TALL BUILDINGS SAFETY STRATEGY

October 2018

About the Tall Buildings Safety Strategy

The Tall Buildings Safety Strategy was authored by the Applied Technology Council (ATC), a non-profit whose mission is to provide state-of-the-art, user-friendly engineering resources and applications for hazard mitigation. ATC convened a team of seismic engineering experts to address different aspects of the study.

An Executive Panel that included the City Administrator, Chief Resilience Officer, Department of Building Inspection, Department of Emergency Management, and the Public Utilities Commission oversaw the study. Key stakeholders representing elected officials, private engineers and architects, developers, community organizations, and city officials met on two occasions to receive updates on the study's progress and provide feedback.

A copy of the recommendations developed from the strategy is available online at: onesanfrancisco.org/resilient-sf.

The Tall Buildings Safety Strategy adds to San Francisco's many innovative programs and initiatives to improve the City's preparedness and ability to recover in the event of a major earthquake and strengthens the integrity and resilience of the City's infrastructure, neighborhoods, and residents. It follows and considers such leading efforts as the Building Occupancy Resumption Program (BORP), established to help building owners pre-certify private post-earthquake inspections and facilitate safe reoccupancy; the Community Action Plan for Seismic Safety (CAPSS), a report to understand and mitigate earthquake risks; and the Earthquake Safety Implementation Program (ESIP), a thirty-year work plan and timeline created in 2011 for implementing CAPSS. It complements the Mandatory Soft Story Program and Private School Evaluation as initiatives undertaken to evaluate and retrofit our buildings ahead of the next large earthquake.

Questions about the Tall Buildings Strategy should be directed to Danielle Mieler, Principal Resilience Analyst, Office of Resiliency and Capital Planning at Danielle.Mieler@sfgov.org or (415) 554-4540.

San Francisco Pioneers Nations's First Tall Buildings Safety Strategy

We are pleased to share these recommendations from San Francisco's Tall Buildings Safety Strategy. A pioneering effort, the Tall Buildings Safety Strategy is the first of its kind in the country. It represents 14 months of citywide collaboration to close the data gap on San Francisco's tall building stock and provide the City with the key information needed to think collectively and proactively about the seismic safety and resiliency of these highly complex structures.

Too often, conversations about our vulnerabilities and safety improvements take place as we learn from the lessons of the most recent disaster. With the Tall Buildings Safety Strategy we are committing to preparedness as the best step forward in providing for the safety for all who come to San Francisco to live, work, and visit. We are also positioning ourselves to react quickly and efficiently as a united, coordinated city to assess the safety of our buildings after the next big earthquake and to enable reoccupancy and full recovery. In making this information available to the public, we are partnering with all San Franciscans to prioritize informed action as our strongest guard against the next big earthquake.

The recommendations of the Tall Buildings Safety Strategy, prepared by seismic engineering experts of the non-profit Applied Technology Council, stem from a study of the 156 tall buildings in San Francisco, primarily in the northeast neighborhoods. The recommendations are also applicable to a wider network of buildings that support similar functions or may share similar vulnerabilities. The recommendations are presented in this report with the specific issues they were developed to resolve and with a proposed timeline for implementation.

Though finalization of the Tall Buildings Safety Strategy, including its summary of 16 recommendations, completes a significant undertaking to understand the unique seismic safety and recovery risks associated with tall buildings and their surrounding neighborhoods, we know our work is far from done. For San Francisco to maintain its leading position in seismic safety policy and regulation, we must build on the pioneering efforts of the Tall Buildings Safety Strategy to include open, public discourse.

We look forward to the critical conversations ahead as we continue to coordinate the efforts of our City departments and engage our elected officials and residents in supporting a safe, resilient, and vibrant San Francisco.

Sincerely,

Naomi Kelly
City Administrator

Sincerely,

Mary Ellen Carroll
Executive Director of the Department of Emergency Management

Table of Contents

SUMMARY RECOMMENDATIONS

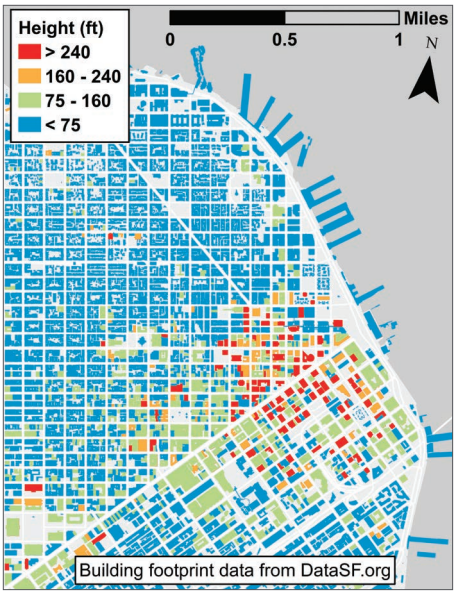
Introduction

For San Francisco, resilience begins with preparing for recovery. We know an earthquake is coming. The U.S. Geological Survey (USGS) estimates that we have a 72 percent chance of a 6.7 magnitude or greater earthquake before 2043. With the recommendations of the Tall Buildings Safety Strategy, we are building on the City's Resilient San Francisco plan, developed in 2016, to advance our innovations in earthquake resilience. The strategy continues previous work undertaken by the City to understand our unique seismic safety vulnerabilities and risks.

In 2011, the City of San Francisco developed the Earthquake Safety Implementation Program's Workplan 2012-2042 which outlines programs for broad groups of new and existing buildings throughout the city. In looking ahead, the City recognized that within each broad group, some buildings would need special attention through exemptions, programmatic solutions, or specific technical criteria, to make the work feasible.

One such subgroup comprises the city's "tall buildings." In tall buildings, difficult exterior access, multiple tenants and uses within a building, and their sheer size complicate evaluation and retrofit. Their structural systems preclude generic performance assumptions and prescriptive engineering solutions. Damage to a tall building can pose risks well beyond its own footprint. Perhaps most important, San Francisco's new and existing tall buildings represent a dominant portion of the City's business sector, and increasingly contain residents as well. Their high concentration downtown poses an aggregate risk to neighborhood and citywide recovery not presented by other building groups.

For these reasons, the City and County of San Francisco contracted in 2017 with the Applied Technology Council to conduct the first project in the nation to consider the impact of earthquakes on a city's tall buildings. The project conducted investigations in seven focus areas under separate tasks. This document presents a summary of the recommendations. A report currently under development documents the complete findings and recommendations of each task. An inventory developed for the project identified 156 buildings, either constructed or permitted for construction, that are 240 feet or taller and primarily located in San Francisco's northeast neighborhood (Supervisorial Districts 3 and 6). Approximately 60 percent of these buildings contain primarily business uses, while the others are predominantly residential.



Enhanced general inventory (Districts 3 and 6). *Source: DataSF*

Tall Buildings (over 240 feet)

The recommendations presented here flow from a study of these tall buildings but most are also applicable to a wider set of buildings supporting similar functions or posing similar risks. Tall buildings, even in downtown San Francisco, are only part of a neighborhood's building stock, and from a public policy perspective, their earthquake performance is bound up with that of the shorter buildings around them.

Each recommended action identifies one or more City departments to lead its implementation. However, implementation of any new policy is assumed to involve appropriate coordination with other City departments, outside experts (as needed), and other stakeholders. Some recommended actions require enactment of legislation by the Mayor and Board of Supervisors or action by the Building Inspection Commission and can only commence after these approvals.

Sections 1 through 4 below summarize the findings from the study in issue statements and describe the associated recommendation to address the issue. Section 5 presents the recommendations in a table format showing different aspects of each recommendation, including potential implementation timeframe, relationship to the Workplan 2012-2042, and City department responsible for implementation.

1. ACTIONS FOR REDUCING SEISMIC RISK PRIOR TO EARTHQUAKES – NEW BUILDINGS

1. Actions for Reducing Seismic Risk Prior to Earthquakes – New Buildings

1A. Develop Regulations to Address Foundation and Geotechnical Issues

Issue: The *San Francisco Building Code* sets minimum requirements for geotechnical site investigations and foundation design. Because they are minimum requirements, they do not fully address all of the geotechnical conditions found in San Francisco. Over the past several decades, the San Francisco geotechnical community has developed best practices for geotechnical evaluation and foundation design, but these are not yet codified. Many of the new tall building developments are challenging even these best practices due to unique soil conditions, the size and weight of the new buildings, and the sophisticated site investigation and the analysis approaches being used to assess overall building behavior, including building response to extreme earthquake ground motions.

Recommendation: To help reduce the risk associated with these geotechnical challenges, the Department of Building Inspection (DBI) should develop an Administrative Bulletin or Information Sheet (with building code amendments as needed) with acceptable practices on topics including the following:

- Settlement design and analysis criteria,
- Quality Assurance/Quality Control for foundation systems,
- Foundation design and other countermeasures for soil liquefaction and lateral spreading,
- Shoring and dewatering design and analysis criteria,
- Lateral earthquake resistance of deep and shallow foundations, and
- Site characterization and exploration.

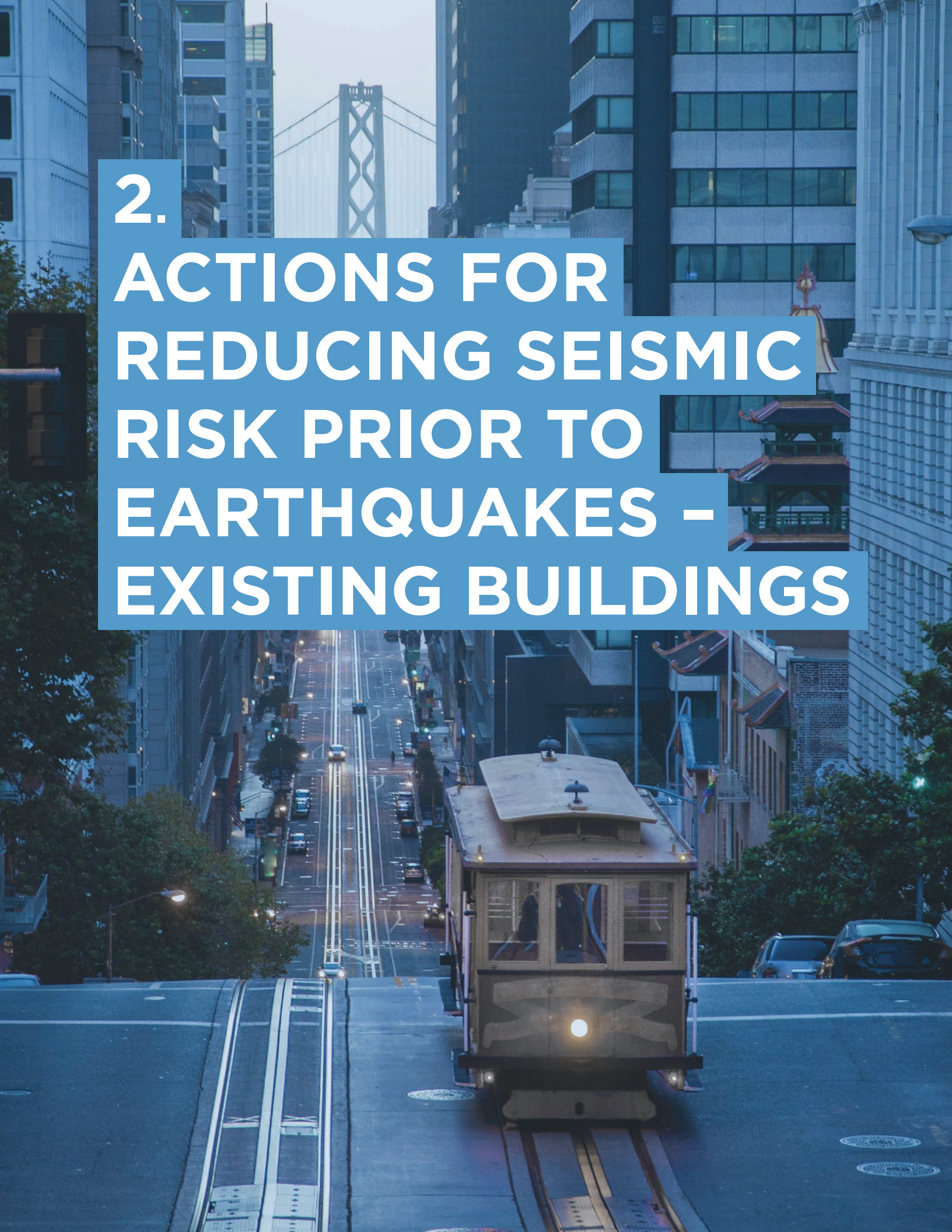
In addition, to strengthen DBI procedures for assessing the completeness of the foundation and excavation design for tall buildings, two actions are recommended:

- Increase DBI's expertise on geotechnical issues related to tall buildings through enhanced training and staffing.
- Develop a geotechnical report checklist to help ensure the completeness of the submitted geotechnical investigation, design, and field monitoring reports.

1B. Establish Recovery-Based Seismic Design Standards

Issue: *San Francisco Building Code* requirements for earthquake design, including the performance-based requirements of Administrative Bulletin 083, R*equirements and Guidelines for the Seismic Design of New Tall Buildings Using Non-Prescriptive Seismic-Design Procedures*, are primarily intended to provide acceptable safety in extreme earthquakes. Studies conducted in this project estimate that for a tall building designed to current standards, it might take two to six months to mobilize for and repair damage from a major earthquake, depending on the building location, geologic conditions, and the structural and foundation systems. Long downtimes in tall buildings can have disproportionate harmful effects on residents and businesses in San Francisco. By the City's tentative recovery goals, even three months of downtime is unacceptably long for major employers and other recovery-critical uses.

Recommendation: To shorten downtime in new tall buildings, DBI should develop an Administrative Bulletin (with building code amendments as needed) that supports the implementation of the City's tentative recovery goals and specifies recovery-based seismic design and construction requirements, including tighter drift limits under expected ground motions, enhanced design criteria for critical mechanical, electrical, plumbing, and elevator systems, enhanced detailing requirements for exterior cladding and interior partition walls, and measures to mitigate externalities that impede recovery. San Francisco's Building Occupancy Resumption Program (BORP) is designed to address some of these externalities (see recommendation 3B). BORP, or a program like it, should be required for all new tall buildings.



2. ACTIONS FOR REDUCING SEISMIC RISK PRIOR TO EARTHQUAKES – EXISTING BUILDINGS

2. Actions for Reducing Seismic Risk Prior to Earthquakes – Existing Buildings

2A. Apply the Repair Provisions of the San Francisco Existing Building Code with Respect to Loma Prieta Damage

Issue: The 1994 Northridge earthquake revealed unexpected damage to dozens of welded steel moment frame structures throughout greater Los Angeles (some of which were tall; most of which were not). In most cases, the damage did not reveal itself through obvious damage or noticeable changes under everyday use. Five years earlier, without the benefit of the lessons later learned in Northridge, San Francisco's steel buildings were not systematically inspected for weld damage, which they might or might not have sustained in the 1989 Loma Prieta earthquake.

Recommendation: As a special case of mandatory seismic evaluation, the City should apply the inspection, evaluation, and repair provisions of the *San Francisco Existing Building Code* as applicable to pre-1989 welded steel moment frames. Criteria for the work should be based on FEMA 352, Recommended Postearthquake Evaluation and Repair Criteria for Welded Steel Moment-Frame Buildings. Because the enforcement would be taking place so long after the damaging earthquake, it would likely benefit from a special program including notification, guidance to owners and tenants, and appropriate deadlines. In addition, the program should be open to inspection, evaluation, and repair work done voluntarily since 1994.

2B. Amend the San Francisco Existing Building Code Triggers for Alteration and Acquisition Projects

Issue: San Francisco has its own set of code provisions that trigger seismic upgrade when building alterations exceed a certain scope. However, because these code provisions apply only when two-thirds of a building's floors are involved in any given project, they almost never apply to tall buildings. Therefore, even the most collapse-prone tall buildings almost never receive the scrutiny intended by the code. That said, since the retrofit of an occupied tall building is especially expensive and disruptive, a more aggressive trigger provision could discourage modernization or tenant improvement. Thus, the *San Francisco Existing Building Code*'s generic provisions are problematic for tall and similarly large or complex facilities.

Recommendation: As the *San Francisco Existing Building Code* is amended to coordinate with the 2019 California codes, the Building Inspection Commission should consider revisions that would find the right balance between the trigger and the

triggered scope, perhaps setting a lower trigger that would apply to tall buildings, but requiring only evaluation and disclosure for most of them; retrofit would be required only for the most collapse-prone structures. For purposes of resilience and recovery planning, the triggered evaluation might be required to include an estimate of recovery time as well as safety.

In addition to triggering seismic evaluation and disclosure when major alterations are made, the Building Inspection Commission should consider additional triggers based on when buildings are purchased or leases are renewed. Many federal and state government agencies, as well as some private institutions, use such acquisition-based triggers. Understanding that triggered retrofits of tall buildings can be unreasonably expensive and disruptive, acquisition-based triggers for evaluation only would at least ensure that buildings are properly valued with respect to the risks they pose to owners and tenants. For purposes of resilience and recovery planning, the triggered evaluation might be required to include an estimate of recovery time as well as safety. Implementation of this recommendation would likely require participation of the Office of Assessor-Recorder.

2C. Recommend Minimum Levels of Earthquake Insurance or Other Collateral to Ensure Post-Earthquake Recovery

Issue: Available information suggests that earthquake insurance availability and market penetration for commercial and residential buildings are low. Furthermore, when available, the insurance coverage is often limited to a small fraction of the building replacement cost, raising questions about the ability to repair and recover after a damaging earthquake. Insurance or other resources to cover losses suffered by the neighbors of a tall building or costs to the City (for debris removal or emergency protective measures) are also unclear.

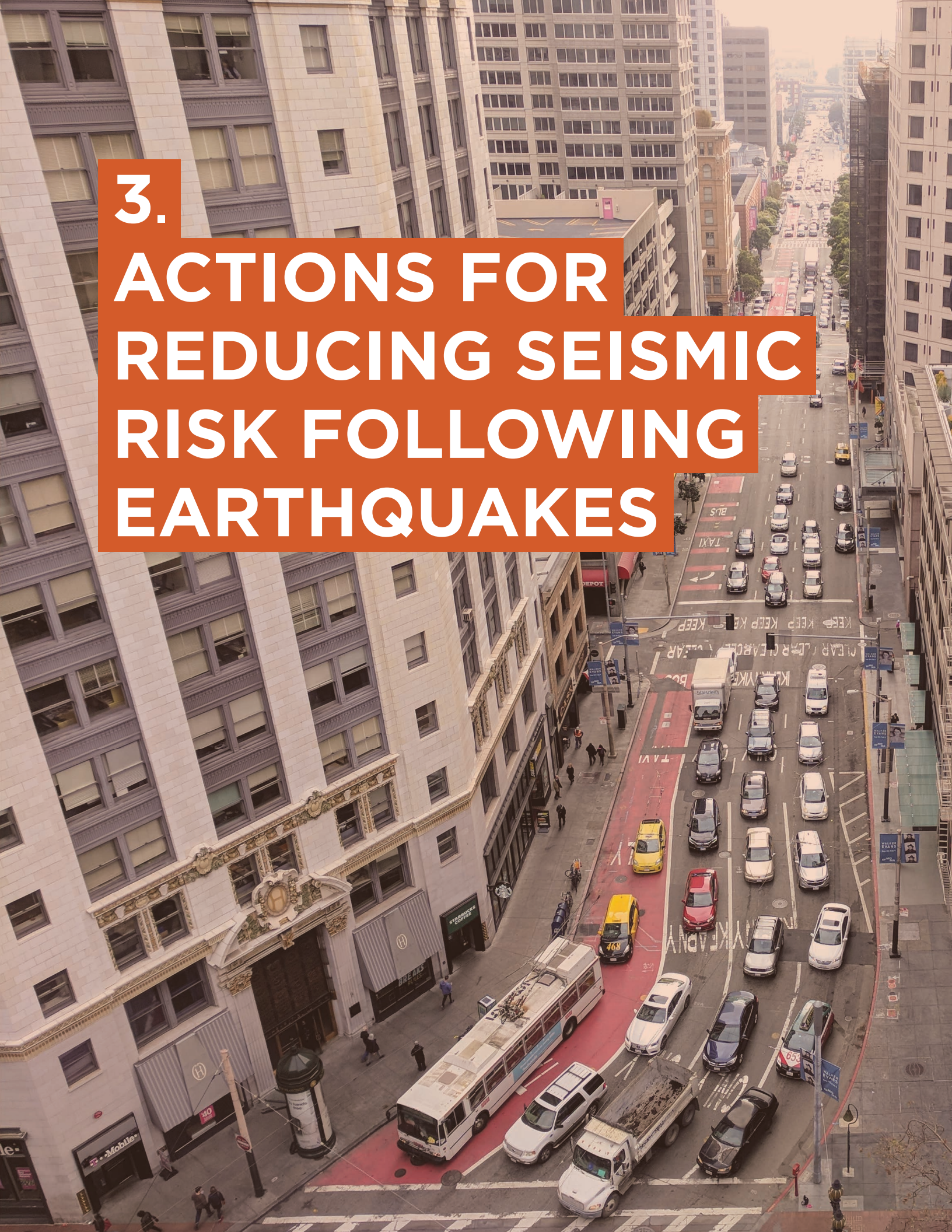
Recommendation: The City should identify potential limitations on the availability of financial capital after a damaging earthquake and recommend minimum levels of insurance (or other collateral) for tall building owners to ensure recoverability of their buildings and the neighboring community.

2.

2D. Review Requirements for Post-Earthquake Fire Suppression and Evacuation Systems

Issue: Tall buildings rely on automatic fire suppression systems (typically sprinklers) to inhibit fire spread and allow time for evacuation. Automatic fire suppression will be particularly important following a significant earthquake, when risk of fire ignitions might be higher, and the response time of fire departments might be longer than usual. Normally, sprinkler systems in high-rise buildings use water from the City's municipal system, pressurized with pumps and emergency generators. Recognizing the risk that the City water supply may be disrupted by an earthquake, the *San Francisco Building Code* requires many buildings to have an in-building secondary water supply to operate the sprinkler system for 30 minutes.

Recommendation: The San Francisco Fire Department (SFFD) and the Department of Emergency Management (DEM) should coordinate a study to evaluate the adequacy of automatic fire suppression and occupant evacuation systems in tall buildings for conditions following a significant earthquake. The study should be coordinated with other City departments and within the broader context of the *San Francisco Emergency Response Plan* to evaluate whether (1) the in-building secondary water supply for automatic fire suppression in tall buildings is sufficient to inhibit fire spread and allow safe evacuation, and (2) the building code provisions that rely on elevators for evacuation during a fire emergency will be effective following an earthquake. The study should develop requirements and recommendations for the *San Francisco Building Code and Emergency Response Plan* to address any significant limitations or risks that are identified.



3. ACTIONS FOR REDUCING SEISMIC RISK FOLLOWING EARTHQUAKES

3. Actions for Reducing Seismic Risk Following Earthquakes

3A. Develop New Policies and Procedures for Implementing the State's Safety Assessment Program

Issue: The Safety Assessment Program (SAP), through which volunteer inspectors "post" buildings with red, yellow, or green placards, is run by the California Office of Emergency Services (Cal OES). DBI is charged with implementing San Francisco's participation in the program. The SAP procedures and criteria are based on ATC-20, Procedures for *Postearthquake Safety Evaluation of Buildings*, and are generic and not well-suited to complex or recovery-critical facilities, including most tall buildings.

Recommendation: DBI should develop its own procedures suited to San Francisco's tall buildings (and otherwise unique building stock) regarding such topics as limits on exterior-only inspection, limits on rapid evaluation, damage estimates, placard use, and placard text.

In coordination with its implementation of SAP, DBI should also develop a plan to use specially qualified SAP volunteers to inspect pre-selected groups of buildings, one of which might be tall buildings, especially those not covered by BORP. More generally, the building groups of interest should be related to the City's adopted recovery goals. These specially trained and assigned inspection teams would facilitate recovery of building types with fast recovery goals.

3B. Extend and Improve the Building Occupancy Resumption Program

Issue: BORP, created by DBI, allows building owners to arrange in advance for post-earthquake safety inspections using their own contracted inspectors. Participation is voluntary. DBI approves each participating building's application and pre-certifies the owner's inspection team. Most of the current BORP participants are downtown office buildings. BORP solves many of the problems associated with applying the general Safety Assessment Program to tall or otherwise complex or recovery-critical buildings. To enhance BORP's effectiveness and to derive the most value from it, DBI should maintain and update the program.

Recommendation: DBI should enhance the BORP program with the following:

- Conduct simulation-based training to ensure readiness of building staff, BORP-certified inspectors, and DBI staff.
- Update the BORP instructions and procedures to improve consistency and practicality. In particular, material required for certification by DBI should be separate from material to be used by the BORP inspection team in the field. The field material should be organized to align with the ATC-20 evaluation procedures already adopted by BORP as its standard.
- Add specific criteria and pre-earthquake procedures to facilitate implementation of FEMA 352, *Recommended Postearthquake Evaluation and Repair Criteria for Welded Steel Moment-Frame Buildings*, for welded steel moment frame structures.
- Require BORP for all new tall buildings. The program should be extended through incentive programs, triggers, and possibly even mandates (see recommendations 1B and 3H) for certain tall or otherwise recovery-critical buildings. The purpose would be to require at least a basic recovery plan, if not full BORP documentation and implementation, for a larger set of existing buildings.
- Together with ORCP, extend the BORP scope to support functional recovery in addition to safe reoccupancy. For tall buildings, this might include additional procedures for individual tenant spaces.

3C. Clarify and Update Roles and Responsibilities Associated with Post-Earthquake Emergency Response and Safety Inspection

Issue: Current procedures and practices for post-earthquake emergency response and safety inspection are inconsistent, and sometimes out of date, regarding the roles of certain City departments and their interaction with state-level programs and private sector plans (including BORP).

Recommendation: DEM, in coordination with DBI and Public Works, should update the *Earthquake Annex of the San Francisco Emergency Response Plan* regarding activation of the Cal OES Safety Assessment Program.

DBI and Public Works should also update their SAP and BORP procedures regarding the division of responsibility and criteria for establishing cordons and barricades, in coordination with Lifelines Council recommendations for priority transit routes. (See also recommendation 3G.)

3.

3D. Update and Amend the San Francisco Existing Building Code Triggers for Repair Projects

Issue: San Francisco has pioneered a number of code provisions for existing buildings. As the state code catches up, the *San Francisco Existing Building Code* has fallen out of coordination. Specifically, the *San Francisco Existing Building Code* triggers seismic upgrade based on the extent of earthquake damage. For most buildings, the requirements are rational, but for larger structures, the requirement can become disproportionately expensive and disruptive; if repairs to many large buildings are triggered, the aggregate impact can affect the City's overall recovery. San Francisco's code amendments might exacerbate the problem by not allowing use of reduced loads typical for retrofits.

Recommendation: As the 2019 California code becomes effective, DBI should take the opportunity to update its traditional amendments and coordinate them with the state code.

Regarding repair-triggered retrofits, ORCP, together with appropriate Building Inspection Commission committees, should investigate whether San Francisco should relax its code provisions for certain buildings, especially regarding the "substantial structural damage" trigger. The study should consider typical San Francisco buildings, ideally with a scenario that considers the effects of multiple buildings on downtown recovery.

3E. Update Administrative Bulletin 099 and Clarify its Application to Tall Concrete Structural Systems

Issue: Administrative Bulletin (AB) 099, *Post-Earthquake Repair and Retrofit Requirements for Concrete Buildings*, supplements the San Francisco Existing Building Code by implementing FEMA 306, Evaluation of Earthquake Damaged Concrete and Masonry Wall Buildings, published in 1998. Many of AB-099's references are due for updates. Further, while AB-099 applies to all concrete buildings, some of its provisions might prove difficult to apply to tall buildings.

Recommendation: DBI should update AB-099 to coordinate with newer building code provisions and reference standards. DBI should also develop a commentary to the updated AB-099 to guide its application to tall and otherwise complex concrete buildings.

3F. Develop a New Administrative Bulletin for Post-earthquake Inspection and Evaluation of Welded Steel Moment Frames

Issue: Many of San Francisco's tall buildings have welded steel moment frames as their structural systems. FEMA 352, *Recommended Postearthquake Evaluation and Repair Criteria for Welded Steel Moment-Frame Buildings*, was developed after the 1994 Northridge earthquake specifically for this structure type, but it is not fully referenced by San Francisco codes and procedures.

Recommendation: DBI should develop an Administrative Bulletin to implement FEMA 352. If code amendments are necessary, DBI should work with the Mayor, Board of Supervisors, and the Building Inspection Commission to approve them.

For post-earthquake safety evaluation, the recommended Administrative Bulletin should clarify the procedures and criteria that DBI will accept in coordination with Rapid and Detailed Evaluations using ATC-20. (As noted in recommendation 3B, FEMA 352 is already allowed by BORP, but the program procedures are incomplete regarding its use, so the recommended AB could address that shortcoming as well.)

For post-earthquake application of upgrade triggers, just as AB-099 supplements the *San Francisco Existing Building Code* for concrete buildings, a similar bulletin should be developed for welded steel moment frames, which are even more common in San Francisco's tall buildings.

3G. Create Protocols and Procedures for Establishing Cordons around Damaged Buildings

Issue: Cordons or barricades are often needed to protect the areas around a damaged building. The cordoned area is generally based on the perceived level of damage and the risks posed by potential aftershocks, wind loading, time-dependent creep effects, or other factors. While cordons may be required around buildings of any height, the disruptive implications of current generic guidance for cordon distance increase dramatically with building height, potentially leading to unnecessary closure of neighboring buildings and infrastructure.

3.

Recommendation: Public Works, in coordination with DBI (see recommendation 3C) should develop protocols and procedures for cordoning around damaged buildings. The procedures should be based on current practices but should also account for tall building effects on neighborhood safety and recovery, as well as new information regarding aftershock risks and early warning.

3H. Require Existing Buildings to File Recovery Plans

Issue: Because aggressive retrofit triggers and mandates can be unreasonably expensive and disruptive for occupied tall buildings, thorough recovery planning is a more feasible alternative. BORP can facilitate recovery in a lightly damaged building, but as a voluntary program, it is not used widely enough to improve the recovery of a whole neighborhood like San Francisco's downtown, where the City's tall buildings are most densely clustered.

Recommendation: ORCP, in coordination with DBI, should identify buildings critical to the City's recovery and mandate the filing of building information, and possibly a basic recovery plan, with the City. The building information would enhance existing databases and inform the City's response and recovery planning, and the building-specific recovery plan would be a way of extending the benefits of BORP without requiring ongoing expense from owners.

4. ACTIONS TO IMPROVE THE CITY'S UNDERSTANDING OF ITS TALL BUILDING SEISMIC RISK

4. Actions to Improve the City's Understanding of Its Tall Building Seismic Risk

4A. Maintain and Expand the Database of Tall Buildings

Issue: This project compiled a database with information about all buildings 240 feet or taller, either constructed or currently permitted for construction, in San Francisco. The database includes information on building location, height, occupancy, age, construction material, structural system, year of retrofit, and foundation type. Prior to the creation of this database, the City had no centralized, searchable repository with this information about all tall buildings in its jurisdiction. Following the completion of this project, the City will need to develop a mechanism for maintaining or expanding the database.

Recommendation: As the owner of the database, the ORCP should work with DataSF and DBI to maintain and expand the tall building database. Specific recommended actions include:

- Develop mechanisms for harvesting building data from building permits or inspections administered by DBI or other agencies. For example, S*an Francisco Existing Building Code* Chapter 4E will yield information on building façades as the provisions are implemented over the coming years.
- Make the database available for public review and use. This will encourage updates by building owners and will facilitate use of the data in studies to promote recovery and resilience planning.
- Expand the database to include the following:
    - All buildings taller than 75 feet. As described in the project report, the 240-foot height criterion for the initial database was somewhat arbitrary. To the extent that the *San Francisco Building Code* imposes elevator, fire safety, and other requirements on high-rise buildings defined as those taller than 75 feet, it would be useful to expand the database to include at least all buildings above this height.
    - Specific building uses by industry or employment sector. The data should be coordinated with development of the City's overall recovery goals. Ideally, similar data for non-tall buildings serving those same recovery functions would also be compiled, allowing a better understanding of the tall building effects in terms of neighborhood and citywide recovery.
    - Foundation type of any building on a site mapped as susceptible to liquefaction.

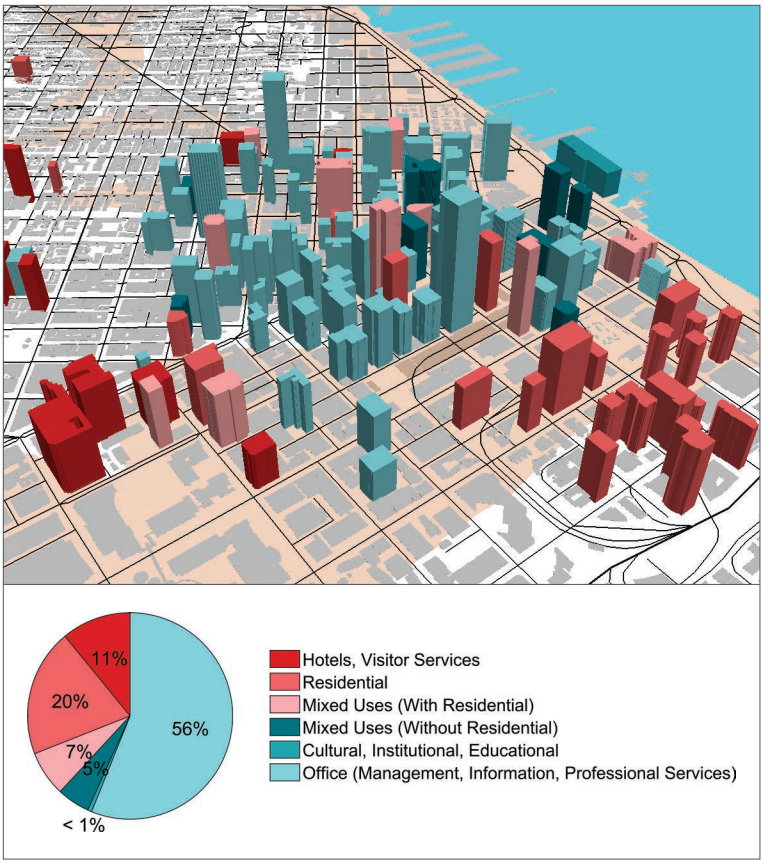
4.

4B. Develop a Comprehensive Recovery Plan for the Financial District and Adjacent Neighborhoods

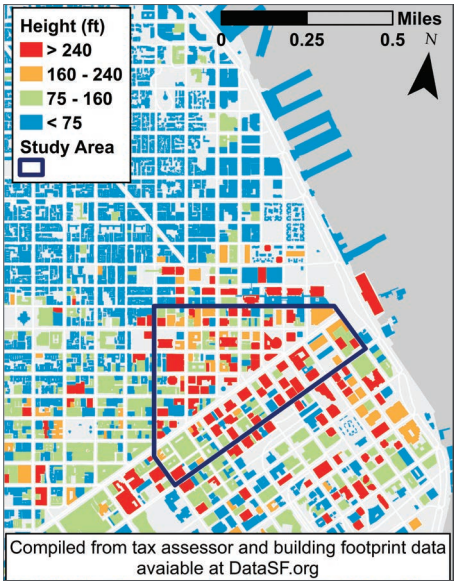
Issue: The present study addresses the effect of tall building damage on the tall buildings themselves and, to a lesser extent, on the downtown neighborhoods where tall buildings are densely clustered and on the City overall. But it does not explicitly address the likely interactions between the tall buildings, the non-tall buildings that still comprise most of downtown, and the critical infrastructure that serves the neighborhood. Nor does it explicitly consider resource demands and capacities of the businesses, residents, workers, and other stakeholders.

Recommendation: A separate recovery plan, drawing on the present study's findings, would bring these ideas together in a practical way to support a neighborhood and its functions, as opposed to just individual buildings with certain characteristics. An interim recovery plan, which should be developed by the City Administrator, would need to make many assumptions. This should be followed by a more thorough recovery study to confirm or correct those assumptions and to fill in the most critical knowledge gaps. Such a study would address the combined effects of tall buildings, non-tall buildings, and infrastructure, including liquefaction effects. The study would develop a recovery curve estimating the level of immediate functional loss and the extent of reoccupancy and recovery over time following one or more scenario earthquakes.

The recovery plan should consider developing alternative habitability standards for tall buildings. In 2012, SPUR recommended relaxing normal habitability standards during post-earthquake recovery, gradually returning to a state of normalcy. But the SPUR recommendations were developed primarily for houses and wood-frame apartment buildings. Tall buildings, by contrast, rely on sophisticated systems for heating, ventilation, air-conditioning, elevators, and fire suppression, so the SPUR recommendations will not apply. DEM, together with ORCP, should develop alternative recovery-phase habitability standards for tall buildings, considering minimum requirements for fire barriers, suppression and safety systems, vertical transportation, water services, and electricity.



Tall Building Occupancies



Building Stock: Downtown Context

SUMMARY TABLES

Summary Tables

Table 1 presents the recommendations in terms of potential implementation timeframes. Table 2 relates the recommendations to relevant tasks in Workplan 2012-2042. In some cases, this tall building study identified additional programs and initiatives not detailed in Workplan 2012-2042. In others, the tall building recommendations identify specific technical criteria, exemptions, or programmatic solutions suitable for tall and similarly complex buildings, even relaxing some of the Workplan's broad directives. Table 3 presents the recommendations in terms of City departments responsible for implementation.

Table 1: Implementation Timeframe

Recommended Action	SHORT-TERM	MID-TERM	LONG-TERM
1. Actions for Reducing Seismic Risk Prior to Earthquakes – New Buildings			
1A. Develop Regulations to Address Foundation and Geotechnical Issues			
• Training and checklist	X		
• Develop Geotechnical Regulations		X	
1B. Establish Performance-Based Seismic Design Standards			X
2. Actions for Reducing Seismic Risk Prior to Earthquakes – Existing Buildings			
2A. Enforce the Repair Provisions of the San Francisco Existing Building Code with Respect to Loma Prieta Damage		X	
2B. Amend the San Francisco Existing Building Code			
• Alteration triggers	X		
• Acquisition triggers		X	
2C. Require Minimum Levels of Earthquake Insurance to Ensure Recovery			X
2D. Increase Local Water Supply for Automatic Fire Suppression Systems in Tall Buildings		X	

Table 1: Implementation Timeframe

Recommended Action	SHORT-TERM	MID-TERM	LONG-TERM
3. Actions for Reducing Seismic Risk Following Earthquakes			
3A. Develop New Policies and Procedures for Implementing the State's Safety Assessment Program	X		
3B. Extend and Improve the Building Occupancy Resumption Program			
• Conduct simulation-based training	X		
• Update procedures	X		
• Extend program		X	
3C. Clarify and Update Roles and Responsibilities Associated with Post-Earthquake Emergency Response and Safety Inspection	X		
3D. Update and Amend the San Francisco Existing Building Code		X	
3E. Update Administrative Bulletin 099 and Clarify its Application to Tall Concrete Structural Systems			X
3F. Develop a New Administrative Bulletin for Post-earthquake Inspection and Evaluation of Welded Steel Moment Frames			X
3G. Create Protocols and Procedures for Establishing Cordons Around Damaged Buildings	X		
3H. Require Existing Buildings to File Recovery Plans			X
4. Actions to Improve the City's Understanding of its Tall Building Seismic Risk			
4A. Maintain and Expand the Database of Tall Buildings	X		
4B. Develop a Comprehensive Recovery Plan for the Financial District and Adjacent Neighborhoods			X

Footnotes for Table 1: Short-term actions can be started with essentially no additional study and completed without a legislative process. Typical examples include administrative updates, development of Administrative Bulletins, and initiatives requiring only nominal inter-departmental coordination. Mid-term actions can normally be completed without substantial additional study and without a legislative process but are expected to involve substantial input from multiple stakeholder groups. Long-term actions are expected to require substantial additional technical study or a legislative process.

Table 2: Relationship of Recommended Actions to ESIP Workplan 2012-2042 Tasks

Recommended Action	ESIP Workplan 2012-2042 Task
1. Actions for Reducing Seismic Risk Prior to Earthquakes – New Buildings	
1A. Develop Regulations to Address Foundation and Geotechnical Issues	New action
1B. Establish Performance-Based Seismic Design Standards	**B.6.a.** Update code for new buildings to reflect desired performance goals
2. Actions for Reducing Seismic Risk Prior to Earthquakes – Existing Buildings	
2A. Enforce the Repair Provisions of the San Francisco Existing Building Code with Respect to Loma Prieta Damage	**B.4.b** Develop post-earthquake repair and retrofit standards
2B. Amend the San Francisco Existing Building Code	**C.1.a** Mandatory evaluation on sale or by deadline **C.1.b** Evaluation of buildings retrofitted prior to 1994 or building to non-conforming performance standards **C.2.a** Mandatory retrofit of older non-ductile concrete residential buildings **C.2.d** Mandatory evaluation and retrofit of pre-1994 welded steel moment frame buildings **C.2.e** Mandatory evaluation and retrofit of other low-performance buildings
2C. Require Minimum Levels of Earthquake Insurance to Ensure Recovery	**A.1.b** Provide information and assistance about insurance
2D. Increase Local Water Supply for Automatic Fire Suppression Systems in Tall Buildings	**A.6.i** Study fire-related earthquake resilience topics
3. Actions for Reducing Seismic Risk Following Earthquakes	
3A. Develop New Policies and Procedures for Implementing the State's Safety Assessment Program	**A.4.f** Update post-earthquake inspection (ATC-20) policies and procedures
3B. Extend and Improve the Building Occupancy Resumption Program	**B.1.b** Develop non-structural upgrade program for businesses

Table 2: Relationship of Recommended Actions to ESIP Workplan 2012-2042 Tasks

Recommended Action	ESIP Workplan 2012-2042 Task
3C. Clarify and Update Roles and Responsibilities Associated with Post-Earthquake Emergency Response and Safety Inspection	Procedural update
3D. Update and Amend the San Francisco Existing Building Code	**B.4.b** Develop post-earthquake repair and retrofit standards
3E. Update Administrative Bulletin 099 and Clarify its Application to Tall Concrete Structural Systems	**A.4.d** Adopt disproportionate damage trigger **B.4.b** Develop post-earthquake repair and retrofit standards
3F. Develop a New Administrative Bulletin for Post-earthquake Inspection and Evaluation of Welded Steel Moment Frames	**3F.** Develop a New Administrative Bulletin for Post-Earthquake Inspection and Evaluation of Welded Steel Moment Frames **A.4.d** Adopt disproportionate damage trigger **B.4.b** Develop post-earthquake repair and retrofit standards
3G. Create Protocols and Procedures for Establishing Cordons Around Damaged Buildings	Program update, new action
3H. Require Existing Buildings to File Recovery Plans	**B.1.b** Develop non-structural upgrade program for businesses
4. Actions to Improve the City's Understanding of its Tall Building Seismic Risk	
4A. Maintain and Expand the Database of Tall Buildings	**A.2.b** Adopt façade maintenance regulations
4B. Develop a Comprehensive Recovery Plan for the Financial District and Adjacent Neighborhoods	**A.4.a** Develop and adopt Shelter-in-Place policies and procedures **B.2.b** Mandatory evaluation of 5+ dwelling unit residential buildings and hotels/motels **C.2.b** Mandatory evaluation and retrofit of critical stores, suppliers, and service providers **C.2.c** Mandatory evaluation and retrofit of larger (over 300 occupants) assembly buildings

Footnote to Table 2: The Earthquake Safety Implementation Program (ESIP) Workplan 2012-2042 was published by the City and County of San Francisco in 2011 as a result of the Community Action Plan for Seismic Safety (CAPSS) in response to Mayor Newsom's Executive Directive 10-02.

Table 3: Responsible Department

Recommended Action	BIC	DATASF	DBI	DEM	Public Works	OAR	ORCP	SFFD
1. Actions for Reducing Seismic Risk Prior to Earthquakes – New Buildings								
1A. Develop Regulations to Address Foundation and Geotechnical Issues			X					
1B. Establish Performance-Based Seismic Design Standards			X					
2. Actions for Reducing Seismic Risk Prior to Earthquakes – Existing Buildings								
2A. Enforce the Repair Provisions of the San Francisco Existing Building Code with Respect to Loma Prieta Damage			X					
2B. Amend the San Francisco Existing Building Code	X					X		
2C. Require Minimum Levels of Earthquake Insurance to Ensure Recovery			X					
2D. Increase Local Water Supply for Automatic Fire Suppression Systems in Tall Buildings								X
3. Actions for Reducing Seismic Risk Following Earthquakes								
3A. Develop New Policies and Procedures for Implementing the State's Safety Assessment Program			X					
3B. Extend and Improve the Building Occupancy Resumption Program			X				X	
3C. Clarify and Update Roles and Responsibilities Associated with Post-Earthquake Emergency Response and Safety Inspection			X	X	X			
3D. Update and Amend the San Francisco Existing Building Code	X		X				X	

Table 3: Responsible Department

Recommended Action	BIC	DATASF	DBI	DEM	Public Works	OAR	ORCP	SFFD
3E. Update Administrative Bulletin 099 and Clarify its Application to Tall Concrete Structural Systems			X					
3F. Develop a New Administrative Bulletin for Post-earthquake Inspection and Evaluation of Welded Steel Moment Frames	X		X					
3G. Create Protocols and Procedures for Establishing Cordons Around Damaged Buildings			X	X	X			
3H. Require Existing Buildings to File Recovery Plans			X				X	
4. Actions to Improve the City's Understanding of its Tall Building Seismic Risk								
4A. Maintain and Expand the Database of Tall Buildings		X	X				X	
4B. Develop a Comprehensive Recovery Plan for the Financial District and Adjacent Neighborhoods				X			X	

Footnote to Table 3:

Abbreviation	Representative Organization
BIC	Building Inspection Commission
DATASF	Data SF
DBI	Department of Building Inspection
DEM	Department of Emergency Management
OAR	Office of Resilience and Capital Planning
ORCP	Office of Assessor-Recorder
SFFD	San Francisco Fire Department

Tall Buildings Safety Strategy Stakeholders

Interest Group	Representative Organization
Board of Supervisors	District 3
	District 6
Private Engineers and Architects	DBI Code Advisory Committee
	Heller Manus Architects
	Building Inspection Commission
	HOK
	Maffei Structural Engineering
	BXP
	SEAONC AB 82/83 Code Advisory Committee
	Fennie+Mehl Architects
Developers	San Francisco Apartment Owners Association
	Tishman Speyer
	Boston Properties
Business	San Francisco Chamber of Commerce
Real Estate	Real Estate Advisory Services
Community and Non-profit Organizations	SPUR
	BOMA
	The East Cut Community Benefit District
City and County of San Francisco Staff	Department of Building Inspection
	Real Estate Division
	Department of Emergency Management
	Planning Department
	Fire Department
	SFPUC
	Public Works
	Office of Resilience and Capital Planning

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