance of historic resource buildings. The Historic Preservation Commission should seek funds to conduct rapid visual screening for earthquake vulnerability of designated historic resource buildings and buildings located within designated historic districts, and then work with building owners to encourage retrofitting.

h) Provide need-based loans for qualified retrofits.

Many owners lack the assets or cash flow to qualify for commercial loans to finance retrofitting. The City could help by offering conventional or deferred loans. For conventional loans, the City could create an opt-in district that would use the proceeds of tax advantaged bonds to lend to residential building owners, including single family dwelling owners, the funds needed to retrofit to the City's standard. The loans would be paid back with interest through annual property tax collections. For deferred loans, the City could raise funds through the sale of a general obligation bond to lend funds needed to retrofit buildings that would not be paid back until the building is sold or refinanced.

i) Advocate for federal and state incentives.

The City could advocate for federal and state incentives such as tax credits and depreciation schedules to reduce owners' costs and lessen federal and state costs following earthquakes. The state also could require homeowner and condominium associations to include in facility plans provisions for either repairing earthquake damage or for retrofitting vulnerabilities.

Recommendation 9. Require gas shut-off valves on select buildings. The City should require owners of certain vulnerable buildings and buildings in Fire Department designated Post-Earthquake High Fire Hazard Areas to install automatic gas shutoff valves.

In past earthquakes, gas leaks have played a significant role in fueling post-earthquake fires. Gas appliances can break away from connections and building damage can sever gas lines. San Francisco is a densely packed City with mostly wood frame, flammable buildings, making post-earthquake fire risk a serious concern.

Automatic gas shutoff valves, either triggered by shaking or excess flow, can play a role in reducing this fire risk. Buildings that are found through seismic evaluation to be particularly vulnerable should be required to install automatic gas shutoff valves. In addition, the Fire Department, working with DBI, should identify locations where fire risk is particularly high and where shut off valves would be required. These areas would be called Post-Earthquake High Fire Hazard Areas.

While gas shutoff valves reduce fire risk, they increase some social risks because it can take a long time to get all gas lines restarted after an earthquake. If shutoff valves were installed on all buildings, many residents in buildings with little damage could be left without heat, hot water, or cooking facilities for an extended period after an earthquake. This could be deadly to the City's large elderly and disabled populations, which is why this report only recommends shutoff valves for buildings most at risk of fueling fires. Requirements for shut off valves should be coordinated with social service agencies so that the needs of dependent persons are addressed.

Recommendation 10. Track evaluations and retrofits in a database system. The City should include information relating to seismic evaluations and retrofits in DBI's updated database system to allow tracking progress of mitigation activities and recording inventories, evaluation reports and retrofit information.

DBI is in the process of installing an updated database system. This system should include a range of information to support earthquake risk reduction programs, such as the following:

- Information about building use
- Whether and when buildings have undergone seismic retrofits, and to what standard a building was retrofitted
- Building structural type and characteristics that affect vulnerability
- The findings of building seismic evaluations

DBI's current database system does not include information about seismic retrofits or vulnerability and cannot aggregate and manipulate information for evaluation and tracking citywide progress of mitigation programs.

Recommendation 11. Provide technical assistance for building retrofits. The City should help residents and building professionals to evaluate and seismically retrofit buildings efficiently and in accordance with City codes.

Training programs and other technical assistance can help make retrofitting easier and contribute to high-quality work. The following types of technical assistance activities would encourage retrofitting:

a) Develop standard plan sets for retrofits of typical San Francisco buildings.

Many of San Francisco's buildings are similar in design and construction. This means that similar seismic retrofit solutions should work for a number of buildings. DBI should develop standard plans sets for seismic retrofits of common and simple building types. Buildings that are similar to those in the plan set could use these plans for retrofit. Plan sets reduce design costs for retrofits and have been in use in the East Bay for cripple wall buildings (a building type that is not common in San Francisco) for several years.

b) Provide training for engineers and other licensed professionals in conducting building seismic evaluations.

The City should offer hands-on technical training for how to conduct building seismic evaluations (recommendation 3). This type of training would help make sure that evaluations are competent. The City could post a list of professionals that have completed this training on its website, which would help consumers.

c) Provide information on retrofit costs and effective technical approaches based on experience as the program progresses.

The City should monitor lessons learned when owners undertake retrofits, including effective retrofit design, construction techniques, costs, and innovative use of technology. The City can share these lessons with building owners, design professionals and contractors to help retrofit programs grow increasingly effective and efficient over time.

d) Provide training for design professionals and contractors in conducting seismic retrofits.

The City should provide training in how to conduct seismic retrofitting, particularly in how to use updated technical standards. This training could include an overview of innovative products and technologies developed for seismic retrofits. Again, the City could post a list of those who have completed this training on its website, which would help consumers.

e) Develop additional standards as needed to reduce falling hazards and improve post earthquake building usability, including bracing of heavy equipment and shelves, elevator functionality, etc.

Safety and post earthquake usability are affected by the performance of contents, appliances, equipment, elevator functionality, functionality of HVAC and utility systems, and other building elements not directly associated with a building's structural system. These elements can pose safety hazards during earthquakes, play a big role in whether buildings can be used after an earthquake and affect the scope of economic losses. The building code already includes some standards. However, DBI should develop additional technical standards for reducing the hazard from objects and systems not covered. These standards would be used to enforce any requirements and guide voluntary efforts.

f) Conduct inventories of structural types and building uses of concern.

There are structure types in the City that are known to pose risks to the safety of residents, and building uses of special importance. However, the City has no inventory of exactly where these buildings are or how many there are. DBI should lead an effort to get a good inventory of the highest risk structure types and buildings with selected important uses in the City so programs to address the risk of these buildings can move forward.

Inventories are needed for the following types of structures:

- Concrete tilt up buildings;
- Concrete frame buildings constructed prior to 1980;
- Concrete and steel frame buildings with unreinforced masonry infill walls;
- Early retrofitted buildings; and
- Large welded steel moment frame buildings built before 1994.

Lists of owners responsible for buildings with the following uses are needed:

- Social service providers;
- Daycare centers and preschools;
- Medical service providers;
- Critical retail services (e.g., grocery stores, pharmacies);
- Private schools and universities; and
- Large institutions with control over many buildings.

Recommendation 12. Enact a façade ordinance, requiring periodic inspection of façades, parapets and decorative features fixed to building exteriors, and require repair of materials found to be falling hazards.

Parts of building façades can fall off and injure passers-by during earthquakes or at any time. Many cities have passed laws requiring regular inspection of façades and other building elements that could fall, and requiring maintenance of deficient conditions. San Francisco should have such an ordinance. San Francisco enacted measures in the 1970's to brace parapets and to prevent exterior building elements from falling on the sidewalks or adjacent buildings. These measures should be extended to address building façades and cladding vulnerable to falling.

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Recommendation 13. Promote development and implementation of effective ideas on earthquake risk reduction. The City should encourage efforts to improve knowledge about building performance and effective ways to reduce earthquake risk that are relevant to San Francisco.

Large earthquakes near a big city are rare. Scientists and engineers learn tremendous amount about how to build earthquake-resilient communities from each such event. The City should engage with ongoing review of structural, geotechnical and social science topics to make sure issues important to San Francisco are addressed and applied in San Francisco. As evidence that the City can influence research, the CAPSS project's work on wood frame soft-story buildings has already resulted in the technical community working to define better standards for retrofits of this type of structure.

The following activities would provide information helpful to San Francisco:

a) Plan data collection programs to follow the next damaging earthquake, focused on learning about issues of policy importance to San Francisco.

The City should plan now to make sure that important lessons relevant to San Francisco are learned from the next earthquake to strike the City. Earthquake damage is ephemeral, disappearing as residents repair and rebuild. Data collection programs should be planned in advance. This will help the City be better prepared for the inevitable earthquakes that follow.

b) Support efforts to test and research innovative and low-cost retrofit concepts, such as bracing garage doors and adding ductility and energy absorption to brittle or weak building elements.

DBI should work with universities, companies and individuals developing innovative and potentially low-cost solutions for seismic retrofits. Encouraging such innovators to conduct demonstration projects or to conduct seminars in San Francisco can help move these technologies closer to reality and channel them in directions that make sense for San Francisco.

c) Support research needed to modernize and improve evaluation and retrofit standards.

Current building codes generally rely on analysis methods that are decades old. More modern methods, such as those developed for Performance Based Design, are increasingly becoming viable approaches for retrofits and building codes. DBI should work with the research community to help translate improved analysis methods into practical code standards that could be adopted by the City.

d) Reexamine the expected performance of previously retrofitted buildings.

San Francisco pioneered efforts to improve the earthquake performance of its building stock. In the 1970's the City required building owners brace parapets and decorative elements and began requiring retrofitting of vulnerable buildings before they were enlarged or renovated to change their

use. In the 1990's the City began its program to retrofit unreinforced masonry buildings, except for residential buildings with four or fewer units. Since then, knowledge about retrofitting has changed in significant ways and some of the early retrofits might not provide the performance the owners and tenants expect, or that the City requires. The City should conduct a careful analysis of previous retrofits, especially the use of thin-wall steel tube braced frames. The City should report whether additional retrofits are needed to protect public safety and improve the City's resilience.

e) Study the hazard from masonry chimneys in San Francisco, and recommend necessary mitigation measures.

Masonry chimneys, mostly on small dwellings, often are unreinforced and prone to falling dangerously. San Francisco's fire chief was killed when a chimney fell during the 1906 earthquake. Unreinforced chimneys are not allowed by code and some cities encourage their removal. The extent of risk to San Franciscans needs further analysis.

f) Support installation of instruments to measure building movement in earthquakes.

Records of building movements during earthquakes provide information that is useful when evaluating the extent of damage a building has experienced and its level of post-earthquake safety. The recordings also provide evidence to better understand how buildings respond when subjected to strong shaking.

g) Study the feasibility of administrative measures to mitigate against ground failures that affect multiple properties and cannot be completed by a single building owner.

Liquefaction and landslide ground failures generally involve more than a single parcel, making it difficult for a single owner to address the hazard. Administrative arrangements, such as opt-in districts (geologic hazard abatement districts) can be used to fund and execute projects involving several owners, government agencies and utilities. Administrative measures will be needed when remediation technology (below) advances to become useful.

h) Periodically review liquefaction remediation technology and provide guidance to owners in potential liquefaction zones when techniques become feasible.

Current research into liquefaction remediation measures suitable for built up areas shows some promise, but it not yet ready for widespread commercial application. The City should monitor progress periodically and consider administrative ways to use the technology when appropriate.

Recommendation 14. Evaluate measures to reduce post-earthquake fires. Multiple City Departments should work together to evaluate and implement measures to reduce fire ignitions and spread, and improve fire suppression capacity following earthquakes.

Fires triggered by earthquakes pose a serious risk that transcends City departments. Strong efforts are needed to reduce the number of ignitions that occur after future earthquakes and limit the ability of fires that do occur to spread to adjacent buildings. Issues that affect ignitions, fire spread, and fire suppression are the responsibility of a number of City departments, private owners, and entities outside of City control (e.g., Pacific Gas and Electric company and property insurers). The most sensible ways to manage post-earthquake fire risk should be determined through dialogue of all of these groups. Each of these groups should share what they know with other groups, to help everyone make good decisions for San Francisco.

A diverse group of City Departments and others should evaluate and consider implementing the following actions:

a) Improve water supply systems to cover those neighborhoods not served by the Auxiliary Water Supply System.

The Auxiliary Water Supply System provides a redundant water system for fighting fires after earthquakes, and at other times, and incorporates many earthquake resistant features in its design. However, this system covers only the northern and eastern City neighborhoods, those that were developed in the early part of last century when the system was constructed. The City needs adequate, reliable water sources to fight fire post-earthquake fires in all neighborhoods. There are a number of options to improve the water supply in neighborhoods not served by the Auxiliary System, including expanding the City's Portable Water Supply System, which can be deployed wherever needed. This important issue needs to be addressed as soon as possible.

b) Expand the training and scope of Neighborhood Emergency Response Teams (NERT) to include fire suppression, fire reporting, assisting vulnerable residents, and assisting with neighborhood recovery.

The San Francisco Fire Department runs training programs for Neighborhood Emergency Response Teams (NERT) and has trained thousands of residents to help their neighborhoods after an emergency. NERT volunteers could be trained to help in new ways, including basic fire suppression, fire reporting, and helping neighbors who are dependent on functioning utilities and others for the delivery of food, water, oxygen, medicine and health services. The City should examine how to take maximum advantage of the enthusiasm of NERT teams to help the City to respond to and recover from major earthquakes.

c) Increase accessibility of water shutoff valves on building fire sprinkler systems to control water loss from damaged sprinkler systems.

Damaged water sprinkler systems broken by earthquake shaking can leak, contributing to loss of water needed to fight fires from the municipal water system. The City should investigate whether making shutoff valves for these systems more accessible is a cost effective way to improve post-earthquake water availability.

d) Improve storage of chemicals in educational science and other labs.

In past earthquakes, a number of ignitions have started in chemistry labs. These ignitions could be reduced through proper storage of chemicals. The City should investigate how that could be accomplished. Many of the educational facilities with chemistry labs do not fall under City jurisdiction (e.g., public schools and universities), but the risk of ignitions in these buildings spreading fire to neighboring buildings means that it make sense for the City to work with relevant groups to address this issue.

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Recommendation 15. Initiate a comprehensive program to address the hazards from damage to furnishings, appliances and equipment and non-structural building elements.

Falling hazards, such as furniture toppling or ceiling fixtures falling, cause serious problems in every earthquake, including deaths, increased economic losses, and making building space unusable. DBI should initiate a comprehensive program to encourage, and in some instances, require measures to reduce these hazards. Building communications, electrical, plumbing and HVAC systems, elements such as stairs and elevators, furnishings, appliances and equipment, and inventories can be more valuable than the building structures. These elements greatly affect whether buildings can be used following earthquakes, the magnitude of losses and safety of inhabitants. Measures to reduce damage to these elements generally are not difficult and are affordable. The comprehensive approach recommended would be carried out as part of the three-step strategy through step 1 public information, step 2 evaluations and step 3 retrofits.

Recommendation 16. Periodically evaluate progress and implementation of these recommendations.

The preceding fifteen recommendations in this report call for significant new policies and programs to improve the earthquake resilience of San Francisco's building stock. DBI should commission an independent evaluation at least every five years to review progress and consequences of the resulting program and to make recommendations for improving it. The recommendations in this report are interrelated, and will be most effective if implemented as a complete program, instead of piece by piece. The evaluation should look at what actions have been taken by the City and highlight important steps that may have been neglected. The evaluation should also recommend adjustments based on lessons learned. Although these recommendations have been carefully selected, some of them may not work as intended when implemented. It is imperative that they be reviewed periodically to measure their effectiveness in reaching the City's objectives and to recommend changes to make them work better.

Building Categories and Deadlines

Categories of Buildings

The City should divide the building stock into “categories,” or groups of buildings defined by the importance of a building’s use or occupancy, its type of structural system, or both. This way of grouping buildings allows setting priorities based on both the importance of buildings to the community and public safety. All buildings in a category would be moved through the three-step approach—information, evaluation, and retrofit—as appropriate. The sequence in which building categories would be addressed would be assigned based on how important the type of building is to San Francisco’s resilience (e.g., two important uses are rental housing and private schools) or the threat the building type poses for injuries and deaths (e.g., structural categories with known safety risks include unreinforced masonry bearing wall buildings, concrete tilt-up buildings, and concrete frame buildings constructed before 1980).

Many buildings would be included in two categories, one because of their use and another because of the type of structure. The category approached first would take precedence, but the retrofit standards should be the same. For example, if there is an assisted living facility located in a large concrete building constructed before 1980, the owner would be required to evaluate the building because it houses an assisted living facility, not because it is an older concrete building. When the program advances to the category of older concrete buildings, buildings evaluated and retrofitted earlier would be exempt.

The City could choose to prioritize within each category so that buildings with greater numbers of occupants, more important uses, located on weak soils, or with greater vulnerability, or a combination of these attributes, would be addressed first. These characteristics could be identified when an inventory of buildings in the category is prepared.

This report recommends 19 categories of buildings, based on use, structure type or both. Each category is described below. Table 4-3 summarizes the categories and how they are comprised of both uses and building types.

- **Wood frame residential buildings with three or more stories and five or more units**
There are about 4,400 buildings of this type, many with a soft-story condition at the ground level. A soft-story is significantly weaker or more flexible than the stories above it. The weakness at the ground level usually comes from large openings in perimeter walls, due to garage doors or store windows, and/or few interior partition walls. During strong earthquake shaking, the ground level walls cannot support the stiff and heavy mass of the stories above them as they move back and forth. The ground level walls could shift sideways until the building collapses, crushing the ground floor. This building type is expected to be responsible for about one-third of housing units that cannot be occupied after future earthquakes. Retrofits of this type of structure are relatively easy and inexpensive, compared to other structure types. The risk of this type of building and the benefits associated with retrofits are explored in detail in the CAPSS report *Earthquake Safety for Soft-Story Buildings* (ATC 52-3). The Mayor formed a task force to create a program and legislation to implement the report’s recommendations.

- **Residential buildings with three and four units**

There are an estimated 6,000 wood frame residential buildings with three to four units. Many of these have a soft-story at the ground level. There also are a small number of unreinforced masonry buildings that were exempt from the earlier mandatory retrofit program, and a number of buildings of various other structural types. These buildings are expected to be responsible for about one-third of residential units that cannot be occupied after a large earthquake (in addition to the third associated with larger wood frame buildings, discussed above). A mandatory program addressing these buildings should begin as soon as progress on the five unit buildings progresses to the point that DBI can expand the program, about five years from the present.
- **Concrete residential buildings built before 1980**

Older reinforced concrete buildings can experience extensive damage and dramatic and deadly collapses during earthquakes. Such collapses are responsible for many of the casualties in earthquakes around the world. There are older reinforced concrete buildings in San Francisco being used as apartment buildings and residential hotels. Thousands of people live in these buildings and many would be displaced by damage. Persons residing in SROs and transient hotels would be hard hit because replacement buildings would take years to construct. Retrofit of these buildings may be expensive, but is important due to the risks they pose to the City. It may make sense to retrofit these buildings to a “collapse prevention” standard, recognizing that, even after retrofit, many of them may not be habitable or repairable after an earthquake.
- **Other types of residential buildings with five or more units**

This category includes all large residential buildings not constructed from wood or concrete that are found to be vulnerable through evaluation. This category includes diverse and vulnerable buildings, such as reinforced masonry and steel frame buildings with masonry infill walls. Mostly, these buildings are multi-unit; many of them have historic features. Many of these buildings provide housing for low income tenants and will be difficult to replace. It may be appropriate to retrofit some of these buildings to a “collapse prevention” standard.
- **Single family homes and two unit residences**

This is by far the most common type of building in San Francisco, with an estimated 112,000 single-family homes and almost 20,000 two-unit residential buildings. Many of these buildings are vulnerable to earthquakes because of garages at the ground level creating a weak or soft-story condition. There are a small number of unreinforced masonry buildings of this size that were exempted from the earlier mandatory program. DBI should develop prescriptive standards for typical buildings that would improve the likelihood that residents could shelter in place.
- **Non-profits providing important services to vulnerable populations**

These providers serve the homeless, persons confined to their homes due to health or disabilities, persons with medical or psychological issues, the poor and others. Many City

agencies use these organizations to deliver services. Tens of thousands of San Franciscans rely on these organizations for services that keep them alive.

- **Preschools and daycare centers**

Children in preschool and daycare centers should be safe in earthquakes, just as their older siblings are in public schools. Moreover, parents rely on these facilities to care for their children while they work. San Francisco's recovery following earthquakes depends on people returning to work.

- **Clinics and facilities providing urgent and critical medical services**

Neighborhood urgent care and psychological clinics, dialysis centers, medical suppliers, and hospital facilities not regulated by the State of California⁹ provide critical services to San Franciscans. These services would be needed to treat the thousands of injuries that do not require hospitalization immediately after earthquakes, and in the days, weeks and months that follow.

- **Private K-12 schools and private universities**

Most people assume that school buildings are safe, but private schools are probably no safer than the general building stock. Many of San Francisco's private school buildings were constructed when building standards were much less stringent than today. Nearly one third of school children—more than 23,000—attend private schools in San Francisco, the highest rate in the entire state¹⁰. The City must ensure that all of San Francisco's children attend school in buildings that meet standards equivalent to the standards for public schools. The CAPSS project did not consider public schools, which serve about 55,000 students in San Francisco. Public schools built to state standards are among the most earthquake resistant buildings in California. However, like other buildings, some were constructed to older standards and some of the buildings constructed before the state standards were adopted in 1933 were retrofitted, but do not provide for the performance expected from modern school buildings. In 2002, the Department of Conservation, Division of the State Architect published a list of public school buildings, *Seismic Safety Inventory of California Public Schools*, to identify non wood frame school buildings built before July 1, 1978 that should be evaluated because of their age and building type. There are 72 buildings belonging to the San Francisco Unified School District on this list.

- **Assisted Living facilities**

The City's elderly and disabled should be in facilities that are safe and functional after future earthquakes. Relocation after an earthquake would be hardest on these residents. The City would need to provide assistance to non-profit facilities and those serving low-income residents.

- **Concrete non-residential buildings built before 1980**

⁹ State law gives the Office of Statewide Health Planning and Development authority over the design and construction of acute care hospital and skilled nursing facilities.

¹⁰ California Department of Education, 2009.

Older reinforced concrete buildings can experience dramatic and deadly collapses during earthquakes. Such collapses are responsible for many of the casualties in earthquakes around the world. There are older reinforced concrete buildings in San Francisco being used as office buildings and warehouses. Thousands of people use these buildings daily. Retrofit of these buildings may be expensive, but is important due to the risks they pose to the City. It may make sense to retrofit these buildings to a “collapse prevention” standard, recognizing that, even after retrofit, many of them may not be repairable after an earthquake.

- **Hotels and motels serving tourists**

Hotels and motels of all structural types must be safe during and quickly reoccupied after future earthquakes. Hotels play a key role during post earthquake recovery by housing emergency workers, including those brought to the City to restore utilities. Moreover, because tourism is a key part of the City’s economy, improving the performance of visitor serving buildings is critical for the City’s earthquake recovery.

- **Critical retail stores and suppliers**

Certain businesses are critical to helping the City recover quickly and it is desirable to have them operational as soon as possible. San Franciscans need pharmacies, grocery stores, and similar retail establishments that provide the items required for daily living. Some of these important businesses may be located in weak buildings that would not be usable after a large earthquake. Many of these businesses may rent the space they use, and retrofit timelines should allow time to renegotiate leases as part of this process.

- **Buildings used by large audiences**

Theaters, places of worship and other buildings that are used to gather many people need to be safe, considering both damage to the building and falling hazards. Although many of these buildings are occupied only a few hours each week, when they are occupied there is the chance of a large number of casualties.

- **Historic buildings, and contributing buildings in historic districts**

Historic resource buildings should be repairable after future earthquakes so the City maintains its heritage. This could include many older masonry buildings previously upgraded to standards only intended to reduce casualties, but not to assure reparability.

- **Concrete tilt-up buildings**

These buildings have heavy precast concrete panels that are raised in place to form the building walls. If the walls are not adequately connected to each other and to the roof, they can separate when shaken by an earthquake, causing the roof and wall sections to collapse on the occupants and contents of the building. This structure type is often used for industrial purposes, but may also be used for some grocery stores or other commercial purposes. There are an estimated 200 of these in San Francisco. These buildings are relatively easy and inexpensive to retrofit, compared to other structure types, and a number of communities have enacted retrofit

programs for this type of building. Prescriptive standards for retrofitting are available for adoption into the San Francisco Building Code.

- **Large workplaces with welded steel moment frames built before 1994.**
 Many office buildings and workplaces were constructed with welded steel moment frames with details that were found vulnerable in the Northridge earthquake. Welding procedures and connection details were changed in 1994 to improve the performance of buildings built since then. The connection details used before then can be damaged, resulting in buildings that cannot be used and might have to be razed. These large buildings should be retrofitted to reduce the chance of damage and increase the likelihood that the businesses they support will not be displaced and the buildings can be repaired and reoccupied quickly.
- **Early retrofitted buildings**
 Some retrofits conducted decades ago may be inadequate. These include early retrofits with thin-wall steel tube braced frames, those meeting very low standards, and those with partial retrofits not meeting an adopted standard. In these early retrofits, tube walls may be too thin, allowing buckling to occur, welded connections might be inadequate, or there may be other vulnerabilities.
- **Other buildings categories**
 There are other categories of vulnerable buildings and important building uses not include on this list. Buildings with mixed structural systems and parking structures are examples. The City should add additional categories as the need arises as part of the regular evaluation of mitigation programs (recommendation 16).

Table 4-3. Building Categories Summary

Building Category	Estimated Number of Buildings
Categories Based only on Structural Systems	
Concrete tilt-up buildings	200
Early retrofitted buildings	Unknown
Categories Based on Structural System and Use	
Wood frame residential buildings with three or more stories and five or more units	4,400
Concrete residential buildings built before 1980	Unknown
Other types of residential buildings with five or more units	Unknown
Concrete non-residential buildings built before 1980	Unknown
Large workplaces with welded steel moment frames built before 1994	Unknown

Categories Based Only on Building Use	
Residential buildings with three and four units	More than 6,000
Single-family homes and two-unit residences	112,000 single family 20,000 two unit
Non-profits providing important services to vulnerable populations	Unknown
Preschools and daycare centers	Unknown
Clinics and facilities providing urgent and critical medical services	Unknown
Private K-12 schools and private universities	About 100 private K-12 schools, xx colleges and universities
Assisted Living facilities	Unknown
Hotels and motels serving tourists	Unknown
Critical retail stores and suppliers	About 30 large grocery stores and 100 pharmacies
Buildings used by large audiences including places of worship	Unknown
Historic buildings, and contributing buildings in historic districts	Unknown

Sources: *Potential Earthquake Impacts* (ATC 52-1, 2010).

Recommended retrofit deadlines for building categories

This report recommends that San Francisco’s buildings go through a three-step process to improve their seismic resilience—information, evaluation, and retrofit. The first step, providing information and incentives to inform and assist owners, should begin immediately for all building types (recommendations 1, 2, 8, 10 and 11). The second step (recommendation 3), requiring evaluation upon sale, should begin for all building types within five years. The five-year timeframe allows the City time to adopt evaluation criteria and procedures and improved retrofit standards before the mandatory evaluations commence.

The third and final step, mandatory retrofits, should begin immediately for some building categories, and should conclude for all building categories in thirty years. This report recommends the City enact mandatory retrofit requirements for the following building categories in the following timeframe:

Ongoing

- **Continue to enforce retrofitting buildings as part of significant repairs, alterations, expansions, changes of use, and repair of damage above specified thresholds. Retrofitting should be required as a condition to converting multi-unit residential buildings to condominiums.**

Begin to require retrofitting immediately and accomplish within ten years

- **Wood frame residential buildings with three or more stories and five or more units**
- **Concrete tilt-up buildings**

Begin to require retrofitting in five years and complete within fifteen years

- **Residential buildings with three and four units**
- **Private K-12 schools and private universities**
- **Assisted Living facilities**

Start in ten years and complete within twenty years

- **Concrete residential buildings built before 1980**
- **Other types of residential buildings with five or more units**
- **Hotels and motels serving tourists**
- **Critical retail stores and suppliers**

Start within twenty years and complete within thirty years

- **Single family homes and two unit residences**
- **Concrete non-residential buildings built before 1980**
- **Buildings used by large audiences**
- **Historic buildings, and contributing buildings in historic districts**
- **Large workplaces with welded steel moment frames built before 1994.**
- **Early retrofitted buildings**

Other Categories

The following use-based building categories are very important to San Francisco’s earthquake resilience. However, many of these organizations are not profit entities that do not own the buildings they occupy. This report recommends that the City assist these groups to evaluate and retrofit buildings where possible, or relocate, if necessary. However, buildings used for these purposes would trigger mandatory retrofit if they also fall under one of the other categories, such as a concrete building built before 1980.

Other categories:

- **Non-profits providing important services to vulnerable populations**
- **Preschools and daycare centers**
- **Clinics and facilities providing urgent and critical medical services**