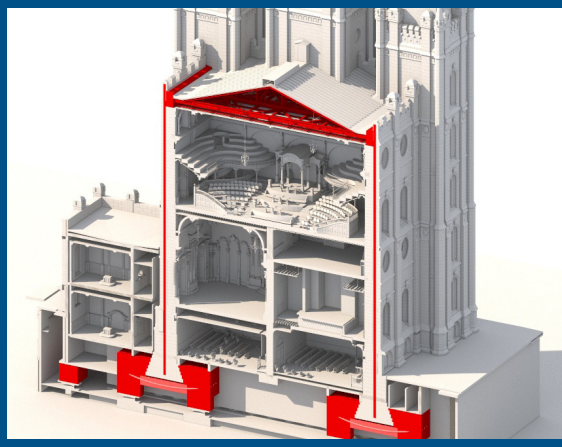

Wasatch Front Unreinforced Masonry Risk Reduction Strategy

MARCH 2021

FEMA

Utah Seismic Safety Commission

nehrp

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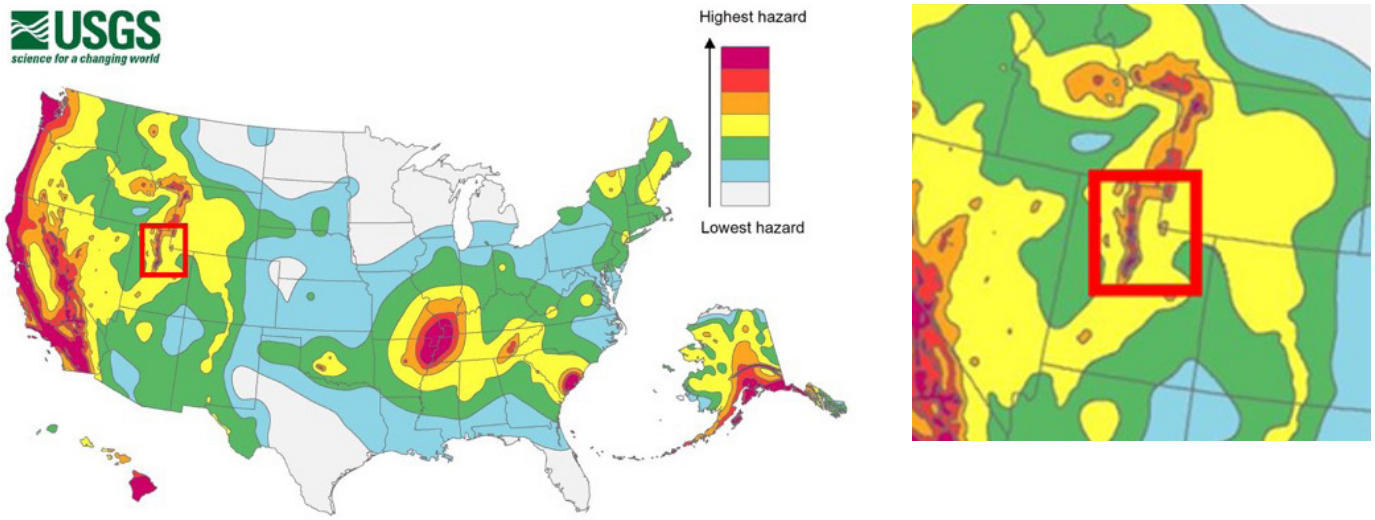
Cover image — Starting top left, in clockwise order: (1) commercial building damaged during 2020 magnitude 5.7 Magna, Utah, earthquake; (2) Salt Lake Temple base isolation retrofit; (3) close-up of parapet bracing; and (4) earthquake warning placard.

Photo credits — (1) building damage; (2) Salt Lake Temple; (3) parapet bracing; and (4) warning placard.

Executive Summary

The Wasatch fault poses one of the most catastrophic natural threat scenarios in the United States. The Wasatch Front has a 43% chance of a magnitude 6.75 or greater earthquake in the next 50 years, and experts project that such an event would be among the deadliest and costliest disasters in U.S. history. In a magnitude 7.0 earthquake on the Salt Lake City segment of the Wasatch fault, FEMA's economic loss model, Hazus, estimates 2,000-2,750 fatalities, 8,000-10,000 injuries potentially requiring hospitalization, and roughly 78,000 displaced households.[1] The 2018 Long-term National Seismic Hazard Map (Figure 1) from the U.S. Geological Survey (USGS) shows the location of the Wasatch fault and the high earthquake hazard in that area.[2]

Figure 1. USGS 2018 Long-term National Seismic Hazard Map



The devastating potential of the Wasatch fault is due, in part, to the high likelihood of a large earthquake near Utah's most densely populated urban areas. This danger is heightened by the number of people who live, learn, work, worship or shop in unreinforced masonry (URM) buildings and may be unaware of the potential danger. Additionally, those who live in URM buildings often include a disproportionate number of disadvantaged and marginalized populations. A typical URM building has brick walls with few or no steel reinforcing bars. During an earthquake, unretrofitted URM buildings often collapse, both inward and outward. These buildings crumble on top of people, cars, sidewalks, or other structures in and around them. Most injuries and deaths expected in a Wasatch fault earthquake are linked to these buildings. Utah building codes no longer permit URM for new buildings. However, it is estimated that more than 140,000 URM buildings across the Wasatch Front were built before they were prohibited in the 1970s.[3]

[1] EERI Utah, Scenario for a Magnitude 7.0 Earthquake on the Wasatch Fault–Salt Lake City Segment https://dem.utah.gov/wp-content/uploads/sites/18/2015/03/RS1058_EERI_SLC_EQ_Scenario.pdf

[2] USGS, 2018 Long-term National Seismic Hazard Map https://www.usgs.gov/media/images/2018-long-term-national-seismic-hazard-map

[3] USGS: A Study of Earthquake Losses in SLC, Utah Area https://pubs.usgs.gov/of/1976/0089/report.pdf

FEMA and the state of Utah recognize the importance of mitigation in reducing exposure to future losses from disasters. The interagency National Mitigation Investment Strategy (Investment Strategy) — published in July 2019 — was developed to help the nation be more intentional about setting resilience and mitigation investment priorities to benefit the whole community. Due to Utah's URM issues and its dedication to creating a solution, the Wasatch Front URM Risk Reduction Strategy was selected as a pilot project through the Investment Strategy. This project brings together local and national experts to develop a mitigation strategy that highlights key concepts that drive risk reduction outcomes. By learning from Salt Lake City's successful previous investment in mitigation through Fix the Bricks, FEMA and Utah are collaborating to expand the investment in seismic mitigation, both across the Wasatch Front and nationally, in other seismically active cities.[4]

The purpose of this project is to provide Utah with a strategy for significantly reducing the risks posed by URM buildings across the Wasatch Front. This strategy leverages resources and case studies from Utah and other seismically vulnerable areas. It was developed to be actionable, by recommending best practices in identifying URM buildings, designing retrofits, and developing and implementing programs. While this strategy was developed for communities across the Wasatch Front, it is also replicable. Its approach is intended to support and guide the development of URM risk reduction programs across the United States. The strategy follows guidance from several documents and is predominantly grounded in the following publications:

1. *FEMA P-774: Unreinforced Masonry Buildings and Earthquakes, Developing Successful Risk Reduction Programs.*[5]
2. *Mitigation Framework Leadership Group (MitFLG) National Mitigation Investment Strategy.*[6]
3. *FEMA 275: Planning for Seismic Rehabilitation: Societal Issues.*[7]
4. *Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings.*[8]
5. *Utah Students at Risk: The Earthquake Hazards of School Buildings.*[9]

The strategy's five broad recommendations are intended to influence public policy and professional practice. However, the details of any policy will be developed through conversations between design-build professionals and community stakeholders, based on a community-wide goal of mitigating the risk posed by URM buildings across the Wasatch Front.

This strategy is organized into three chapters, with supplemental information in the appendices. Chapter 1 defines the strategy's purpose, intended audience, and organization. Chapter 2 summarizes the context of the problem and the origin of the strategy development project, including how it ties into the Investment Strategy. Chapter 3 outlines its five recommendations for the state of Utah. Each recommendation highlights potential implementation challenges for key stakeholders. The appendices provide details on stakeholder-specific communication support and a thorough engagement process, which will ensure inclusive, whole-community support for these resilience-supporting recommendations.

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[4] Salt Lake City Government, Fix the Bricks https://www.slc.gov/em/fix-the-bricks/

[5] FEMA P-774, Unreinforced Masonry Buildings and Earthquakes, Developing Successful Risk Reduction Programs https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

[6] FEMA, National Mitigation Investment Strategy https://www.fema.gov/emergency-managers/national-preparedness/frameworks/mitigation/mitflg

[7] FEMA 275, Planning for Seismic Rehabilitation: Societal Issues https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

[8] USSC, 2016 https://ussc.utah.gov/pages/view.php?ref=1281

[9] USSC/SEAU, 2011 https://ussc.utah.gov/pages/view.php?ref=147

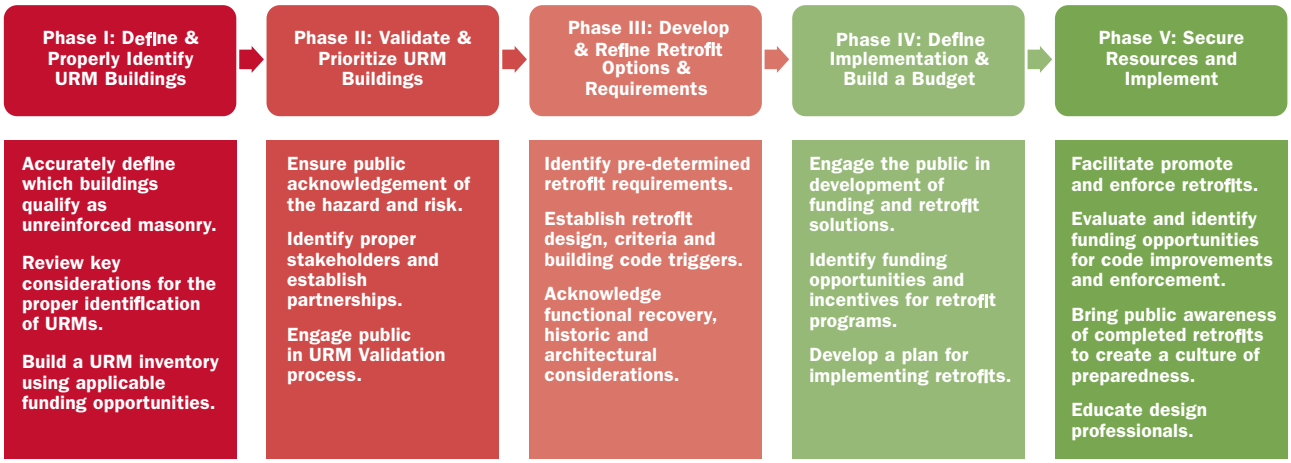
*Table 1. Recommendations for Implementing Seismic Risk Reduction for URM Buildings in Utah**

Recommendation	Objectives
URM School Risk Reduction Program	• Validate and finalize the statewide inventory of URM school buildings. • Meet with individual districts to review inventory and discuss mitigation options. • Assess building risks and prioritize mitigation strategies (e.g., retrofit or replacement). • Establish target dates for all URM schools to be repurposed, retrofitted or demolished. • Fund seismic mitigation.
Retrofit Program Focused on Government-Owned URM Structures	• Expand and update the inventory of government-owned URM buildings. • Assess building risks. • Prioritize building uses when making mitigation decisions. • Implement and maintain an inclusive stakeholder engagement process. • Enforce state building codes and standards. • Set enhanced goals for government-owned high occupancy buildings. • Fund improvements.
Statewide URM Risk Reduction Program	Coordinated state- and local-level agency support: • Provide dedicated funding to the Utah Seismic Safety Commission (USSC) to maintain and oversee the state-level URM risk reduction program. • Enhance the effectiveness of programs that advise state agencies, local jurisdictions and other governmental agencies on earthquake safety. • Recommend that a State Resilience Officer or other high-level advisors help shape policy on matters related to disaster risk reduction and recovery efforts. • Seek and provide funding for local jurisdictions to inventory and assess their URM vulnerability. Statewide URM risk reduction program: • Include a URM mitigation priority and funding strategy in the Utah State Hazard Mitigation Plan. • Create a state-level Hazard Mitigation Plan for URM mitigation. • Develop, update or propose adoption of post-earthquake inspection, repair and retrofit standards for damaged buildings.

Recommendation	Objectives
Utah State Construction Code Enhancements	• Require seismic upgrades for URM buildings converted to condominiums. • Strengthen or amend International Existing Building Code (IEBC) requirements to include any re-roofing as a trigger for seismic improvements to roof-wall attachments. • Amend the state building code to allow upgrading for seismic performance without triggering other code upgrade requirements. • Expand IEBC compliance triggers for URM one- and two-family dwellings.
Utah State Construction Code — Local Amendments	• Require seismic upgrades for URM buildings converted to condominiums. • Assess vulnerabilities and prioritize retrofits. • Evaluate tools for mitigation, including ordinances and planning and land-use requirements.
**Appendices A-E provide stakeholder-specific communication support and define an engagement process that ensures inclusive, whole-community support for implementing these recommendations.*	

The recommended phases for applying a successful URM risk reduction strategy are detailed in Appendices A through E. These processes are meant to guide stakeholders through the implementation process for the recommendations proposed in this strategy. Figure 2 gives an overview of this process, and more information on each phase can be found in the appendices.

Figure 2. Recommended Phases for a Successful URM Risk Reduction Strategy



Appendix F provides a list of all the Utah stakeholders that will contribute to a successful URM risk reduction program. While stakeholder engagement and community outreach are referred to throughout the strategy, detailed information on the URM Stakeholder Engagement Strategy is found in Appendix G. Appendix H provides a history of URM risk reduction across the Wasatch Front, starting with the 1967 Governor's Conference on Geological Hazards in Utah. Appendix I dives into case studies of various URM risk reduction efforts in the Western United States, most notably in Portland, Oregon; Seattle, Washington; and California. This appendix also includes important lessons learned from these cases to help Utah build upon these experiences. While the majority of this strategy focuses on pre-disaster mitigation, Appendix J provides supplementary information on post-disaster URM risk reduction strategies and recommendations. Examples of city-level model ordinances for voluntary and mandatory retrofit ordinances can be found in Appendix K; these examples highlight the characteristics of previous ordinances around the country. Endnotes and references are in Appendix L, and a list of project participants is in Appendix M.

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Chapter 1: Introduction

1.1: PURPOSE AND SCOPE

The purpose of the Wasatch Front URM Risk Reduction Strategy is to provide the state of Utah with a risk reduction strategy that will significantly reduce the risks posed by URM buildings across the Wasatch Front. This strategy leverages a collection of resources and case studies from Utah and other seismically vulnerable areas. It was developed to be actionable and recommends best practices in identifying URM buildings, designing retrofits, and developing and implementing a program. This strategy, while developed for communities across the Wasatch Front, is also replicable; its approach is intended to support and guide the development of URM risk reduction programs across the United States.

1.2: INTENDED AUDIENCE

This strategy has been written to provide state and local policymakers with a clear list of actions to take as soon as possible, through policy and with budgeting, legislation, and executive actions, as appropriate. Whatever form the policy takes, the design-build community of building inspectors, engineers, planners, contractors, and architects is prepared to help inform the policy, develop community consensus around it, and support leading policymakers that are ready to champion the recommendations.

1.3: DOCUMENT ORGANIZATION

The strategy is organized into three chapters, with supplemental information in the appendices.

- Chapter 1 defines the purpose of this strategy, the intended audience and how the strategy is organized.
- Chapter 2 summarizes the context of the problem, how this strategy development project came about and how it ties into the Investment Strategy.
- Chapter 3 outlines five recommendations to reduce URM risk, including identifying potential hurdles during the planning phase. The appendices provide additional details on implementation.
- Appendices A through E outline the phases and processes for successfully applying the recommendations.
- Appendix F provides a list of the Utah stakeholders that could contribute to the successful application of a URM risk reduction program.
- Appendix G includes detailed information on the URM Stakeholder Engagement Strategy. Additionally, there are references to stakeholder engagement and community outreach throughout the Strategy.
- Appendix H provides a history of URM risk reduction across the Wasatch Front, starting with the 1967 Governor's Conference on Geological Hazards in Utah.

- Appendix I dives into case studies of various URM risk reduction efforts in the Western United States, most notably in Portland, Oregon; Seattle, Washington; and California. This section also includes important lessons learned from these cases to help Utah build on these experiences.
- Appendix J provides information on post-disaster URM risk reduction strategies and recommendations.
- Appendix K provides examples of city-level model ordinances for voluntary and mandatory retrofit ordinances. These examples highlight the characteristics of previous ordinances around the country.
- Appendix L includes Works Cited.
- Appendix M lists project participants.

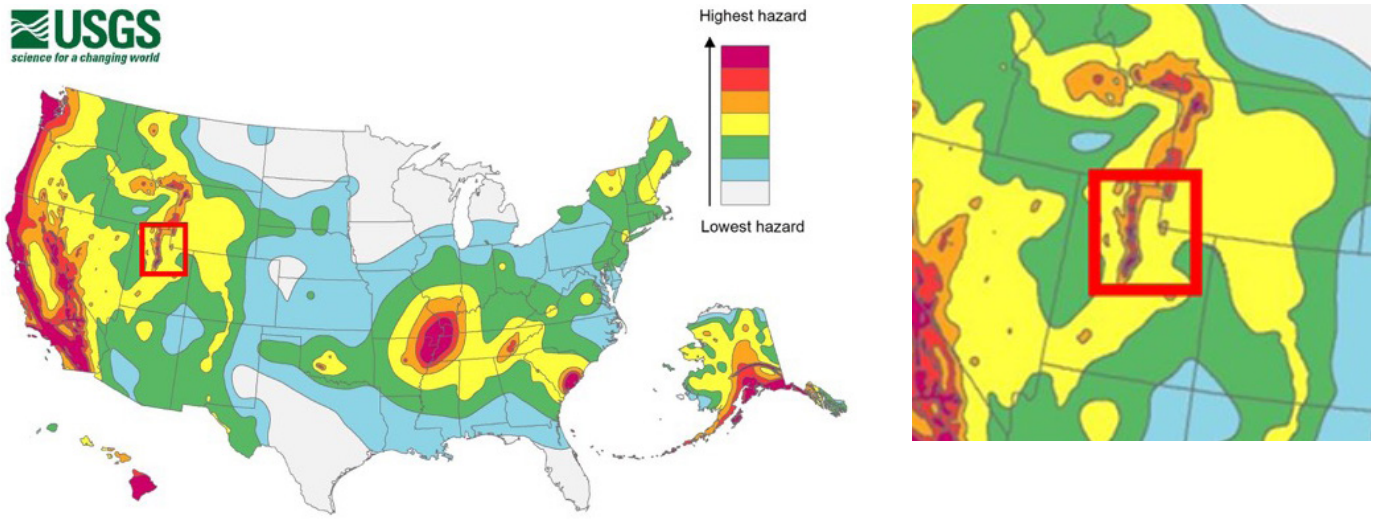
Note: *The "life safety" term used in this document indicates a reasonable level of safety for a building's occupants, as well as the public in its immediate vicinity, during a damaging earthquake. Mitigating to this extent does not guarantee that the structure itself will be usable after an earthquake. Put simply, "life safety" retrofits aim to protect people, not property. The informal "life safety" term used in this document should not be conflated with the formal "Life Safety" performance objective used to define levels of seismic analysis and design in various building codes and standards.*

Chapter 2: Context of the Problem

2.1: CONTEXT OF THE PROBLEM

The Wasatch fault poses one of the most catastrophic natural threat scenarios in the United States. The Wasatch Front has a 43% chance of a magnitude 6.75 or greater earthquake in the next 50 years, and experts project that such an event would be among the deadliest and costliest disasters in U.S. history. In a magnitude 7.0 earthquake on the Salt Lake City segment of the Wasatch fault, FEMA's loss model, Hazus, estimates 2,000-2,750 fatalities, 8,000-10,000 injuries potentially requiring hospitalization, and roughly 78,000 displaced households.[1] The 2018 Long-term National Seismic Hazard Map (Figure 3) from the USGS shows the location of the Wasatch fault and the high earthquake hazard in that area.[2]

Figure 3. USGS 2018 Long-term National Seismic Hazard Map



The devastating potential of the Wasatch fault is due, in part, to the high likelihood of a large earthquake near Utah's most densely populated urban areas. This danger is heightened by the number of people who live, learn, work, worship or shop in URM buildings and may be unaware of the potential danger. Additionally, those who live in URM buildings often include a disproportionate number of disadvantaged and marginalized populations. A typical URM building has brick walls with few or no steel reinforcing bars. During an earthquake, unretrofitted URM buildings often collapse, both inward and outward. These buildings crumble on top of people, vehicles, sidewalks or other structures in and around them. Their failure will cause most injuries and deaths in an anticipated Wasatch fault earthquake. Utah building codes no longer permit URM for new buildings; see Appendix A, Section A.2.4.1, for more information. However, it is estimated that more than 140,000 URM buildings

[1] EERI Utah, Scenario for a Magnitude 7.0 Earthquake on the Wasatch Fault–Salt Lake City Segment https://dem.utah.gov/wp-content/uploads/sites/18/2015/03/RS1058_EERI_SLC_EQ_Scenario.pdf

[2] USGS, 2018 Long-term National Seismic Hazard Map https://www.usgs.gov/media/images/2018-long-term-national-seismic-hazard-map

across the Wasatch Front were built before they were prohibited in the 1970s.[3] URM buildings were popular due to their economical, durable and naturally fire-resistive properties, as well as their definitive architectural character. The three main types of risk in an earthquake are:

- **Injury or Death:** Damage to URM buildings is dangerous because the masonry units tend to break into sections, or even individual bricks, and then collapse. When debris falls, it is potentially lethal. A single brick weighs 5 or more pounds, and just 1 square foot of a typical wall weighs 100 pounds or more.[4] URM buildings can endanger not only occupants but also pedestrians and those in adjacent buildings. Particularly vulnerable are parapets — short walls that often extend around the perimeter of a roof, chimneys and decorative architectural elements such as cornices.
- **Building Damage:** Past earthquakes have shown that expensive repairs are needed to rehabilitate damaged URM buildings. Not only are buildings of this type more likely to become damaged in an earthquake, but they require costly repairs, during which the building is unsafe to occupy. Often, a damaged URM building will be irreparable and need to be demolished. A falling parapet from an adjacent building may also collapse onto a perfectly performing adjacent building, causing it to suffer damage or collapse.
- **Loss of Function:** Due to the high likelihood of damage during even a moderate magnitude earthquake, URM buildings will be affected the most across the Wasatch Front. A damaged URM building is more likely than other buildings to be "red-tagged" as unsafe to enter. It may need to be upgraded to higher safety standards before it can reopen. These buildings may be unusable for months or years — if they are even found to be repairable. As a result, families, businesses and even the occupants of neighboring buildings can be displaced for extended periods, or even permanently.

The damage potential of URM buildings was highlighted by the magnitude 5.7 earthquake that struck in Magna (Salt Lake County) on March 18, 2020 (Major Presidential Disaster Declaration DR-4548). The State Historic Preservation Office reported that nearly 150 historic buildings were damaged, including notable buildings such as the Sears and Fisher mansions and the Rio Grande Depot. Damage ranged from "major structural cracks, to failed parapets and masonry walls, and damaged or collapsed chimneys."[5] Buildings along Magna's main street, near the earthquake's epicenter, also experienced extensive damage, including the partial collapse of a local deli. The total damage is estimated at roughly $100 million.[6] The potential magnitude 7.0 earthquake will be 20 times larger, with 89 times the energy released and a significantly longer time of actual shaking.[7]

As of May 15, 2020, when Utah requested a Major Disaster Declaration from the President, the Granite School District (GSD) had reported over $51 million in structural damages. This number is expected to increase as GSD begins recovery and fixes its damaged structures. The GSD, one of the largest school districts in the state, has buildings from the east side of the valley to the west and was the hardest hit by the Magna earthquake. The GSD reported 30 structures with damages of at least $3,000.

West Lake Junior High, Granite Park Junior High, and Cyprus High School sustained the most damage, and West Lake was deemed to be a complete loss. Due to COVID-19, schools were not occupied when the earthquake occurred, so no injuries

[3] USGS: A Study of Earthquake Losses in SLC, Utah Area https://pubs.usgs.gov/of/1976/0089/report.pdf

[4] ASCE/SEI 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures https://ascelibrary.org/doi/book/10.1061/9780784414248

[5] SL Tribune: They may be historic, charming and cherished, but brick buildings bore the brunt of Utah's earthquake https://www.sltrib.com/news/environment/2020/04/14/they-may-be-historic/

[6] Deseret News: Earthquake damage estimates hit $48.5 million, Salt Lake County officials say https://www.deseret.com/utah/2020/4/9/21213767/earthquake-damage-millions-salt-lake-county-5-7-magnitude

[7] United States Geological Survey, Earthquake Hazards Program https://earthquake.usgs.gov/education/calculator.php

were reported, and school closures due to the earthquake did not have a direct impact on students. In Davis County, South Davis Junior High sustained damage to an expansion joint and flooring, and Clearfield High School had expansion joint damage. Schools in the Jordan, Weber and Tooele school districts received minor and mostly cosmetic damages.

Across the Wasatch Front, the owners of several notable URM buildings have voluntarily conducted seismic retrofits to make them less dangerous in an earthquake. Iconic buildings such as the Salt Lake City and County Building, the Utah State Capitol, and the Salt Lake Tabernacle have been seismically upgraded. A massive retrofit project involving base isolation and seismic strengthening is currently underway at the Salt Lake Temple. Salt Lake City's Fix the Bricks program offers to fund improvements to homes in Salt Lake City, to increase the likelihood that occupants can escape the building after a damaging earthquake.[8] At the current rate of retrofitting, however, it will take hundreds of years to improve every URM building across the Wasatch Front. Any attempt to expand or replicate the program to meet mitigation demand and to accelerate progress in Salt Lake City and elsewhere in the state will require additional sources of funding and technical support.

Social equity and community engagement need to be addressed in any risk reduction program. Some of the proposed initiatives will potentially create contention between stakeholders, so local governments will need strategic allies from within the community. In particular, these should include nonprofits and other groups that represent vulnerable populations, such as low-income communities and communities of color. These populations are integral to a community and are also more likely to be affected by a major disaster. Appendices A-G provide communication support and a stakeholder engagement framework for the URM mitigation process to obtain, value, and integrate the perspectives of all stakeholders.

This strategy provides five broad recommendations that the state of Utah can use to significantly reduce the risks posed by URM buildings in an earthquake, with an aspiration to eliminate the risk entirely. The strategy is critical to the resilience of the Wasatch Front and the state of Utah. URM buildings threaten more than just the lives, safety and shelter of those nearby; they pose a threat to the economic future of the Wasatch Front. Significantly reducing the number of high-risk URM buildings will substantially improve the Wasatch Front's ability to survive and recover equitably in the likely event of a large earthquake.

2.2: NATIONAL MITIGATION INVESTMENT STRATEGY

Mitigation represents a sound financial investment. For earthquake mitigation measures, FEMA found that the public saves $3 in losses for every $1 spent through mitigation grants. The Benefit-Cost Ratio (BCR) is even higher — 4:1 — for investments that exceed select provisions of the 2015 model building codes.[9] Given the rising frequency of disaster events and the increasing cost of disaster recovery across the nation, mitigation actions are crucial for saving money, property, and, most importantly, lives. Activities designed to reduce disaster losses also may spur job growth and other forms of economic development.

FEMA and the state of Utah recognize the importance of mitigation in reducing the exposure to future losses from disasters. The interagency Investment Strategy — published in July 2019 — was developed to help the nation be more intentional about setting resilience and mitigation investment priorities to benefit the whole community. Due to Utah's URM risk and its dedication to creating a solution, the Wasatch Front URM Risk Reduction Strategy was selected as a pilot project through the Investment Strategy. This project brings local and national experts together to develop a mitigation strategy that highlights key concepts that drive risk reduction outcomes. By learning from Salt Lake City's successful previous investment in mitigation through Fix the Bricks, FEMA and Utah are collaborating to expand the investment in seismic mitigation, both across the Wasatch Front and nationally, in other seismically active cities.

[8] Salt Lake City Government, Fix the Bricks https://www.slc.gov/em/fix-the-bricks/

[9] National Institute of Building Sciences, 2019, Natural Hazard Mitigation Saves: 2019 Report https://www.nibs.org/page/mitigationsaves

Figure 4. Goals of the National Mitigation Investment Strategy

2.3: BUILDING RESILIENT INFRASTRUCTURE AND COMMUNITIES

Since the Disaster Recovery Reform Act of 2018 (DRRA) was signed into law, FEMA has been developing the Building Resilient Infrastructure and Communities (BRIC) program, which has lofty goals. "The BRIC program aims to categorically shift the federal focus away from reactive disaster spending and toward research-supported, proactive investment in community resilience. FEMA anticipates BRIC funding projects that demonstrate innovative approaches to partnerships, such as shared funding mechanisms or project design. For example, an innovative project may bring multiple funding sources or in-kind resources from a range of private and public sector stakeholders or offer multiple benefits to a community in addition to the benefit of risk reduction."[10]

The BRIC program allows FEMA to set aside 6% of the estimated disaster expenses for each major disaster to fund a mitigation grant program to assist states, local governments, tribes and territories. The new program supersedes the Pre-Disaster Mitigation (PDM) grant program and promotes a national culture of preparedness and proactive mitigation. BRIC does this by encouraging investments to protect communities and infrastructure and through strengthening national mitigation capabilities to foster resilience.

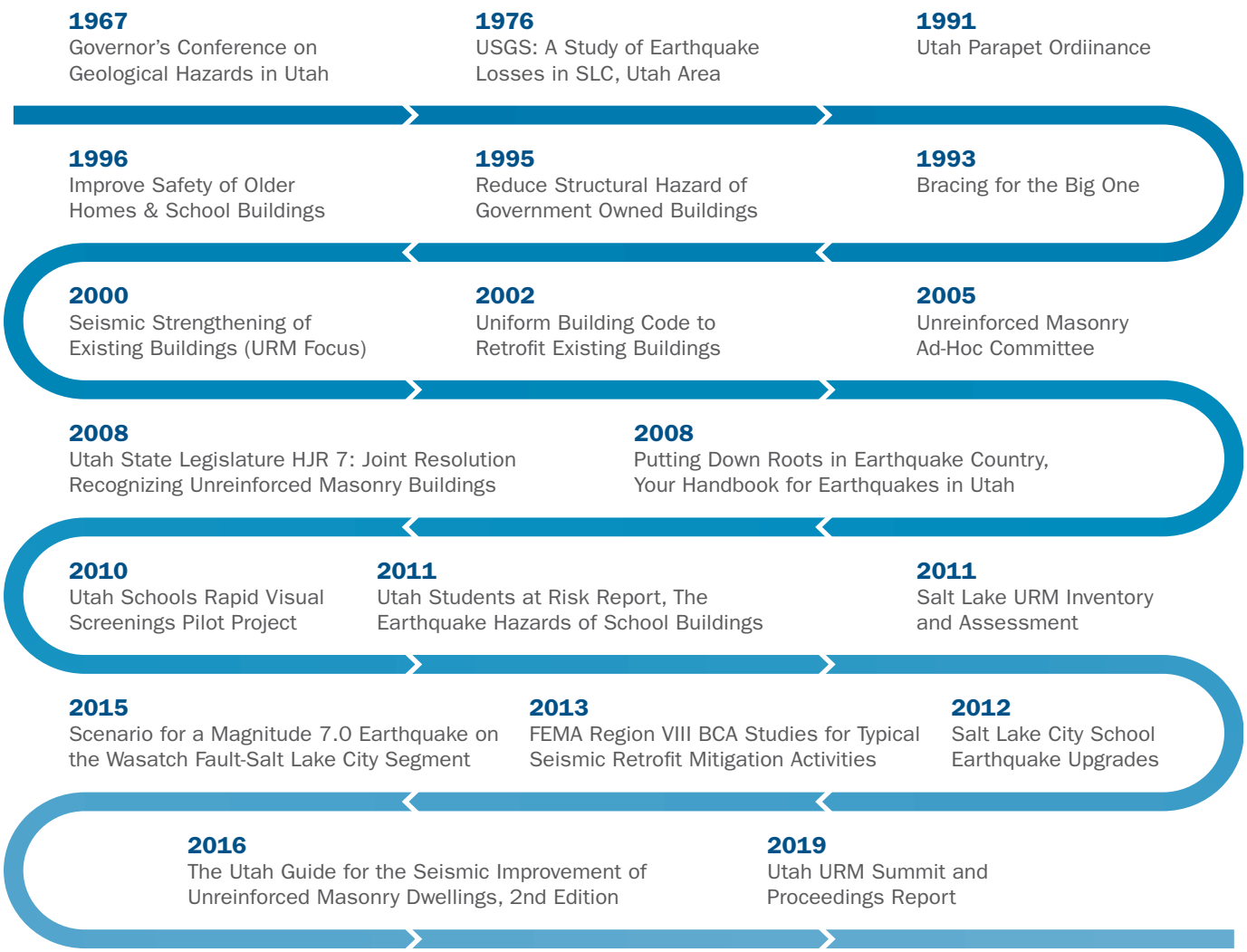
Note: *This section on BRIC can be substantially expanded in the future through a continued partnership between FEMA, Utah and Wasatch Front stakeholders. It is recommended that this partnership review the BRIC pre-disaster mitigation grant programs to identify ways in which this strategy's recommendations align with BRIC-eligible projects. For more information on the Fiscal Year 2020 Notice of Funding Opportunity for Hazard Mitigation Assistance Grants (including BRIC and the Flood Mitigation Assistance (FMA) grant program) see: https://www.fema.gov/grants/mitigation/fy2020-nofo*

[10] FEMA, 2020, Building Resilient Infrastructure and Communities (BRIC) https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities

2.4: TIMELINE OF PAST URM RISK REDUCTION INVESTMENTS AND RECOMMENDATIONS IN THE WASATCH FRONT

The following timeline summarizes key URM risk reduction investments and recommendations for the Wasatch Front. Please refer to Appendix H for more information on specific items in this timeline. The timeline documents the local and national commitment to URM risk reduction and displays the history of mitigation investments in the Wasatch Front. These have contributed to lessons learned and informed the development of this strategy.

Figure 5. Timeline of Past URM Risk Reduction Investment and Recommendations along the Wasatch Front



Chapter 3: Recommendations for Seismic Risk Reduction for URM Buildings in Utah

This chapter describes the proposed recommendations for retrofitting URM buildings in Utah. Each of the five recommendations includes the challenges to key stakeholders and is supplemented by appendices detailing stakeholder-specific communication support. Additionally, a thorough engagement process will ensure inclusive, whole-community support for carrying out these resilience-supporting recommendations. Please note that across these recommendations are many opportunities to connect objectives to hazard mitigation planning.

For each of the five recommended actions, social equity and community engagement remain critical to success. Those who live in URM buildings often include a disproportionate number of disadvantaged and potentially marginalized populations, such as low-income communities and communities of color. Partnering with strategic allies within the community, such as nonprofits, can help local governments ensure vulnerable populations are represented and avoid many potential hurdles. Utah's unique exposure to the risks from URM buildings in an earthquake stems from the large number of these buildings, as well as their potential for endangering lives and loss of use when damaged. The challenge is to significantly reduce this risk sooner, rather than later. To make progress, hard decisions will be necessary, including choosing whether to collectively require (mandate) retrofit work or create voluntary programs. Appendix D, sections D.3 Voluntary Retrofit Programs and D.4 Mandatory Retrofit Programs, discuss these options further.

A continued partnership between FEMA, the state of Utah and Wasatch Front stakeholders could substantially expand these recommendations. It is suggested that this partnership focus future efforts on:

1. Developing stakeholder-specific communications informed by social science and post-event social listening analyses of DR-4548 (03/18/2020 M 5.7 Magna, UT Earthquake).
2. Supporting whole-community engagement to:
    a. Encourage local ownership of URM retrofits.
    b. Facilitate locally based funding strategies and knowledge of BRIC eligibility.
    c. Facilitate equitable implementation of this document's recommendations.

Note: *Appendix J provides a framework for engaging and maintaining communication with all community stakeholders. An example of engagement from this strategy includes a partnership between the local government and a nonprofit to validate building inventories within the community. Nonprofit volunteers could perform some of the non-engineering tasks (such as household surveys). This could ease the financial burden of using paid government staff or contractors, while also increasing local awareness of the URM issue, trust in the identification process, and support for local funding of URM retrofits.*

RECOMMENDATION 1: URM SCHOOL RISK REDUCTION PROGRAM

Overview of Recommendation

Select Utah school districts have been retrofitting or replacing seismically deficient school buildings for over 20 years. This has resulted in districts developing funding mechanisms and programs to replace or seismically retrofit older URM schools; see Appendix H for detailed examples. While much has been done, a disparity exists between school districts with significant financial resources and those that are unable to overcome major obstacles in dealing with seismically deficient buildings, including a lack of viable funding mechanisms. Additionally, even the districts with financial resources continue to face challenges when applying seismic URM mitigation programs.

The state of Utah mandates that children attend schools; hence, the state should be considered a partner in ensuring that all schools are safe. To effectively organize, structure and facilitate a URM risk reduction program for schools, the following objectives should be achieved:

- **Validate and finalize the statewide inventory of URM school buildings** — Existing Division of Emergency Management (DEM) inventory to be verified and updated by a supervising structural engineer and confirmed by school districts.
- **Meet with individual districts to review inventory and discuss mitigation options** — DEM personnel or delegated surrogates meet one-on-one with the affected districts.
- **Assess building risks and prioritize retrofits or mitigation strategies** — All school districts need to address their inventory of URM buildings, develop funding strategies and prioritize mitigation strategies to reduce the risks posed by URM buildings.
- **Establish a target date for all URM schools to be repurposed, retrofitted or demolished** — Maximum 12-year timeframe ("URM Free by 2033").
- **Fund seismic mitigation** — Prioritize state and federal funding for school districts that are unable to develop local funding options. The new BRIC program encourages applications based on community lifelines and partnerships (schools are classified under the "Safety and Security" Lifeline). A strategically developed multi-year funding plan that leverages local and state mitigation planning processes and funding would make a strong BRIC application.

Note: *Appendices A and B provide guidance and process support for identifying, validating and prioritizing URM retrofits. Appendices F and G identify key stakeholders for this recommendation and provide basic stakeholder engagement and communication strategies.*

Table 2 identifies the parties responsible for the specific mitigation actions for Recommendation 1.

Table 2. Recommendation 1: Stakeholders Responsible for Implementation

Owners Responsible for Implementation	Recommended Mitigation Action
State of Utah Legislature and Governor's Office, State of Utah DEM or designated agency	• Validate and finalize the statewide inventory of URM school buildings. • Support the hazard mitigation planning process for schools to review URM inventory and discuss mitigation options. • Establish a target date for all URM schools to be repurposed, retrofitted or demolished. • Encourage the Legislature and Governor to commit to provide state funds toward a School Risk Reduction Program. • Identify funding for local, affordable and incremental seismic retrofits. • Facilitate development and planning of a statewide BRIC application for school seismic retrofits.
Affected school districts	• Assess risks and prioritize retrofits or mitigation strategies through the hazard mitigation planning process. • Raise the awareness of seismic vulnerability among school staff, parents and students through preparedness education and training. • Collaborate among districts and funding partners to pool funds and resources for seismic retrofits. • Coordinate with the state and local municipalities to develop a lifeline- and partnership-focused BRIC application to extend local funding for seismic retrofits.
Local municipalities	• Conduct a thorough hazard mitigation planning process, engaging local schools, school district administration, and community stakeholders (public and private) to review URM inventories and prioritize local seismic mitigation needs. • Identify local funding for affordable, accessible and incremental seismic retrofits. • Coordinate with the state, schools and school districts to develop a BRIC application to extend local funding for seismic retrofits. • Engage the public to solicit feedback on school earthquake mitigation and preparedness priorities and retrofit plans.

The designated "owners" of the actions listed above should be considered the primary stakeholder(s), although they may receive support from other organizations. For example, while the state of Utah is the designated owner of the effort to validate and finalize the statewide inventory of URM school buildings, it is anticipated that other organizations, such as the USSC and the Structural Engineers Association of Utah (SEAU), will be well-positioned to continue assisting in the completion of this effort.

Also, some school districts may not feel capable of internally assessing vulnerabilities and prioritizing retrofits or other mitigation measures. In such cases, these school districts may engage the Utah State Board of Education, nonprofits or outside consultants and use other resources to assist with assessments and planning.

The parents, students, teachers, administrators and other members of the public that benefit from school facilities are key stakeholders for deciding on mitigation priorities and retrofit plans. Early engagement of these stakeholders, including on issues that may be considered "technical" and potentially outside the stakeholders' purview, is essential for successfully implementing a URM school mitigation program.

Many stakeholders benefit from each mitigation action. In general, any group that uses school buildings will benefit from the seismic assessment and mitigation of the URM buildings. Selected school buildings may be designated as post-disaster shelters or have other critical functions following an earthquake. In that case, these buildings should be prioritized, and stakeholders may choose to replace the existing URM building, or to evaluate and upgrade it to a performance level above life safety (the typical designated performance level for the majority of retrofitted URM buildings). In this way, stakeholders could increase the probability that the building will remain functional and available for use following the event. Table 3 documents the anticipated drivers and barriers that may contribute to stakeholders' support or opposition of the URM school mitigation efforts.

Table 3. Recommendation 1: Stakeholder Drivers and Barriers

Stakeholder(s)	Primary Drivers	Potential Barriers
Parent organizations in the district	• Increased safety for their children who attend the affected schools.	• Potential expenditures for the design and construction of seismic retrofits while underfunded for normal operations. • Potential for temporary or permanent relocation of school activities.
Teachers union	• Increased safety for the teachers who work in the affected school buildings.	• Construction during retrofits may cause disruptions. • Other funding priorities.
Residents of the school district	• Increased safety for the children in their communities. • Availability of emergency shelter facilities.	• Lack of incentive to fund schools if immediate and personal benefits are not realized.

Stakeholder(s)	Primary Drivers	Potential Barriers
Historic preservationists	• Preservation of historic spaces; reduced risk to historic structures.	• Physical alteration affecting the historical character of buildings.
Affected school districts	• Increased safety of school staff and students. • Reduced trauma to students and teachers that experience an earthquake in school facilities. • Faster recovery and return to normal operations after an earthquake.	• Expenditures for the design and construction of seismic retrofits, potentially at the expense of other school district programs. • Differences between districts and schools in the urgency for retrofits and the lack of authority over school-owned (vs. district-owned) structures.
Local municipalities, residents	• Increased safety of community members. • Decreased earthquake response needs and costs. • Potential for improved emergency shelter operations. • Pride in local commitment to seismic resilience.	• Potential expenditures for the design and construction of seismic retrofits. • Unaware of risk or do not believe they are at risk.
Envision Utah, State of Utah, USSC, SEAU, Earthquake Engineering Research Institute, Utah Chapter (EERI) Utah Division of Risk Management	• Improved safety of URM buildings leads to the improved resilience of Utah's communities (fewer deaths, injuries and economic losses during a major earthquake).	• FEMA Benefit-Cost Analysis (BCA) requirements for seismic retrofit grants are complex and may require training to use effectively.

Overall, broad support of URM school mitigation is anticipated from stakeholders, including district students, parents, teachers and local technical organizations (SEAU, EERI, USSC), due to the benefits of the mitigation projects. The primary driver of mitigation supporters is the increased safety for the students, teachers and staff in school buildings, which serve a critical purpose for our communities and economy. Potential barriers that may limit stakeholder engagement and support include the expenditures required for seismic retrofit, as well as challenges associated with obtaining the positive BCR that is required to obtain FEMA grant funding. Some opponents may be very vocal in their opposition, which is expected to focus

on potential expenditures for the design and construction of seismic retrofits, especially since many school districts and programs are already coping with inadequate funding. The "owners" identified in Table 1 will need to focus on mobilizing those who support the mitigation efforts and ensure that these groups express that support of the URM school mitigation effort within the community. Table 4 identifies some of these potential implementation challenges and the corresponding mitigation actions for this recommendation.

Table 4. Recommendation 1: Implementation Challenges

Challenge	Mitigation
Availability of funding and design and construction information for school buildings	• Determine the type of information needed and disseminate it to stakeholders through suitable channels (such as websites and social media applications, face-to-face or virtual meetings, workshops or webinars, printed materials or downloadable PDFs, online tools, etc.) and leverage existing data sources and channels. • Collaborate with districts and funding partners to pool funds and resources for seismic retrofits. Provide appropriate training to help districts and funding partners network with each other and learn how to best leverage the shared resources. • Coordinate with the state of Utah and local municipalities to develop a lifeline- and partnership-focused BRIC application to extend local funding for seismic retrofits.
State funding and personnel capacity concerns	• Identify financial and human resource needs and potential funding mechanisms, from resources identified in this strategy and other potential sources (such as grant funding, realignment of state funding, public-private partnerships, and partnerships with academia, including cooperative or internship and assistantship programs). • Obtain a commitment from the legislature and governor to provide state funds toward implementing a School Risk Reduction Program. • Collaborate with districts and funding partners to pool funds and resources for seismic retrofits.

Challenge	Mitigation
Participation of the affected school districts, and other local stakeholders (including residents and teachers)	• Increase awareness of seismic vulnerability among school staff, parents and students. • Develop and implement a stakeholder engagement and outreach campaign to include school and city or county officials in affected school districts, local taxpayers, parent and teacher groups, and students. • Explore partnerships with schools to reach students through interactive, community-based educational programs (such as youth education initiatives).
District vs. school ownership and authority issues	• Encourage and facilitate collaboration among entities, where feasible, and establish clear guidelines and requirements with defined roles and responsibilities.
Affected school districts (with limited resources) and local municipalities may object to a firm deadline	• Collaborate among districts and funding partners to share resources, meet grant application and reporting deadlines and requirements, and provide training and information to help streamline the process and level of effort. • Ensure districts and municipalities understand the rationale for deadlines and the impact of not meeting them (such as losing out on critical funding). • Provide an appeals process where districts can request additional time based on a demonstrated hardship.

There are several logistical challenges anticipated. These challenges include validating and finalizing the statewide inventory of URM school buildings and identifying and prioritizing vulnerabilities to be addressed by the mitigation program. The greatest challenge anticipated is identifying and obtaining available funding for the planning, design and construction of the seismic mitigation measures.

While it is anticipated that state and local agencies, as well as local and regional professional groups (such as SEAU and USSC), will help resolve many of the logistical and technical challenges, disseminating advice and recommendations related to funding sources may be more difficult. It is recommended that the state have a designated person (or persons) that will act as the point of contact for districts to obtain detailed information and advice on potential mitigation funding sources. The funding of this position could potentially be included in a BRIC application for a statewide school retrofit program.

Because private schools are governed differently than public schools, Recommendation 1 should be applied as much as state officials and school owners deem possible for private schools. This will ensure that private school pupils are provided comparable safety to their public school counterparts.

Note: *Appendices A-G and the FEMA developed guidance Safer, Stronger, Smarter: A Guide to Improving School Natural Hazard Safety can guide and support the state, school districts, schools and local municipalities to overcome the identified challenges in implementing school seismic retrofits.*

RECOMMENDATION 2: RETROFIT PROGRAM FOCUSED ON GOVERNMENT-OWNED URM STRUCTURES

Overview of Recommendation

An earthquake will significantly impact URM buildings in the state. Earthquake hazards can cause severe adverse impacts and will more greatly affect marginalized populations. The estimated social and economic impacts, functional losses, and potential injuries and deaths support the need for proactive measures. At a minimum, government agencies within the state — including local and tribal entities — are responsible for the safety of the buildings they own. A survey found that of 193 state-owned buildings constructed before 1974, 111 need structural upgrades.[1] It is presumed that many of these are URM buildings. Executive Order 13717 — Establishing a Federal Earthquake Risk Management Standard (EO 13717) would also apply to, and require inspection and mitigation of, any URM buildings that are federally owned, leased and assisted.[2]

A retrofit program focused on government-owned URM structures would update, validate and expand the current state-owned building inventory to include other government-owned buildings in the state, specifically buildings owned by tribal and local (city or county) governments. Although the state would manage the overarching program, each relevant tribal or local entity would continue to be responsible for managing the inventory of buildings they own. Jurisdictions would have the flexibility of identifying specific structures to be elevated to higher structural performance levels (higher than life safety), to enable public or state and local government access to a building or particular set of buildings after an earthquake. Once the inventory of government-owned buildings is completed, the retrofit of URM structures should be prioritized; the highest risk buildings should be retrofitted first.[3] These would include "essential," yet structurally vulnerable, buildings in high and very high hazard areas (such as schools, utility facilities, fire stations, emergency centers, hazmat storage, etc.). However, if an inclusive stakeholder engagement process reveals a building with a lower collapse risk, but with a higher occupancy rate or more public value, that building may be awarded a higher priority for retrofit. As noted in Section A.2.2: Classification and Prioritization of Existing URM Buildings, decisions about which buildings to retrofit would take into account government functions that are critical for earthquake response or early recovery (such as fire stations, hospitals and building departments) or that present a special risk.

Note: *Appendices A-G identify key stakeholders and support the communication and messaging required to successfully implement this recommendation.*

Although funding may not be available to retrofit all government-owned URM structures at once, at a minimum, dedicated funding should be set aside for seismic upgrades of government-owned buildings in Utah. This funding could be used as local match funds in a BRIC application for the seismic retrofit of publicly owned infrastructure across the Wasatch Front. The Utah legislature has previously supported the approach of Recommendation 2 through *HJR 7 — House Joint Resolution Recognizing Unreinforced Masonry Buildings*, passed in 2008.[4] This legislation urged the USSC to inventory public URM buildings in Utah and recommend how to address the problem. Recommendation 2 will help execute this legislative directive.

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[1] USSC, 2000. Appendix A: *2000 – Seismic Strengthening of Existing Buildings (URM Focus)*

[2] United States, Executive Office of the President [Barack Obama]. Executive order 13717: Establishing a Federal Earthquake Risk Management Standard. 2 Feb. 2016. Federal Register, vol. 81, no. 24, 5 Feb. 2016, pp. 6405-10, www.gpo.gov/fdsys/pkg/FR-2016-02-05/pdf/2016-02475.pdf.

[3] Risk Category III or IV per ASCE 7 or IBC

[4] H.J.R. 7 Joint Resolution Recognizing Unreinforced Masonry Buildings, https://le.utah.gov/~2008/bills/static/HJR007.html

A retrofit program focused on government-owned URM structures should be comprehensive and include the following objectives:

- **Expand and update the inventory of government-owned URM buildings** — Inventory and assessment to be completed by the Utah Division of Facilities and Construction Management (DFCM), with input and collaboration from tribal and local government agencies. Other community and building stakeholders to validate all government-owned URM buildings, including those owned by local and tribal governments.
- **Assess building risks** — State Building Board and Risk Management to assist in evaluating risk and prioritization.
- **Prioritize building uses when making mitigation decisions** — The highest risk buildings should be retrofitted first, when aligned with stakeholder priorities for retrofit.
- **Implement and maintain an inclusive stakeholder engagement process** — This process requires dedicated staff time and resources. Appendices A-G can help identify key stakeholders and support the communication and messaging required to successfully implement this recommendation.
- **Enforce state building codes and standards** for all modifications to government-owned buildings.
- **Fund improvements** — The State Legislature and Governor should consider federal and state resources for funding; tribal and local governments should consider tribal and local resources, in addition to federal and state resources, for funding.
- **Set enhanced goals** for government-owned high occupancy and critical buildings. This means completely addressing issues and possibly defining a higher level of performance for a particular structure. Clarification is offered here as a means to spur further discussion and refinement as the strategy morphs into an implementation plan for the program.

This retrofit program would be a collaborative partnership between the state of Utah and participating tribal and local governments. The framework would be developed with input from stakeholders, including tribes, local governments and community stakeholders. Table 5 identifies the parties responsible for implementing specific mitigation actions for Recommendation 2.

Table 5. Recommendation 2: Stakeholders Responsible for Implementation

Owners Responsible for Implementation	Recommended Mitigation Action
DFCM	• Expand and update the inventory of government-owned URM buildings.
State Building Board and Division of Risk Management	• Assess building risks.
State of Utah (DFCM, Uniform Building Code Commission [UBCC])	• Enforce state building codes and standards. • Set enhanced goals for government-owned high occupancy and critical buildings.
State of Utah (Legislature and Governor's Office)	• Fund improvements.
Tribal and local governments	• Assess building risks. • Prioritize building uses when making mitigation decisions. • Fund improvements. • Provide continuity and preparedness education and training to raise awareness among building occupants of URM and their seismic vulnerability.

As discussed previously, many stakeholders benefit from the respective mitigation actions. Table 6 documents the anticipated drivers of, and barriers to, the actions proposed in this recommendation. It may be used to craft the implementation strategy and outreach approach for this recommendation.

Table 6. Recommendation 2: Stakeholder Drivers and Barriers

Stakeholder(s)	Primary Drivers	Potential Barriers
State and local government agencies, legislative or rule-making bodies (May include agency departments with planning, code enforcement, and building ownership or management roles)	• Community risk-reduction and availability of validated or expanded inventory would be seen as positive aspects of program participation. • Available financial and other resources • Local interest and commitment.	• Temporary or permanent displacement of residents or government employees and services. • Potential increased financial burden on local residents or agency budgets stemming from program participation. • Perceived or actual financial and policy impacts and adoption or implementation timelines. Considerations may include long- and short-term funding, maintenance, and staffing needs, as well as changes to capital improvement, hazard mitigation, and other community-based plans and budgets. Additional staffing, training and technology or equipment requirements should also be considered.
Historic preservationists	• Preservation of historic spaces; reduced risk to historic structures. • Opportunity to raise awareness of, and support for, historic preservation efforts.	• May be cautious and vigilant with regards to implementing changes that may appear to impact the character or integrity of historic structures negatively. • Concern about potential or actual financial, procedural or policy impacts of shifting responsibility to local agencies.

Stakeholder(s)	Primary Drivers	Potential Barriers
Low income or disadvantaged stakeholders	• Safer living spaces and community facilities; reduced risk of displacement or disruption to living arrangements or regular activities as a result of earthquake damage.	• Fear they will be temporarily or permanently displaced from their homes while mitigation actions are being completed. • Concern regarding potential disruption of government provided services. • Worry about financial impacts (e.g., increased rent).
Envision Utah, State of Utah USSC, SEAU, EERI Utah Division of Risk Management	• Improved safety of URM buildings will result in fewer deaths, injuries and economic losses during a major earthquake.	• Need to allocate staff and budget to execute risk reduction efforts.
Design-build professionals	• Enhanced market demand for safer products and retrofit or reconstruction projects more generally.	• Additional (more restrictive) or costly requirements.

Table 7 identifies some of the potential implementation challenges and solutions for this recommendation.

Table 7. Recommendation 2: Implementation Challenges

Challenge	Mitigation
Staffing and resource availability	• Hire or train additional code inspectors and other specialized personnel. Consider leveraging FEMA BRIC program for support.
Overarching outreach and training needed to implement recommendation	• Communicate details about the mitigation program (overview, short- and long-term goals, benefits, requirements) to stakeholders and seek their input. The overarching methodology for developing and implementing this outreach and training strategy should incorporate a data-driven approach that seeks to reach and engage all stakeholders, including vulnerable populations. Data sources may be quantitative and qualitative. • Where necessary, an inclusive partnership-building and maintenance effort (such as with building energy efficiency upgrades) should be undertaken to form or strengthen relationships, operationalize the program, and foster and maintain continued and incremental progress aligned with program goals. • Develop and distribute outreach toolkits that tribes and local agencies may customize and use to communicate information about the mitigation program to their stakeholders. • Partner with locally based nonprofits to effectively leverage resources, increase community engagement and foster local trust in the process.
Program planning, development and implementation timeline	• Completion of program structure, goals and schedule. • Define program tracking and progress reporting requirements and procedures, or fold into existing structures and established procedures. • Compliance with any state, local or tribal due process; legislative; and individual agency requirements. • Hiring, staffing and training of required personnel. • Outreach to agencies, government workforce and customers regarding program and benefits, and any associated impacts.

RECOMMENDATION 3: STATEWIDE URM RISK REDUCTION PROGRAM

Overview of Recommendation

Utah's large inventory of privately owned URM buildings ranges from one-story, single-family residences to multi-story structures housing hundreds of people. They occupy the streets of every city and county in the state, causing a high collective exposure. This recommendation addresses this exposure through the lens of shared responsibility, one in which state and local government agencies work together to prioritize and invest in resilience-based URM mitigation programs suited to the needs of all affected stakeholders.

URM buildings require attention because they represent significant financial investments and are a life safety liability during a moderate or large earthquake. Additionally, their loss of use will significantly impact how quickly the state and communities will recover. This recommendation aims to minimize these consequences through inclusively educating and engaging stakeholders, establishing effective retrofit methodologies, and providing significant incentives to reduce the URM risk in Utah.

A statewide URM risk reduction program should include the following objectives:

- **Coordinated state and local agency support.**
  - ***Provide dedicated funding to the USSC to maintain and oversee the state's URM risk reduction program.*** For over 25 years, the USSC has been the state's earthquake advisory commission, with a 15-member board representing state and non-governmental interests. As a voluntary commission, its effectiveness is hindered by limited available resources. Providing funding for the commission to administer a state URM risk reduction program would ensure that it receives broad input and reflects the founding goals of the commission. This type of partnership, paired with the intent to upgrade infrastructure, would make for a strong BRIC application.
  - ***Enhance the effectiveness of programs that advise state agencies, local jurisdictions and other governmental agencies on earthquake safety.*** There are a number of state and local programs that independently advise entities on earthquake safety. Some examples include:
    - Utah Geologic Surveys' Hazard Assistance Program.
    - State of Utah's Hazard Mitigation Plan.
    - Salt Lake City's Fix the Bricks program.

    These existing programs should be coordinated and incorporated into the statewide URM risk reduction effort, thereby enhancing their effectiveness.
  - ***Recommend that a State Resilience Officer or other high-level advisors help shape policy on matters related to risk reduction and recovery efforts.*** This new position should be an independent, top-level policy advisor charged with broad responsibilities to direct, implement and coordinate the state's resilience efforts. URM buildings have been identified as a significant contributor to the after-effects of a major earthquake and would need to be addressed in any resilience plan for Utah.
  - ***Seek and provide funding for local jurisdictions to inventory and assess their URM vulnerability.*** To effectively establish local engagement in a URM risk reduction program, funding is required for the stages outlined in Figure 2. By leveraging resources and increasing community engagement at the same time, community residents can be directly involved in the inventory process. For example, the inventory process could be a partnership effort between the government and a nonprofit, in which nonprofit volunteers are utilized in some of the non-engineering tasks (e.g., household surveys). This could help ease the financial burden by utilizing nonprofit volunteers instead

of paid government staff or contractors. Additionally, partnering with locally based nonprofits will help increase local trust in the process. *Appendix B provides guidance and recommendations to inclusively engage stakeholders during the URM validation process, while simultaneously building support for community retrofits.*

- **A statewide URM risk reduction program would include the following:**
  - ***A URM mitigation priority and funding strategy in the State Hazard Mitigation Plan.*** URM mitigation efforts should be a priority in Utah's State Hazard Mitigation Plan. Consideration should be given to amending and updating the current plan, given the lack of emphasis on URM risk in the existing plan and the need to prioritize state efforts to proactively reduce this risk. State and federal funds supporting the State Hazard Mitigation Plan's planning process, stakeholder engagement, and funding strategy should be aligned with the process and recommendations in this Strategy. Future editions of the State Hazard Mitigation Plan that fail to prioritize URM risk reduction should not be approved by FEMA until revised to reflect this notable risk.
  - ***A state requirement for URM mitigation included in Local Hazard Mitigation Plans.*** Local Hazard Mitigation Plans must be reviewed and approved by the state and FEMA. States have the authority to establish additional Hazard Mitigation Plan requirements in addition to FEMA's requirements established in 44 CFR 201.6. Utah should require Local Hazard Mitigation Plans across the Wasatch Front to prioritize URM retrofits and document their funding strategy for these efforts, along with their inclusive stakeholder engagement process and progress in completing retrofits. This requirement would make a commitment to URM retrofits, state mitigation grants, or other forms of funding.

    To avoid creating inequity in housing safety standards, it is critical that all stakeholders, including community residents, be highly engaged in the implementation of any risk reduction requirements being considered for residential buildings. Stakeholders must be engaged in identifying and developing local financial incentives, affordable retrofit options, and establishing supportive and efficient resources to guide homeowners throughout the retrofit process. *Appendices D and G may help with the expansion of IEBC compliance triggers for one- and two-family dwellings.*
  - ***Develop, update, or propose adoption of post-earthquake inspection, repair, and retrofit standards for damaged buildings.*** The 2020 Magna, Utah Earthquake (Major Presidential Disaster Declaration DR-4548) revealed several issues specifically related to URM buildings. The post-earthquake safety evaluation tagging of buildings and the establishment of protocols in response to addressing repairs highlighted the need for more preparations in this area. The unique attributes of URM construction in Utah warrant a review and update of the inspection and tagging protocols found in Field Manual: Postearthquake Safety Evaluation of Buildings (ATC-20-1). Additionally, complications from the COVID-19 pandemic introduced unique inspection challenges. Finally, the state is unprepared to uniformly apply repair standards for URM buildings following a damaging earthquake. The state would benefit from proactive considerations so that repair standards are not developed under emergency circumstances. See Appendix J for a list of existing documents.

The state, tribes, and local jurisdictions all have primary roles in implementing Recommendation 3. State agencies would be tasked to coordinate and prioritize URM risk reduction strategies. A statewide URM law could be legislatively established, requiring tribes and local jurisdictions to develop and implement mitigation programs with minimum life safety standards. The design of these mitigation programs must be developed with input from stakeholders in the building owner and rental communities, and with representatives of low income and disadvantaged populations. Failure to do so may result in perpetuating socioeconomic injustices and a decline in the quality, affordability, and accessibility of housing and commercial spaces.

Note: *Appendices A-G provide inclusive stakeholder engagement opportunities and messaging to support the successful implementation of this recommendation.*

Table 8 identifies the parties responsible for implementing specific mitigation actions for Recommendation 3.

Table 8. Recommendation 3: Stakeholders Responsible for Implementation

Owners Responsible for Implementation	Recommended Mitigation Action
State of Utah (Legislature and Governor's Office) State of Utah (DEM, DFCM, UBCC)	• Provide dedicated funding to the USSC to maintain and oversee the state URM risk reduction program. • Seek and provide funding for local jurisdictions to inventory and assess their URM vulnerability. • Require local jurisdictions to address URM risk reduction strategies.
State of Utah (Legislature and Governor's Office)	• Enhance the effectiveness of programs that advise state agencies, local jurisdictions, and other governmental agencies on earthquake safety. • Consider a State Resilience Officer or other high-level advisors to help shape policy on matters related to risk reduction and recovery efforts.
State Hazard Mitigation Officer	• Include a URM mitigation strategy in the State Hazard Mitigation Plan. • Create a requirement that local Hazard Mitigation Plans address URM mitigation; plan updates should document URM-specific community engagement and progress made in retrofitting.
State of Utah (DFCM, UBCC) USSC	• Develop, update, or propose adoption of post-earthquake inspection, repair, and retrofit standards for damaged buildings.

Table 9 documents the anticipated barriers and drivers that will contribute to the support or opposition of the actions proposed in this recommendation.

Table 9. Recommendation 3: Stakeholder Drivers and Barriers

Stakeholder(s)	Primary Drivers	Potential Barriers
Community resilience advocates: Neighborhood associations Business continuity groups Homeowner associations	• Increased community resilience. • Improved social equity.	• Inequitable burden on disadvantaged populations. • Lack of capacity to support implementation.
Historic preservationists	• Preservation of historic spaces and reduced risk to historic structures.	• Physical alteration affecting appearance and character of buildings.
Residential homeowners	• Desire for safe and affordable housing. • Desire to protect their investment.	• Inequitable burden on disadvantaged populations. • Lack of awareness regarding anticipated residential damages. • Lack of familiarity with retrofit process. • Inability or unwillingness to pay up-front cost for potential future benefit. • Concerns about impacts to resale value once property is labeled as high risk.
State agencies and local jurisdictions	• Required to ensure the safety of Utahns. • Interest in preserving tax base post-earthquake.	• Increased administrative responsibilities if not adequately funded.
Building code enforcement agencies	• Understand the danger of URM structures.	• Increased administrative responsibilities if not adequately funded.

Stakeholder(s)	Primary Drivers	Potential Barriers
Commercial/multifamily residential building owners	• Desire to help protect their investment and increase economic resilience post-event, if possible.	• Increased costs for retrofit work. • Displacement of tenants and disruption to business during construction. • Disincentive to conduct routine maintenance if retrofits are triggered.
Real estate agencies	• Ensure the safety of their clients. • Gain notoriety for protecting clients. • Build trust with the community.	• Stigmas from devaluation of properties and notification.
Apartment renters and low-income housing property owners	• Desire for access to safe and affordable housing. • Desire to protect their investment and belongings.	• Displacement during construction. • Lack of access to affordable housing.
Envision Utah, State of Utah USSC, SEAU, EERI	• Improved safety of URM buildings. • Increased resilience of Utah's communities (fewer deaths, injuries, and economic losses during a major earthquake).	• Implementing such a large-scale program is challenging and nuanced. • Concerns about staff availability to execute mitigation programs.

Table 10 identifies potential implementation challenges and solutions for this recommendation.

Table 10. Recommendation 3: Implementation Challenges

Challenge	Mitigation
• The Utah legislature has consistently been pro-business and has opposed unfunded mandates. Any statewide initiative or program will need to handle how these concerns will be addressed.	• Key considerations for the success of this proposal will be funding for its implementation and engagement of the public and lawmakers. Appendix D discusses potential funding sources.
• The business community generally lacks understanding of post-earthquake recovery implications, and corresponding economic damages, to adequately prepare their businesses and community.	• The recent Magna earthquake is a preview of how businesses can be affected and a lesson about the value of community-based solutions. • Provide continuity and preparedness training to businesses in high-risk areas and support simulated exercises to identify gaps and community-based solutions.

Note: *Appendix D lists a variety of potential funding sources to support the successful implementation of this recommendation.*

RECOMMENDATION 4: UTAH STATE CONSTRUCTION CODE ENHANCEMENTS

Overview of Recommendation

Despite standards for URM repair and retrofits identified in the International Existing Building Code, the degree of implementation and enforcement of these codes at the community level is unclear. Utah code amendments apply statewide, so any specific URM regulations should govern URM mitigation throughout Utah. Building code implementation can be increased by educating contractors and building owners on the intent, history, and application of these codes. Conveniently, the state of Utah proactively offers general code education for building officials and design professionals through a fund partially supported by building permit fees. Developing and hosting a URM code course through this program should be considered. Additionally, conducting a survey of building officials to better understand the community-level implementation of IEBC provisions, including impediments and education needs, may help to refine these offerings and inform the overarching outreach and engagement approach discussed in other sections of this document.

The repurposing of older URM buildings — from apartment or warehouse use to condominiums — substantially changes the nature of building use, and often involves a change in ownership. The change in building use and ownership under current codes does not trigger IEBC seismic upgrades. URM vulnerability, damage costs, life safety concerns, and economic impacts should be communicated to the building owner and contractor during the project planning and design phase; if seismic upgrades are not implemented, disclosure for building occupants should be considered. To ensure equitable implementation of public safety, all stakeholders must be engaged in developing and implementing risk reduction requirements for residential buildings. Inclusive and meaningful stakeholder engagement will support public-private partnerships in local financial incentives, affordable retrofit options, and establishing supportive and efficient resources to avoid inequity in housing safety standards.

Compared with the current code, the following recommendations would more proactively address known vulnerabilities statewide:

- **Require seismic upgrades for URM buildings converted to condominiums** — Utah has an amendment to IEBC Section 1006.3 (15A-3-801) that requires upgrading when there is a change in occupancy and when the occupant count is increased by 100%, but this would not trigger upgrades when converting an apartment to a condominium.
- **Strengthen or amend IEBC requirements to include any re-roofing as a trigger for seismic improvements to roof-wall attachments** — Current IEBC requires such improvements when re-roofing more than 25% of the roof area.
- **Amend state building code to allow upgrading for seismic performance without triggering other code upgrade requirements.**
- **Expand IEBC compliance triggers for URM one- and two-family dwellings.**

Table 11 helps identify the parties responsible for implementing specific mitigation actions for Recommendation 4.

Table 11. Recommendation 4: Stakeholders Responsible for Implementation

Owners Responsible for Implementation	Recommended Mitigation Action
State of Utah (Legislature and Governor's Office) State of Utah (DFCM, UBCC)	• Require seismic upgrades for URM buildings converted to condominiums. • Strengthen or amend IEBC requirements to include any re-roofing as a trigger for seismic improvements to roof-wall attachments. • Amend state building code to allow upgrading for seismic performance without triggering other code upgrade requirements.

Table 12 documents the anticipated drivers of, and barriers to, the actions proposed in this recommendation. This information may be helpful when crafting the implementation strategy and outreach approach for the recommendation. The potential barriers identified provide a starting point for developing messaging to address stakeholder concerns related to the recommendation.

Table 12. Recommendation 4: Stakeholder Drivers and Barriers

Stakeholder(s)	Primary Drivers	Potential Barriers
Envision Utah, State of Utah USSC, SEAU, EERI	• Improved safety of URM buildings. • Increased resilience of Utah's communities (fewer deaths, injuries, and economic losses during a major earthquake).	• Frustration and distrust from developers due to increased costs and "red tape."
Apartment renters and low-income housing property owners	• Desire for access to safe and affordable housing. • Desire to protect their investment and belongings.	• Displacement during construction. • Opposition to changes that may reduce access to affordable housing.

Stakeholder(s)	Primary Drivers	Potential Barriers
Contractors and developers Building owners and associations	• Safety of building occupants. • Limited exposure to legal liabilities.	• Displacement of tenants or disruption to business during retrofit work. • Disincentive to conduct routine maintenance if retrofits are triggered. • Reduced profits due to increased construction costs, duration of construction, and "red tape."

Table 13 identifies potential implementation challenges and solutions for this recommendation.

Table 13. Recommendation 4: Implementation Challenges

Challenge	Mitigation
• Emphasis on state amendments to the adopted version of the IEBC may equate to Utah accepting a triggered program, as opposed to a mandatory or incentivized program. There are known issues with accepting a triggered program, as the IEBC already has a range of triggers for URM buildings that are avoidable—and occasionally discourage other work (e.g., roof maintenance or an adaptive reuse). • Degree of Utah's adherence to URM retrofit requirements in USCC and IEBC is unknown.	• Utah could mandate certain disclosures—if that is not an unfunded mandate—though this is typically ineffective at getting work done at scale. • Identification of funding and incentives* for stakeholders to encourage code compliance and promote a culture of resilience. • Conduct a survey of building officials to better understand community-level implementation of IEBC provisions, including impediments and education needs.
**Appendices C and D contain guidance for partnering with design-build stakeholders to build consensus on implementation. Appendix D further recommends a variety of incentive and funding opportunities to encourage support of the recommendation.*	

RECOMMENDATION 5: UTAH STATE CONSTRUCTION CODE — LOCAL AMENDMENTS AND POLICIES

Overview of Recommendation

The USCC provisions for existing buildings contain the most current URM retrofit requirements, which apply only when a building undergoes a major alteration, repair or change of use. The current provisions rarely trigger any improvements to residences. As previously discussed, the USCC provisions are based on the IEBC. Utah currently adopts and amends the 2018 IEBC; however, local jurisdictions can amend the USCC provisions based on their specific needs.

The following recommendations target areas of consideration for local-level policy or amendment:

- **Require seismic upgrades for URM buildings converted to condominiums** — When a building is converted to condominiums, the ownership model changes from a single entity to many owners. Furthermore, owners purchasing units in a newly converted building may be unaware aware that the building has not undergone a seismic upgrade. Since the investment to convert these buildings is often extensive and involves major remodeling efforts, an update of the building's lateral load-resisting system should be required. It is also generally more affordable to bundle retrofit projects with other remodeling efforts to minimize secondary costs (e.g., drywall repair).
- **Proactively assess vulnerabilities and prioritize retrofits with input from stakeholders** — Local jurisdictions can elevate their concerns about vulnerable buildings and actively engage their communities to address risk. This can be done through amendments or policies that establish an acceptable level of risk.
- **Evaluate tools for mitigation, including ordinances and planning and land-use requirements** — Individual communities can use planning and land-use regulations to integrate local requirements that address their vulnerable building stock.

Table 14 helps identify the parties responsible for implementing specific mitigation actions for Recommendation 5.

Table 14. Recommendation 5: Stakeholders Responsible for Implementation

Owners Responsible for Implementation	Recommended Action
State of Utah (DFCM, UBCC) Tribal and local governments Local jurisdictions, including building and planning departments	• Require seismic upgrades for URM buildings converted to condominiums.
Local jurisdictions, with help from local organizations such as SEAU and EERI	• Assess vulnerabilities and engage stakeholders to prioritize retrofits.
Local jurisdictions, with help from the Utah Geological Survey (UGS)	• Evaluate tools for mitigation, including ordinances and planning and land-use requirements.

Table 15 documents the anticipated drivers of, and barriers to, the actions proposed in this recommendation.

Table 15. Recommendation 5: Stakeholder Drivers and Barriers

Stakeholder(s)	Primary Drivers	Potential Barriers
Envision Utah, State of Utah USSC, SEAU, EERI	• Improved safety of URM buildings leads to the improved resilience of Utah's communities (fewer deaths, injuries and economic losses during a major earthquake). • Gain valuable insights on mitigation tools leveraged at the local level that could be enabled statewide.	• Anger and distrust from developers due to increased costs and "red tape."
Tribal and local governments Building code enforcement agencies	• Required to ensure the safety of Utahns.	• Likely responsible for implementation, leading to resource strain and training staff.
Building owner associations, Building owners, Developers	• Safety of building occupants. • Limited exposure to legal liabilities.	• Displacement of tenants or disruption to business during retrofit work. • Disincentive to conduct routine maintenance if retrofits are triggered. • Reduced profits due to increased construction costs, duration of construction and "red tape."

Table 16 identifies a potential implementation challenge and solution for this recommendation.

Table 16. Recommendation 5: Implementation Challenge

Challenge	Mitigation
• Amendments to the building code are unlikely to gain momentum without buy-in from the developer and realtor community.	• Execute a broad stakeholder engagement process to explore potential building code changes and financing options.*
**Appendices C and D contain guidance for partnering with design-build stakeholders to build consensus on implementation. Appendix D further recommends a variety of incentives and funding opportunities to encourage support of the recommendation.*	

Appendix A: Define and Properly Identify URM Buildings

A.1: Defining the Issue: What Qualifies as URM?

To reduce the risks associated with URM buildings, a jurisdiction must first establish what constitutes a URM building. As discussed in Section 2.1, the Wasatch Front has URM buildings constructed of brick walls — with little or no steel reinforcement bars — that were built before modern building codes were developed in the 1970s. These structures pose a danger of rapid and complete collapse, giving their occupants little or no time to escape. Reinforcement is needed to help maintain wall integrity and control the movement of the building during an earthquake, allowing it to displace without collapsing. Other vulnerable structures include unreinforced or under-reinforced concrete block and adobe structures. In order for a URM risk reduction program to be successful, it is critical to identify the qualifying characteristics that determine the URM status of a building, regardless of the locally defined understanding of what constitutes a URM building. This may require detailed building inspections and validation by licensed design professionals.

While the technical determination of a URM building will be developed later in the program, the definition will be shaped by the goals of the risk reduction strategy. These criteria focus on the amount and types of URM buildings to be included, and the targeted level of improvements. Additionally, the criteria for a minimum acceptable level of retrofit will need to be formed to meet the safety level established by the risk reduction program.

A.2: Key Considerations for Identification of URM Buildings and Technical Criteria for Retrofits

A.2.1: Occupancy and Ownership Factors: The People Who Own and Use the Buildings

It is important to consider the usage or occupancy of a building when planning a risk reduction program. Occupancies are defined by building codes, in terms of the number of people who occupy a building, how long people occupy the building, and what functions will take place in the building. More intensive uses, which bring more people to a building, increase risk exposure to earthquake-caused injuries and can trigger higher building design standards. Similarly, current building code regulations require that essential facilities, such as fire stations, be designed to higher earthquake safety standards than ordinary buildings. This suggests that existing buildings with many occupants, or which serve as essential facilities, should have a higher priority for retrofits. See section A.2.2 below for more information.

Tenants are the people most at risk in a URM building but, typically, only owners get to make retrofit decisions; this should be taken into consideration when developing a policy intended to help tenants. Also, the BCR for tenants is different than the BCR for owners. Government-owned or public sector facilities (such as schools, recreational centers, emergency services, post offices, infrastructure support structures, and some housing) have different decision-making mechanisms and procurement rules than privately owned buildings.

If a retrofit project in an apartment building displaces residents for weeks or months, then temporary housing should be provided to those residents. Appendix J provides recommendations for engaging various building owners and occupants that

may also be recognized as vulnerable populations. Much of this information is derived from FEMA 275, *Planning for Seismic Rehabilitation: Societal Issues*, an excellent resource for information about the economic and societal impacts that may be experienced if seismic risks are not mitigated.[1]

A.2.2: Classification and Prioritization of Existing URM Buildings

This section aligns with *National Mitigation Investment Strategy Goal 1, Recommendation 1.3: Use Common Measures to Aid Decision-Making for Mitigation Investment*

Building classifications for the retrofit of URM buildings should be consistent across the spectrum of potential voluntary and mandatory retrofits. The criteria should utilize state-of-the-art engineering codes and standards and should be presented in a manner that is relatively easy to understand and implement. Currently, the American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI) Standard, *Seismic Evaluation and Retrofit of Existing Buildings* (ASCE/SEI 41), is considered the state-of-the-art standard for the seismic evaluation and retrofit of existing buildings.[2] Another ASCE/SEI standard, *Minimum Design Loads for Buildings and Other Structures* (ASCE/SEI 7), which is focused on the analysis and design of **new** buildings, has information that may be useful in the classification of existing URM buildings.[3]

The cities of Seattle, Washington, and Portland, Oregon, have initiated URM mitigation programs; each has taken a different approach to establish program technical criteria. Primary among the differences is how buildings are grouped for consideration by risk and the need for retrofit. Both programs are further described in Appendix I.

Seattle, Washington, URM Policy (2017)

Seattle groups its structures according to three levels of vulnerability to prioritize appropriate actions for combinations of use and occupancy. Table 17 summarizes the building types in each level.

Table 17. Seattle Building Vulnerability Classification

Vulnerability Level	Typical Buildings
Critical	Essential facilities (e.g., hospitals, police, fire, and educational facilities).
High	Buildings with more than three stories in areas of poor soil condition, or buildings that hold 100 or more occupants.
Medium	All other URM buildings with three or more units.

[1] FEMA 275, Planning for Seismic Rehabilitation: Societal Issues: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

[2] ASCE/SEI 41, Seismic Evaluation and Retrofit of Existing Buildings: https://ascelibrary.org/doi/book/10.1061/9780784414859

[3] ASCE/SEI 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures: https://ascelibrary.org/doi/book/10.1061/9780784414248

The Seattle Policy Committee created these three vulnerability categories to capture the city's life safety impacts. Additionally, they recognized that many URM buildings are possibly located on poor soil, which makes them even more vulnerable to earthquake damage. The Seattle Technical Advisory Committee, comprised of engineers, architects, and building owners, worked closely with the Structural Engineers Association of Washington (SEAW) to produce a recommended technical standard for a future URM retrofit policy. The proposed technical standard, referred to as the URM Retrofit Standard in the Seattle documents, is a modification of the Bolts Plus retrofit (described in more detail in Appendix I) for qualifying URM buildings. URM buildings that do not qualify for the modified Bolts Plus standard would be required to meet a more rigorous standard with an engineered design.

Advantages of the Seattle Vulnerability Classification System:

1. Vulnerability levels are clear and are easy to understand.
2. The goal of the proposed Seattle URM Retrofit Standard was to establish cost-effective retrofit requirements to reach a collapse prevention threshold. This simplification may be necessary to gain initial program buy-in.
3. The proposed standards offer alternative methods for compliance, including a building-specific engineered design.
4. Acknowledges that there is no Low level of vulnerability for URM buildings.

Disadvantages of the Seattle Vulnerability Classification System:

1. Vulnerability level assignments may not be easy to define for some facilities.
2. The technical standards of rehabilitation may need to be varied for some occupancies within a specific vulnerability level.
3. Acceptance of model programs, such as Bolts Plus, would require additional study and buy-in from the technical community.

Portland, Oregon, URM Policy (2017)

The Portland, Oregon, URM mitigation policy took a different approach and developed a classification system that, in many ways, mirrors the building risk classification system used in ASCE/SEI 7; however, Portland uses Building Classes instead of Risk Categories. Portland also changes the order of their Building Classes relative to the ASCE/SEI 7 Risk Categories. In the Portland classification system, the seismic evaluation and retrofit technical requirements for the URM buildings are tied directly to the particular building class.

The following are detailed descriptions of Portland's Classification System and Upgrade Level (Portland URM Policy 2017).[4] Additional information for technical audiences can be found in Table 18.

4. **CLASS 1: Critical Buildings and Essential Facilities** — This category is for critical structures, such as hospitals, police and fire stations, power generating stations, and water treatment plants.

5. **CLASS 2: Schools and High-Occupancy Structures** — This category addresses buildings listed as Risk Category III in the Oregon Structural Specialty Code and generally includes schools and other structures with many occupants, such as churches and theaters.

6. **CLASS 3: Average URM Buildings** — This category includes all buildings not classified as URM Class 1, 2, or 4 buildings — most are non-critical buildings with more than 10 occupants (such as restaurants). These buildings pose somewhat less risk because they have no critical uses or large assembly areas. However, they still pose a potentially significant life safety risk to people inside and to people outside near the building during an earthquake.

7. **CLASS 4: Low Occupancy URM Buildings** — This category includes one- and two-story URM buildings with a relatively low number of occupants (10 or under). Buildings in this category include single-story auto garages, etc. These are relatively low-risk, low-occupancy structures.

[4] Portland URM Policy 2017

Table 18. Portland Classification System and Upgrade Levels

Building Classification and Description	Upgrade Level
Class 1 Critical Buildings (Risk Category IV buildings, power stations serving critical facilities, water facilities, other public utilities)	• Evaluation and Retrofit Level: Tier 3 in accordance with ASCE/SEI 41. • Performance Objective: BPON for Risk Category IV. • Structural Performance Objective: Immediate Occupancy for BSE-1N[1] and Life Safety for BSE-2N[2]. • Non-Structural Performance Objective: Operational for BSE-1N for all non-structural components assigned a component importance factor, Ip=1.5 as defined in ASCE/SEI 7-16 Chapter 13, as well as URM parapets, cornices, partitions, chimneys and hollow clay tile partitions.
Class 2 All school buildings Risk Category III buildings	• Evaluation and Retrofit Level: Tier 3 in accordance with ASCE/SEI 41. • Performance Objective: BPOE for Risk Category III. • Structural Performance Objective: Damage Control for BSE-1E[3] and Limited Safety for BSE-2E[4]. • Non-Structural Performance Objective: Position Retention for BSE-1E for URM parapets, cornices, and chimneys, as well as unreinforced masonry or clay tile partitions along major routes of egress.
Class 3 All URM buildings with more than 10 occupants that are not critical facilities, schools, or Risk Category III or IV buildings (everything not in classes 1, 2, or 4).	• Evaluation and Retrofit Level: Tier 2 deficiency only in accordance with ASCE/SEI 41. • Performance Objective: Limited Performance Objective. • Only the following elements are required to be upgraded per ASCE/SEI 41 for Life Safety performance under the BSE-1E and Collapse Prevention under the BSE-2E: a) brace URM parapets, cornices, and chimneys; b) anchor URM walls to floors and roofs for out of plane loading; c) attach diaphragm to vertical elements to transfer in-plane shear; and d) new roof sheathing as required for diaphragm functions.
Class 4 One-story and two-story buildings with zero to 10 occupants.	• Performance Objective: Limited Performance Objective. • Only the following elements are required to be upgraded per ASCE/SEI 41 for Life Safety performance under the BSE-1E and Collapse Prevention under the BSE-2E: a) brace URM parapets, cornices, and chimneys and b) anchor URM walls to roofs for out-of-plane loading.

[1]**BSE-1N:** *Basic Safety Earthquake-1 for use with the Basic Performance Objective Equivalent to New Building Standards, taken as two-thirds of the BSE-2N[2] at a site.*
[2]**BSE-2N:** *Basic Safety Earthquake-2 for use with the Basic Performance Objective Equivalent to New Building Standards, taken as the ground shaking based on the Risk-Targeted Maximum Considered Earthquake (MCER) per ASCE 7 at a site.*
[3]**BSE-1E:** *Basic Safety Earthquake-1 for use with the Basic Performance Objective for Existing Buildings, taken as a seismic hazard with a 20% probability of exceedance in 50 years, but not greater than the BSE-1N[1], at a site.*
[4]**BSE-2E:** *Basic Safety Earthquake-2 for use with the Basic Performance Objective for Existing Buildings, taken as a seismic hazard with a 5% probability of exceedance in 50 years, but not greater than the BSE-2N[2], at a site.*

Advantages of the Portland, Oregon, Classification System:
1. It is currently being utilized elsewhere and there can be "lessons learned" from the experience of others. **2.** The above classification system directly references the state-of-the-art Standard for the Seismic Analysis and Retrofit of Existing Buildings, ASCE/SEI 41. **3.** Chapter 16 of ASCE/SEI 41 details system-specific performance procedures. As part of that chapter, Section 16.2 provides a special procedure for URM. **4.** The IEBC references ASCE/SEI 41 for the seismic analysis and retrofit (rehabilitation) of existing buildings.
Disadvantages of the Portland, Oregon, Classification System:
1. The Oregon Classification System does not directly correspond to the Risk Classification system used by ASCE/SEI 7-16 (e.g., the most critical structures in the table above are in Class 1, while in ASCE/SEI 7, they would be assigned to Risk Category IV). **2.** Assumes a familiarity with ASCE/SEI 41. While ASCE/SEI 41 is a state-of-the-art seismic retrofit standard, it is not understood by most of the architecture and engineering community. **3.** Relegates one- and two-story buildings with zero to 10 occupants to a Class 4 category, which is a Limited Performance objective.

Next Step: After deciding on the technical criteria, and whether the above Portland criteria or different criteria are utilized, there will be a need to provide education and support for their use. The current consensus is that the Portland technical criteria is the best model for the Wasatch Front URM program. It is important to note that if technical criteria are adopted similar to what was used in Portland, the specific Building Classifications and Performance Objectives (performance levels and ground motions) should be tailored to the Wasatch Front region.

A.2.3: Public Safety

While the safety of building owners and tenants is always an important consideration, the use and occupancy of most URM buildings have the potential to make URM risk a public safety issue. Given the large number of URM buildings in Utah, this is a significant issue throughout the state. Because Utah has fortunately had very few damaging earthquakes, URM building vulnerability has not been addressed as quickly as in some other states, such as California, Washington and Oregon. However, the recent magnitude 5.7 Magna earthquake has reminded Utah of the need to address and mitigate the risk posed by URM buildings. Due to this heightened awareness, more people now recognize Utah's high earthquake vulnerability and the extremely dangerous threat that URM buildings represent to life, property, and the economy. While not exhaustive, the below list provides examples of public safety factors to consider when contemplating earthquake mitigation.

Falling Debris

Regardless of building use, one important consideration is where URM debris is likely to fall during a damaging earthquake. While earthquake risk reduction is often framed as a private issue, there are clear impacts to public safety that must also be considered.

Public Right of Way

As described in Section 2.1, debris can often fall outward, potentially onto the public right of way (sidewalks, roads, etc.), endangering pedestrians and those inside nearby vehicles. Ninety percent of the URM-related deaths in the 2011 Christchurch, New Zealand, earthquake resulted from collapsed walls or parapets that killed people *outside* of buildings, as illustrated in the images below.[5]

Left: City bus crushed by URM debris falling from nearby buildings during the 2011 Christchurch earthquake. Twelve of the 13 people on board were killed. Photo credit: Simon Baker[6] Right: Sidewalks, vehicles and portions of the roadway were buried by debris in downtown Christchurch during the 2011 earthquake. Photo credit: The Press/Fairfax NZ[7]

A similar problem occurred during the Magna earthquake. The entire length of Magna's commercial downtown was closed for a period to allow for debris removal and safety improvements to buildings. If this earthquake had occurred during a busy afternoon, rather than at 7:09 a.m., many people would have been killed due to debris falling into the public right of way.

While local officials have the authority to close sidewalks and streets adjacent to damaged buildings, this authority is not proactively enforced prior to an earthquake (unless a mainshock has already occurred and progressive damage is anticipated during aftershocks).[8]

Private Property

Earthquake debris can also impact adjacent private property, such as buildings, land, and vehicles. This presents a potential threat to life safety and property. In fact, even the threat of collapse can impact adjacent properties. In the images below, a building damaged during the 2020 Puerto Rico earthquake is leaning precariously over an undamaged adjacent home in Guánica. In this case, both buildings would receive red placards from building inspectors due to the threat posed by the damaged building to occupants of either structure. Until the damaged building is repaired or demolished, the undamaged building is unusable. Given the high numbers of residential URM buildings in Utah, falling debris from chimneys can be a significant problem when it obstructs driveways and affects adjacent properties.

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[5] ATC-137-2, p. A-14
[6] https://architecturenow.co.nz/articles/luck-played-no-part-in-this/
[7] https://architecturenow.co.nz/articles/luck-played-no-part-in-this/
[8] IPMC Section 109.3, ICC, 2018

Private Business and Government Facilities

Visitors to businesses and government facilities can be unknowingly subjected to URM risk. By simply entering a URM building, or being close to one, visitors are inadvertently put in harm's way. Without proper notification of the risk, few visitors possess the technical expertise needed to make an informed decision about entering a URM building. The same reasoning applies to employees who work in URM buildings, but the risk is amplified due to the time spent within these buildings.

Red placarded 'unsafe' home leaning precariously over an undamaged adjacent home after the 2020 Puerto Rico earthquake. Photo credit: FEMA

Private Property Rights

The issue of private property rights is an important consideration that needs to be addressed in any URM risk reduction program. Consideration of private property rights needs to be balanced against the need to mitigate the risk that privately-owned URM buildings pose to the public during and after an earthquake, and should be reflected in public policy and response. Due to the limited scope of this strategy, the issue of private property rights versus the rights of the public will not be discussed further in this document. However, it is a vital issue that will need to be addressed in any URM risk reduction program.

A.2.4: Building Codes and Standards

Current U.S. building codes allow construction of URM bearing wall buildings, but only in locations where the chance of strong earthquake shaking is very low. However, many existing URM buildings predate modern seismic code provisions and are not required to be assessed unless triggered by repair, alteration, change of occupancy, addition or relocation, in accordance with the IEBC. This makes URM buildings a hidden public danger — one worthy of a fuller disclosure. This was specifically discussed at the 2006 San Francisco Earthquake Conference:

> **New earthquake-resistant construction adds about only two percent to the building stock each year. Yet most building safety regulations focus primarily on new construction. Codes allow owners of existing buildings to continue to use them, provided they are no less safe than when originally constructed. The latest codes even allow five to ten percent reductions in earthquake resistance when owners alter existing buildings. Many minor alterations and deterioration accumulate over decades of a building's life, compounding the reductions in earthquake resistance since there are typically no clear limits to their effect. This long-standing, lax policy provides no assurance to occupants of collapse-risk buildings and passersby that they live in places that are reasonably earthquake safe from major threats to life. Despite the wealth of information available to the public, victims of earthquakes and their relatives still express surprise and outrage when vulnerable buildings do indeed collapse. They expect more from their governments, to ensure that existing, occupied buildings are safe from life-threatening damage.[9]**

The URM problem persists, even in jurisdictions that are now effectively enforcing the current building codes (the latest editions of the *International Building Code* [IBC][10] and *International Residential Code* [IRC] [11]) because URM buildings were constructed before model code seismic provisions were adopted and enforced. A jurisdiction's building department may be able to provide the "benchmark date," which can help policymakers identify the point in time when the local enforcement of building codes began to prohibit the construction of URM buildings.

The state of Utah has also adopted the IEBC, which means the IEBC governs any kind of alteration (to the structure or its use) of existing buildings throughout the state. The IEBC has upgrade triggers that are described in Section C.7: Building Code Triggers. For a list, short descriptions of guidance publications, and building codes or standards that are currently applicable for seismic retrofit projects in Utah, please refer to Section A.2.4.2: Applicable Seismic Retrofit Codes and Standards and Guidance Resources.

A.2.4.1: Benchmark Dates for Seismic Resistant Masonry Construction in Utah

Engineers and code officials refer to benchmark dates as definitive turning points in the history of building code development and engineering practice. These benchmark dates, sometimes triggered by lessons learned from damaging earthquakes or advancements in science or engineering research, represent moments in history when important new natural hazard information and improvements in engineering analysis and design methodologies are acknowledged. These updates are then incorporated into revised code requirements for future building design and construction.

[9] Turner 2006, SF Earthquake Proceedings Paper #351
[10] ICC, International Building Code: https://codes.iccsafe.org/content/IBC2018P4
[11] ICC, International Residential Code: https://codes.iccsafe.org/content/IRC2018P3

Based on the 1976 *Study of Earthquake Losses in the Salt Lake City, Utah Area* conducted by the USGS (summarized in Appendix H), one benchmark date that may apply is 1961, or as the study defines it, "the dividing line between earthquake-resistive brick structures and non-resistive brick structures" in the four-county study area of Davis, Salt Lake, Utah, and Weber counties.[12] Another benchmark date that may apply is one used in *The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings* (summarized in Appendix C, Section C.4), which lists an approximate year as late as 1966 for homes that may have URM exterior bearing walls.[13] Subsequent benchmark dates for additional seismic provision enhancements, like masonry parapet reinforcing (1975)[14] or masonry chimney reinforcing (1975),[15] or the first statewide building code (1977),[16] should also be considered as benchmark dates in Utah, depending on the building's characteristics or location.

A.2.4.2: Applicable Seismic Retrofit Codes and Standards and Guidance Resources

This section aligns with *National Mitigation Investment Strategy Goal 3, Recommendation 3.1: Encourage Communities to Adopt and Enforce Up-to-Date Building Codes*

Retrofitting or seismically upgrading a building to improve its earthquake resistance is not the only way to reduce risk. A building that is demolished poses no further risk. This section focuses on using building codes and standards, along with other published guidance, to reduce risk through structural seismic retrofits.

A variety of retrofit measures can be used as part of a URM risk reduction program, which are described in detail in the applicable building codes and standards or FEMA mitigation guidance documents. One or more of these measures may be appropriate in a given case, depending on a specific project's requirements; however, it is important to note that building code regulations for new buildings are not expected to be used to guide the seismic retrofit of existing buildings. In fact, the seismic retrofit of existing buildings requires specific design criteria, separate from building code regulations for new buildings.

As of January 2021, there are several guidance publications and building codes or standards currently applicable for seismic retrofit projects in Utah, including:

- 2018 IEBC[17] — Provides requirements for repairs, alterations, additions, or change of occupancy for any existing building type or occupancy, including one- and two-family dwellings. ASCE/SEI 41 is also a refenced standard for the IEBC.
- ASCE/SEI 41-17, *Seismic Evaluation and Retrofit of Existing Buildings*[18] — Addresses a specific set of existing building types (including URM) with basic principles and a philosophical approach that differs from those used for seismic design and detailing requirements of building codes for new structures. Forerunner publications to this standard include the following documents: ASCE 31, FEMA 178, FEMA 273, FEMA 274, FEMA 310, and FEMA 356.

[12] USGS, A Study of Earthquake Losses in the Salt Lake City, Utah Area: https://pubs.usgs.gov/of/1976/0089/report.pdf
[13] USSC, 2016: https://ussc.utah.gov/pages/view.php?ref=1281
[14] Utah, 1991 Parapet Ordinance
[15] Utah, 1991 Parapet Ordinance
[16] Utah, State Fire Prevention Board adopted the 1976 editions of the Uniform Building Code
[17] ICC, 2018 International Existing Building Code: https://codes.iccsafe.org/content/IEBC2018
[18] ASCE/SEI 41-17, Seismic Evaluation and Retrofit of Existing Buildings: https://ascelibrary.org/doi/book/10.1061/9780784414859

- FEMA P-2006, *Example Application Guide for ASCE/SEI 41-13 Seismic Evaluation and Retrofit of Existing Buildings; with Additional Commentary for ASCE/SEI 41-17*[19] — Includes example applications of the ASCE/SEI 41 standard for URM bearing wall buildings, which can be found in Chapters 12 and 13.
- FEMA 547, *Techniques for the Seismic Rehabilitation of Existing Buildings*[20] — Provides several retrofit techniques for URM bearing walls that include a variety of considerations and sample details.
- *Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings*[21] — Guides owners of URM homes toward a better understanding of a subset of potential seismic improvements for their homes.
- FEMA P-1100, *Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings*[22] — Volume 1 provides descriptions of common masonry chimney vulnerabilities, as well as masonry chimney retrofit solutions. Volume 2C presents a prescriptive plan for this type of retrofit.
- FEMA P-530, *Earthquake Safety at Home*[23] — Pages 44-49 provide simplified descriptions of common seismic retrofit solutions for homes that have URM.

For additional information on building code triggers and repairing URM buildings that have been damaged by any event, including earthquakes, please refer to Appendix C, Section C.7 and Appendix H.

A.2.4.3: Building Code Adoption and Enforcement

This section aligns with *National Mitigation Investment Strategy Goal 3, Recommendation 3.1: Encourage Communities to Adopt and Enforce Up-to-Date Building Codes*

The state of Utah has historically maintained the Utah State Construction Code by amending and adopting the latest editions of the International Code Council's (ICC) family of model building codes within a year or two of publication, as shown in Table 19 below.

The process for making these changes is described as follows:

Changes in building codes are adopted by the Legislature after receiving a recommendation from the UBCC. The UBCC is obligated under the Uniform Building Standards Act to have a public hearing regarding the proposed changes to the building codes. This public notice and a scheduled public hearing are for the UBCC to receive public comment on the proposed building codes prior to it making its recommendation to the legislative Business and Labor Interim Committee.24

[19] FEMA P-2006, Example Application Guide for ASCE/SEI 41-13 Seismic Evaluation and Retrofit of Existing Buildings; with Additional Commentary for ASCE/SEI 41-17: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes
[20] FEMA 547, Techniques for the Seismic Rehabilitation of Existing Buildings: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes
[21] Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings: https://ussc.utah.gov/pages/help.php?section=Utah+Guide+for+URM+Dwellings
[22] FEMA P-1100, Vulnerability-Based Seismic Assessment and Retrofit of One- and Two-Family Dwellings: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes
[23] FEMA P-530, Earthquake Safety at Home: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes
[24] Utah, Uniform Building Codes: https://dopl.utah.gov/programs/ubc/index.html

Table 19. Utah Building Code Adoption History	
Prior years still being researched	
1997 UBC*	
2000 IBC**	
2003 IBC	
2006 IBC	2006 IRC***
2009 IBC	2009 IRC
2012 IBC	2012 IRC
2015 IBC	2015 IRC
2018 IBC	
**UBC: Uniform Building Code* ***IBC: International Building Code* ****IRC: International Residential Code*	

At the local level, building departments are responsible for plan review, permit issuance, and construction inspections. Ideally, each jurisdiction has adequate staff and training to accomplish this; however, some may not be familiar with the specialized design requirements of the IEBC or ASCE/SEI 41 codes and standards for retrofit work. Additionally, design professionals may not be familiar with theses retrofit measures and may need additional training.

An important element in the retrofit process is construction inspection. Because of the nature of retrofit work on existing buildings, field conditions may vary from the original design assumptions, which will require revisions to the permit documents. This process needs to be thoroughly documented and administered by the code authority.

Some consideration should be given to the following recommendations for URM retrofit work:

- Provide updated statewide education for building code officials and design professionals on the use of the IEBC and ASCE/SEI 41 for URM retrofits.
- Consider requiring a higher level of design review for URM retrofit projects that involve critical facilities, including schools. This may include third-party peer review and requiring structural engineering permit plan reviews.
- Consider requiring the engineer of record to submit field observation reports of the construction to ensure the design is built as intended and to confirm all existing conditions.

A.3: Develop Draft Inventory

Draft inventory data may be collected from a variety of public sources, including assessor data, insurance maps, and other available information to build a rough sketch of the region's vulnerability. The date of construction can be used as an initial filter to capture a quick count of potentially hazardous URM buildings in the region.

A.3.1: Building an Inventory of URM Structures

This section aligns with *National Mitigation Investment Strategy Goal 2, Recommendation 2.1: Make Risk Information More Available and Easier to Use*

An inventory should be the first stage in quantifying the extent of a jurisdiction's URM vulnerability. Typically, in a geospatial dataset, the inventory establishes a list of URM to be prioritized for retrofit. The jurisdiction must first clearly establish what qualifies as a URM in the program, as well as what level of retrofit, if any, removes the URM qualifier from the building to complete a defensible inventory. As stated in Chapter 2, this strategy addresses buildings with walls constructed of masonry — clay brick, hollow concrete block, hollow clay tile, stone, or adobe — but with little or no steel reinforcement bars. URM is one of several historically common construction types that are now recognized as extremely vulnerable in earthquake events. Additional high-vulnerability construction types include soft-story and nonductile concrete. URM has been determined to be the most seismically vulnerable type of building construction; it has been consistently documented as "severely damaged" in earthquakes for more than 130 years.[25]

Initial quantification of URM may be conducted through various methods, including more recently developed remote sensing and data quantification techniques. Often, a desktop analysis using building stock information, construction type, and year built is used to establish a rough count of URM buildings. If this building stock information is incomplete or not sufficiently detailed, a supplemental field survey will be necessary. This is typically conducted by engineers observing the exterior of the structure using the methods identified in FEMA P-154: *Rapid Visual Screening of Buildings for Potential Seismic Hazards*.[26] Once this baseline URM inventory is established, it is important to seek public input from stakeholders to validate the inventory. A lesson learned from a 2019 U.S. District Court ruling against Portland, discussed in more detail in Appendix I, was that URM classification cannot be confirmed, and may not hold legal weight, without entering a building.[27]

A.3.2: Define the Problem

To develop a program to mitigate the risks of URM buildings, an inventory or count of their numbers, and their occupancy classification, it is necessary to assess the extent of the problem. An initial preliminary survey can quickly inform local and state government officials of the magnitude of the issue and set the stage for developing a more detailed review. This second stage of detailed analysis may also include the number and type of occupants and other useful data to help inform the process of outlining the program scope.

A.4: Funding a URM Building Inventory

This section aligns with *National Mitigation Investment Strategy Goal 1, Recommendation 1.2: Increase Mitigation Investment by Building the Capacity of Communities to Address Their Risks*

[25] FEMA P-774, Unreinforced Masonry Buildings and Earthquakes, Developing Successful Risk Reduction Programs: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

[26] FEMA P-154, Rapid Visual Screening of Buildings for Potential Seismic Hazards: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

[27] Masonry Building Owners of Oregon v. City of Portland, Opinion and Order, 5/30/2019, Document 86, Case 3:18-cv-02194-AC, United States District Court, District of Oregon, Portland Division

- **FEMA Planning Grants** — Under FEMA's BRIC grant program, building inventories are an allowable activity if they are supporting the development or update of a hazard mitigation plan. These grants are offered annually and, according to 2018 guidance, are capped at $400,000 for a new mitigation plan and $300,000 for an updated plan.
- **FEMA Hazard Mitigation Grant Program[28] (HMGP)** — Only available after a Presidential Major Disaster Declaration, these grants allow for planning-related activities that include the efforts below and result in the update or development of a FEMA-approved hazard mitigation plan.[29]
  - **Risk and Vulnerability Assessments** — Allowable activities may include defining the location, extent, and probability of hazard, as well as impact to assets. Developing an inventory of URM buildings and other seismically vulnerable structures would be an allowable activity with HMGP funds.
  - **Mitigation Strategy Identification and Linking of Funding Sources** — Allowable activities under HMGP include developing a financing strategy for the implementation of mitigation measures. This could involve consulting with public finance experts on funding strategies for completing retrofits.
  - **Alignment of Plans** — Allowable activities include:
    - Evaluating adoption or implementation of codes and ordinances that reduce risk and increase resilience.
    - Integrating information from mitigation plans with response plans, recovery plans, land-use and master plans, capital improvement or economic development plans, and other long-term community planning initiatives.
- **FEMA National Earthquake Hazards Reduction Program (NEHRP) State Assistance Grant Program** — All High and Very High seismic risk states, including Utah, are offered NEHRP earthquake mitigation grants through FEMA. Grants can be used for a variety of earthquake mitigation activities, including the development of URM inventories.
- **State Supplemental Capital Budget - Building Construction Account** — States can budget funding to initiate URM inventory studies. For example, in 2018, at the direction of the Washington State Legislature, $200,000 of the state's Capital Budget was allocated to inventory URM structures. The project was undertaken through a partnership with the Department of Commerce and the Department of Archeology and Historic Preservation.[30] Another example in Utah is a line item in the Governor's budget, which allocated $150,000 to help complete a statewide Rapid Visual Screening (RVS) inventory of school buildings (see the *Utah Students at Risk Report* in Appendix H).
- **Local Assessor's Office:** Generally, the local assessor's office administers property assessments and mapping in an accurate, fair, and equitable manner. If adequately planned, the budget of the assessor's office could be used to support development and maintenance of a URM inventory. This can be done in coordination with the building official's office by updating the inventory each time a URM is identified through site inspections.
- **Stakeholder Partnerships:** University engineering programs often have partnerships with practicing engineers, as do construction programs with homebuilders. These partnership programs can align to support a more accurate identification of URM and training programs for conducting retrofits.
- **Crowdsourcing:** While not a traditional funding mechanism, incentivizing retrofits could encourage URM owners to formally recognize their buildings as URM to gain access to retrofit program benefits.

[28] Hazard Mitigation Assistance Guidance: https://www.fema.gov/grants/mitigation/hazard-mitigation-assistance-guidance
[29] FEMA Planning Related Activities Using Hazard Mitigation 7 Percent Funding Fact Sheet: https://www.fema.gov/sites/default/files/2020-06/fema-planning-related-activities_5-2-18.pdf
[30] Washington State Department of Commerce, Unreinforced Masonry Building Inventory: https://www.commerce.wa.gov/about-us/research-services/unreinforced-masonry-building-inventory/

Appendix B: Validate and Prioritize URM Buildings

B.1: Stakeholder Engagement for URM Inventory

This section aligns with *National Mitigation Investment Strategy Goal 2, Recommendation 2.1: Make Risk Information More Available and Easier to Use*

B.1.1: Public Acknowledgement of the Hazard and Risk

Before a hazard can be mitigated with support from the public, there must first be public acknowledgment of the hazard. The public does not need to know why a hazard happens, but they do need to understand that it can.[1]

Scientists and engineers have noted, "research shows that the scientific community may unintentionally create uncertainty by different experts communicating intricacies inherent to the issue. In the world of seismic retrofits, these intricacies may include scenario-specific hypotheses (location of rupture, duration of shaking, estimated magnitude, probability of recurrence, etc.) or engineering guidance (design level, fragility curves, conservative estimates, communication of code vs. performance, etc.). These conversations, while important to the scientific understanding of seismic hazards, can impede clear communication to the risk acknowledgment stakeholders, resulting in a loss of credibility and trust of the earthquake experts. For the risk confirmation message of the Experts to be received, the Experts must be viewed as trustworthy, credible, and free of personal and financial gain by the successful implementation of the risk-confirmation message. It is for this reason that there must be an alignment of the goals of the Earthquake Expert Stakeholders around a central risk-confirmation message to be received by the Risk Acknowledgment Stakeholders."[2]

An example message that may resonate with stakeholders from all backgrounds could be similar to the following text, workshopped by the authors:

> **"Nearly 80 percent of Utah's population lives near the active Wasatch fault and near many other active faults that can generate damaging earthquakes. Many buildings in this region are unsafe because they were constructed before the adoption of modern earthquake-resistant designs. These buildings can be made safer through earthquake retrofits, and there is financial assistance available to help you do this."**

[1] Sanquini, Sundar, and Wood (2016).

[2] National Academies of Sciences Engineering and Medicine. (2017). Communicating Science Effectively: A Research Agenda. Washington, D.C.: The National Academies Press. Doi:10.17226/23674.

B.1.2: Shape the Solution and Establish Partnerships

The public can and should be a primary driver in shaping the solution to reduce URM structures. Public contributions to the process will instill public ownership over the solution. To make the public input process valuable, stakeholders must believe that the experts know *how* to retrofit seismically deficient buildings. The jurisdiction needs input and support to make the retrofitting process accessible, affordable, and fully comprehensible to all parties involved.

To establish and build support for earthquake mitigation in Utah, local communities must not only be informed of their vulnerability, but they must also be motivated as individuals, and as stakeholders of a larger community, to positively increase their seismic resilience. Appendix B, Section B.1.3 below provides more details about the recommended stakeholders to engage in this process.

B.1.3: Recommended Stakeholders for Establishing Partnerships

The list of stakeholders for URM engagement is diverse, ranging from homeowners and tenant associations to structural engineers and elected officials. Publications like FEMA 275, *Planning for Seismic Rehabilitation: Societal Issues*,[3] and *Hazard Mitigation: Integrating Best Practices into Planning*,[4] provide considerations for identifying and engaging stakeholders during the planning process. Case studies in Appendix I repeatedly document the need for public support in order to implement a URM retrofit program. Appendix F provides a list of stakeholders identified during the 2019 Utah Unreinforced Masonry Buildings Summit and the 2020 Wasatch Front URM Risk Reduction Strategy Development Meeting, as well as those identified in FEMA 275, *Planning for Seismic Rehabilitation: Societal Issues*. These stakeholders will contribute to the success of URM risk reduction programs in Utah.

Each stage of the URM Risk Reduction Strategy should identify individuals and groups who should be involved during the early stages to support and shape the risk reduction process. It is recommended that jurisdictions intending to develop and implement a URM retrofit program consider the following actions:

- Develop an extensive public education campaign before publishing a draft URM inventory. This public education campaign should provide the context of the URM problem and invite the public and all other stakeholders to be part of the solution to significantly reduce the risk posed by URM.
- Conduct individual interviews with building owners identified in the draft URM inventory. These interviews will serve to develop a personal relationship between the URM owner and the local jurisdiction developing the URM retrofit program.
- Verification of a sampling of buildings from the draft inventory to instill confidence in the URM inventory and identify any shortfalls that need to be addressed prior to full implementation of the program.

Note: *See Appendix G for recommendations and resources supporting the information stated above.*

B.2: Initial Stakeholder Meetings: Stakeholder Engagement for Developing URM Inventory and Retrofit Program Goals

In addition to collecting the inventory, the goals of a URM retrofit program need to be outlined. This will entail identifying the many stakeholders who need to have a voice in shaping and establishing the policy. These include the regulatory decision makers, URM property owners, building code authorities, science and engineering experts, and community representatives, to name a few. This group will develop and refine the initial understanding of the problem and impact and have the authority to shape the URM program. During this stage of the URM Risk Reduction Strategy, public meetings should be held to obtain

[3] FEMA 275, Planning for Seismic Rehabilitation: Societal Issues: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

[4] American Planning Association, Hazard Mitigation: Integrating Best Practices into Planning: https://www.planning.org/publications/report/9026884/

public acknowledgment of the hazard and risk, develop a solution to prioritizing and retrofitting URM buildings, and develop URM retrofit goals. The support gained at these meetings, and the stakeholder interviews, will build trust with the public so that they become active participants in addressing the risk posed by the existing URM buildings.

Note: *See Appendix G for recommendations and resources supporting these initial stakeholder meetings.*

B.3: Funding Available for Public Outreach and Stakeholder Engagement

This section aligns with *National Mitigation Investment Strategy Goal 1, Recommendation 1.2: Increase Mitigation Investment by Building the Capacity of Communities to Address Their Risks*

- **FEMA Planning Grants:** Under FEMA's BRIC grant program, outreach and stakeholder engagement are allowable activities if they are supporting a hazard mitigation plan or a project that advances mitigation.
- **FEMA HMGP5** — Only available after a Presidential Major Disaster Declaration, these grants allow for planning-related activities that include the efforts below and result in the update, or development of, a FEMA-approved hazard mitigation plan.[6]
  - *Risk and Vulnerability Assessments* — Allowable activities may include stakeholder engagement and outreach supporting vulnerability assessments. This could include engaging stakeholders in the URM inventory validation process, as recommended in this strategy.
  - *Mitigation Strategy Prioritization and Funding Strategy* — Allowable activities under HMGP include prioritizing mitigation projects and developing a funding strategy for the implementation of mitigation projects. This could include stakeholder engagement and meetings focused on prioritization of URM buildings for retrofit and facilitating stakeholder engagement for implementation and funding of the retrofits or policy implementation.
- **FEMA NEHRP State Assistance Grant Program** — All High and Very High seismic risk states, including Utah, are offered NEHRP earthquake mitigation grants through FEMA. The grants can be used to conduct stakeholder engagement if it results in advancing mitigation efforts.

B.4: Define the Process for Public Involvement in Validation

To encourage building owners to allow access into their structures as part of the URM validation process, it is critical that the general public and building owners view the validation process as one in which the government is working with the community to solve a problem, rather than mandating a burdensome requirement.

The relationships with community stakeholders can be grown and strengthened by partnering with them to validate the identification of URM buildings and seismically vulnerable structures in their community. By assigning each stakeholder group a design professional to support their identification, the database will have community ownership. Because the remedy to URM vulnerability is simultaneously being advanced by community members and experts, the negative stigma of a structure being designated as a URM should be minimized. Additional considerations to streamline the inventory process include:

[5] Hazard Mitigation Assistance Guidance: https://www.fema.gov/grants/mitigation/hazard-mitigation-assistance-guidance
[6] FEMA Planning Related Activities Using Hazard Mitigation 7 Percent Funding Fact Sheet: https://www.fema.gov/grants/mitigation/hazard-mitigation-assistance-guidance

- Publicly available training and education programs made available to team members, and taught by Earthquake Experts, to identify URM buildings.
- Stakeholders collaboratively identifying a process for removing a building from the URM database if the structure has been found to have been inadvertently classified as a URM, or if the building has been previously retrofitted to the required performance level.

Note: *See Appendix G for recommendations and resources supporting public involvement and validation.*

Early engagement of the community in the development of the URM solution, with an intent to develop fiscally based incentives, should encourage building owners to participate in a comprehensive survey of their buildings for URM classification. Stakeholders to be engaged during this process include, but are not limited to:

- Home builders.
- Building Owners and Managers Association (BOMA) of Utah.
- Historic preservationists.
- Local structural engineering associations.
- Insurance stakeholders.
- Real estate stakeholders.
- Neighborhood organizations.
- Tenant advocacy nonprofits.

Note: *Additional stakeholders are listed in Appendix F.*

B.5: Follow-Up Stakeholder Meetings: Public Process for URM Validation

The public and all key stakeholders should be invited to participate in the URM validation process to engage the public in ownership of their vulnerability and to promote unity as a community working together toward a mitigation solution. By pairing design professionals with members of the public, stakeholder groups, and local community organizations, potential skeptics can take part in the development of the URM inventory while simultaneously learning how to identify URM buildings.

Prior to initiating a public URM validation survey, the jurisdiction should develop an incentive for participating in the validation process. It is critical to the success of the program that formally labelling a building a URM not negatively impact the building value. It is equally critical that local stakeholders establish a clear and accessible mitigation and documentation process to remove a remediated structure from the list.

While the inventory is being validated, stakeholders should coordinate on how to prioritize structures for retrofitting. The prioritization process may require extended discussion and negotiation, as opinions of the relative importance of selected buildings may not be consistent amongst all stakeholders. The jurisdiction should celebrate the success of validation — a milestone in the URM retrofit process — and make prioritization of URM buildings for retrofit a highly engaging process for the community and stakeholders. There is unlimited potential for community partnership and stakeholder engagement in the validation and prioritization of URM buildings.

Note: *See Appendix G for additional recommendations and resources to support and guide engagement opportunities during the URM validation and prioritization process.*

B.6: Retrofit Considerations

Once the inventory of URM buildings has been validated with adequate engagement from the public, design professionals should use their expertise to develop a list of options to mitigate seismic vulnerability.

B.6.1: Options to Reduce URM Risk

There are three broad approaches to addressing URM risk:

1. **Do Nothing, Attrition Over Time:** Local stakeholders may choose to passively let market forces work over time, which may result in sporadic URM retrofit or replacement as needs change over time. These stakeholders may also conclude that other priorities are more important locally, and will risk the potential for URM damage for the sake of funding other initiatives. If preferred, this option should be definitively chosen after careful deliberation, rather than simply be allowed to proceed as the status quo.

2. **Retrofit Existing Structures:** Set aside funding to hire licensed design professionals to plan, design, and execute the retrofit project(s) needed to bring the building up to the specified level of earthquake performance.

3. **Demolition of Existing Structures:** This may be the solution when the risk of any collapse is not acceptable or justifiable to stakeholders, or if the intended use of the building or land is at odds with the risk inherent to a URM or even a mitigated URM.

B.6.2: Inventory and Planning Factors

As a URM inventory is developed, it is important to be intentional about its construction to ensure it can be efficiently referenced during future analysis. An inventory of URM buildings can be presented in a table format to display the buildings' addresses (both street addresses and coordinates), square footage and a number of stories, construction dates, building configurations, and occupancies. The building location is significant for several reasons. What is the earthquake hazard at the site? Are buildings dispersed throughout an area, or are they clustered? How are they located with respect to current zoning districts and proximity to other structures or the public right of way? The community may have a long-range plan for streets, parking, plazas, and pedestrian areas. Any economic redevelopment plans should include a list of the locations of URM buildings. In addition, as discussed in Appendix A, Section A.2.3, the potential impact of a damaged URM building on nearby buildings, sidewalks, and roads should be included during the inventory development process.

Aside from an individual building's architectural or historical merits, it is important to consider the collective effect on a community of having several well-preserved, economically vital, older buildings that define the overall community character. There may also be environmental impact reporting requirements that a retrofit program would trigger; city planning departments should be familiar with any such requirements.

Appendix C: Develop and Refine Retrofit Options and Requirements

C.1: Pre-Determined Retrofit Requirements

To obtain the highest amount of public support for retrofitting seismically vulnerable structures, the validation of URM buildings should be a community-driven process. For this reason, it is recommended that the potential levels of retrofit or "fixes" to the URM problem be identified before engaging the public. The primary intent of defining the solution before the validation of the database is to frame the retrofit message as a community partnership to solve a problem. If experts approach the community with a remedy that requires community action to implement a solution, this will reduce community feelings of denial, fatalism, and victimhood.[1]

The messaging of the selected retrofit repairs is critical to the empowerment of individuals and stakeholders to take action. The following should be considered when developing these messages:

- These retrofits are intended to reduce injury and loss of life in a strong earthquake.
- Damage or collapse of the structure is possible, even after retrofitting.
- Retrofits will not bring a URM building up to the current code, and retrofitted URM buildings will not be as safe as current code-conforming buildings.
- Improvements to building downtime and loss of function.
- What options do owners have to further increase the seismic safety of their homes?[2]
    - The different levels of retrofit, above life safety, that can be implemented.
    - Address both structural and non-structural issues.

Once the preferred method(s) for retrofits has been identified, an extensive educational campaign on resources, training, and support should be developed and tailored to various stakeholders. This is discussed in more detail in Appendix D: Define Implementation and Build a Budget.

C.2: Develop and Refine Options

Once the inventory and initial program goals are developed, a series of alternative options need to be developed and evaluated. Three core variables in this process are the building performance level expectations, the program scope and approach, and the financial impacts and overall costs for implementation. These considerations may incorporate input from other public and private sector entities outside the URM program authority. Additionally, a program of public awareness and input should be integrated into the process.

[1] Baytiyeh & Mohamad, The effects of fatalism and denial on earthquake preparedness levels, Disaster Prevention and Management, Vol 25, No 2, 2016 (pp 154-167).
[2] FEMA P-530, Earthquake Safety at Home: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

C.3: Establish Retrofit Design Criteria

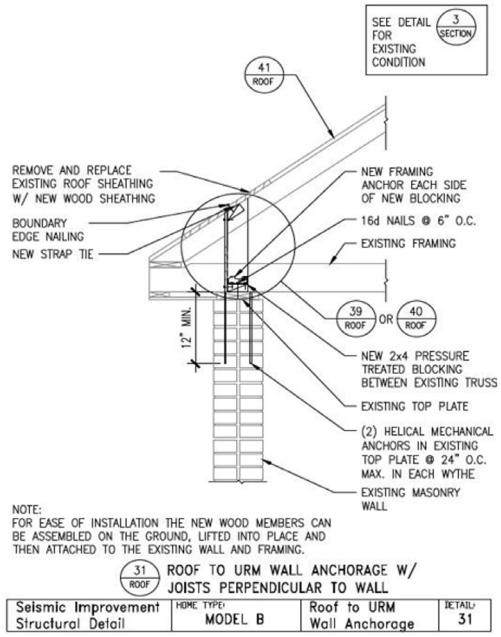
Building upon the seismic retrofit codes, standards, and guidance resources listed in Appendix A, Section A.2.4.1, local stakeholders can develop state-of-the-art, practical retrofit criteria to provide:

1. Minimum prescriptive retrofit standards for simple URM buildings (single-family dwellings).
2. Performance objectives (retrofit performance levels and ground motions) tailored to the values of the Wasatch Front region.
3. Enhanced retrofit objectives, built on the performance objectives identified in #2 above, for URM buildings of all types (multi-family residential, office buildings, public buildings, medical facilities, higher education institutions) that can provide cost-effective, improved seismic performance.[3]
4. Define successful retrofit measures in advance of project initiation, which is critical, as illustrated by the Portland case study described in Appendix I.

C.4: Overcoming Barriers (Besides Cost) and Setting URM Mitigation Programs Up for Success

When introducing a new retrofit program, it is important to identify and address resources (in addition to funding) needed to ensure successful URM mitigation. Two successful existing retrofit programs, Salt Lake City's Fix the Bricks[4] and California Earthquake Authority's Brace + Bolt,[5] highlight innovative means of facilitating program access and solutions to proactively address barriers to success.

Figure 5



Recognizing the need for URM mitigation in Utah, the USSC published *The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings* (Utah URM Guide) in 2016.[6] While this document provides general URM-related information for homeowners, it primarily emphasizes a series of engineer-developed retrofit conceptual plan sets; see the structural detail in Figure 5 as an example. These technical drawings can be used as a reference to support engineers and architects when designing and detailing specifically tailored corrective measures that improve URM performance, but may not prevent damage or collapse.

After the performance objectives (performance levels and ground motions) for the new URM mitigation program have been established, the Utah URM Guide, Salt Lake City's Fix the Bricks, and other similar past mitigation programs should be evaluated to determine if they meet the established performance objectives for the current program.

[3] FEMA P-58, Seismic Performance Assessment of Buildings: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes
[4] Salt Lake City Government, Fix the Bricks: https://www.slc.gov/em/fix-the-bricks/
[5] California Earthquake Authority, Brace + Bolt: https://www.earthquakebracebolt.com/
[6] Utah Seismic Safety Commission, The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings: http://www.slcdocs.com/historicpreservation/information/SI.pdf

Creating Salt Lake City's Fix the Bricks retrofit program from the ground up required rapid innovation, as Utah has less overall experience in the earthquake retrofit field when compared to West Coast states. Many local contractors were interested in performing the construction work, but few were qualified to complete the retrofits. To meet demand and ensure a robust program, Salt Lake City introduced a retrofit training program to equip interested contractors with the expertise needed to retrofit URM buildings.

One particularly promising sign that this government-sponsored program had captured private sector interest is that the specialized hardware required for earthquake retrofits had previously needed to be special-ordered in the Salt Lake City market; now, it is stocked by default at local hardware retailers. What once was an insignificant niche market is now in high demand; URM retrofit requests have skyrocketed in Utah, and several local contractors are now qualified to execute retrofit projects.

To preserve Utah's historic character for future generations, the State Historic Preservation Office (SHPO) consults and assists agencies to ensure historic buildings and their treatment are taken into account, as per federal historic preservation regulations. Because URM construction was banned in the 1970s in Utah, nearly all remaining URM buildings are now historic structures.

Seeing the historic preservation merits of earthquake retrofits, the SHPO engaged with the Utah DEM and FEMA early in the establishment of Fix the Bricks to facilitate project approval without jeopardizing the historic character of Utah's URM buildings. By referencing the aforementioned *Utah URM Guide*, SHPO and Salt Lake City Historic Preservation (SLCHP) were able to pre-identify specific retrofit techniques that resulted in little to no impact on the historic character of URM buildings. SLCHP could then expedite approval of homeowner or contractor proposals utilizing any of these pre-approved techniques. This upfront initiative by SHPO, SLCHP, DEM, and FEMA saved considerable time and effort when reviewing Fix the Bricks projects. Given the historic nature of most URM buildings, any future URM mitigation programs would benefit from similarly incorporating historic preservation considerations and stakeholders into any future projects.

Further west, the California Earthquake Authority (CEA) is a public organization offering earthquake insurance to California residents. CEA's Brace + Bolt residential retrofit program has been very successful. One key to success for the program is its combined consistency and ubiquity. Brace + Bolt began in 2011 and has been available every year since then. According to the Association of Bay Area Governments (ABAG), the program's consistency has produced two key benefits. First, homeowners who have successfully participated in the program become ambassadors, spreading the word to their contacts. Second, local governments have become familiar with the program, enabling many to amplify CEA messaging. Brace + Bolt marketing has been both consistent and effective, developing brand recognition throughout California and beyond. In addition, the relatively low cost of the retrofit (~$3,000) enables CEA to spread its retrofit funding across many homes rather than concentrating its resources in a much smaller pool of properties.[7] To date, more than 12,000 retrofits have been completed statewide through the Brace + Bolt program.

Another accelerator of Brace + Bolt is the sharing of retrofit benefits. The homeowner clearly benefits for two reasons: 1) the retrofitted home will be more resilient to future earthquake shaking, and 2) their CEA earthquake insurance premiums will consequently be reduced. In addition, CEA benefits from this program because the risk of damage to its insurance portfolios shrinks with each successful retrofit project.

In addition to homeowner outreach, Brace + Bolt proactively engages with the contractor community and provides a contractor-specific website with detailed information on program participation.[8] CEA also provides retrofit training to interested contractors to support their eligibility to execute Brace + Bolt projects; this training is free and leverages the existing FEMA P-593, *Seismic Rehabilitation Training for One-and Two-Family Wood-Frame Dwellings*. Once contractors satisfy

[7] Michael Germeraad, Association of Bay Area Governments, personal communication – April 13, 2020
[8] California Residential Mitigation Program: https://www.earthquakebracebolt.com/Content/AboutContractorProgram

program requirements, they are added to the Brace + Bolt Contractor Directory and can be hired to complete Brace + Bolt retrofits. This additional emphasis on contractors helps ensure that supply can meet the growing demand for retrofits in California.

Finally, several complementary resources now exist to support homeowners as they go through the Brace + Bolt process. First, CEA provides a retrofit plan set, which greatly simplifies the engineering effort needed for retrofit success. This significantly lowers the barrier to entry for homeowners. Second, as described above, CEA publishes a Contractor Directory, searchable by ZIP Code, that highlights trained contractors who have been pre-screened. This inventory provides reassurance to homeowners and again lowers the barrier to entry. Third, cities such as San Leandro curate tool lending libraries to facilitate do-it-yourself Brace + Bolt retrofits.[9]

Discussion of Brace + Bolt and Fix the Bricks warrants one important caveat: while both programs enhance the resilience of two known structural vulnerabilities (cripple walls and URM, respectively), it is possible that participating homes will still be damaged during a large earthquake. This is an important communication challenge that needs to be considered.

As residential grant programs, both Fix the Bricks and Brace + Bolt provide strong financial incentives to encourage homeowners to initiate home retrofit projects. While the financial portion of the process is essential, the less obvious programmatic strengths described above help ensure the success of both programs.

C.5: Cost Issues Related to Seismic Retrofits

Groups like a downtown business owners association or chamber of commerce, an apartment owner or renter's association, a neighborhood association, or a historic preservation league, will most likely have concerns about retrofit costs. Structurally strengthening a URM building can be an expensive project, and the cost implications must be considered. As part of developing a risk reduction plan, it is important to collect information on the economic viability of the URM buildings at risk. Are the buildings high in value — generating strong income streams — because they form the heart of the "old town" tourist district that is common in many cities? Or are they in an economically declining area that used to be the central business district, but has been supplanted by shopping centers and office parks located elsewhere? Do the properties provide enough collateral for their owners to obtain construction loans to finance the upgrading work?

As described in more detail in Appendix H: History of URM Risk Reduction across the Wasatch Front, FEMA Region 8 published a report in 2013 to provide order of magnitude retrofit costs and descriptive examples of typically cost-effective seismic retrofit projects for building owners and their consultants. The resulting report is titled *Region VIII BCA Studies for Typical Seismic Retrofit Mitigation Activities*.[10] It includes results from FEMA's Benefit Cost Analysis (BCA) of structural seismic retrofit measures on URM buildings in Salt Lake City.[11] It does not include information on non-structural seismic retrofit measures. The study examined mitigation measures to address the seismic deficiencies of three categories of URM buildings in Salt Lake City and concluded that the cost per square foot that corresponds to a BCR of at least 1.0 is fairly low, indicating that it may be beneficial to bundle retrofit work with renovation or preservation projects, but that seismic-only projects will show only marginal benefits under the assumptions identified in the report. Much of the benefits are achieved through enhancements in life safety benefits of the building provided by structural retrofit, so buildings with higher occupant loads will see higher benefits.

[9] Michael Germeraad, Association of Bay Area Governments, personal communication – April 13, 2020
[10] FEMA, 2013, Final Region VIII Benefit Cost Analysis Studies Report 05222013
[11] FEMA, Benefit-Cost Analysis BCA Toolkit: https://www.fema.gov/benefit-cost-analysis

It is also possible that if these same studies performed today, by using the FEMA BCA Toolkit Version 6.0, would result in higher BCRs because of updates that have been made in the seismic module of the BCA Toolkit as recently as December 2019. For more details on opportunities that may already exist, or that may be created, to reduce the net cost of seismic retrofits, please see Appendix D, Section D.2.

C.6: Historic and Architectural Character

Reducing the seismic risk for people from the earthquake dangers of URM buildings must be a community's highest priority. Protecting the property value of buildings by preventing damage is also important. In addition, some buildings have historical or architectural significance, which is a value to be preserved. Because masonry is a durable material and was often the first choice for important buildings constructed in the past, many communities' most historic and architecturally valued buildings are of this structural type. While the primary objective of the Wasatch Front URM Risk Reduction Strategy is for retrofitted URM buildings to meet the Life Safety performance objective, it should be recognized that selected owners may wish to examine a higher level of performance for their building.

Retrofitting these buildings to increase their earthquake resistance and prevent the loss of life is necessary, even if it may not be possible to prevent irreparable damage to the buildings in a significant earthquake. However, as introduced in Appendix C, Section C.4, the retrofit itself can alter the building's appearance and change its historic character in an undesirable way if not carried out sensitively. Fortunately, today's earthquake engineering methods provide options for dealing with the earthquake vulnerabilities of a building, while leaving its appearance largely unchanged. The technique of seismic isolation has been used for some monumental public buildings in Utah with extensive URM components (e.g., the Salt Lake City and County Building, the Utah State Capitol Building, and the Salt Lake Temple). These isolators can reduce the seismic forces on the building to a fraction of what they would otherwise be, and the isolators are usually installed unobtrusively at the foundation or basement level, leaving the superstructure (or above-ground portion of the building) substantially intact. While a seismic retrofit utilizing base isolation can be extremely costly and intrusive when compared to a conventional retrofit, there are other techniques, such as center coring, that may provide a viable option for retrofitting historic structures in a cost-effective manner.

The Magna earthquake highlighted both the risk to URM buildings in Utah as well as the importance of protecting historic properties and their inhabitants. Residents indicated in a *Salt Lake Tribune* article that the historic Liberty Wells neighborhood of Salt Lake City was hit particularly hard; multiple URM buildings exhibited damage.[12] An excerpt succinctly summarizes the issue:

> **"Masonry buildings give Wasatch Front cities their historic character, but a walk around Liberty Wells gives a sense of how Utah's dominant method of construction a century ago may not be well-suited for quake country. Home after home in this south-central section of Utah's capital shows telltale signs of damage from the March 18 temblor…"**

[12] https://www.sltrib.com/news/environment/2020/04/14/they-may-be-historic/ (accessed 5/22/20)

The Magna earthquake has unfortunately provided strong evidence of the risk posed by URM buildings in Utah. The SHPO completed the *Magna Earthquake Historic Building Damage Windshield Survey* to gather data on the quantity and severity of damage to URM structures.[13] This study, performed during the immediate aftermath of the Magna earthquake, utilized exterior visual inspections to assess damage (or lack thereof) to all historic properties in the affected area of Utah. The study found that non-retrofitted URM buildings consistently exhibited more damage than their retrofitted counterparts; this finding is generally confirmed by the separate FEMA-funded *Post Magna Earthquake URM Performance* study conducted by a local Utah structural engineering firm, BHW Engineers.[14]

Most retrofitted properties had successfully participated in Salt Lake City's Fix the Bricks residential retrofit program. While success stories are important in gaining public support for any future retrofit programs, it is essential to recognize that the ground motions experienced during the Magna earthquake were lower than the expected ground motions during a design level earthquake.[15]

C.7: Building Code Triggers

In addition to the seismic retrofit codes, standards, and guidance resources listed in Appendix A, Section A.2.4.2, it is also important to understand that building codes have triggers that may require building seismic upgrades for some changes in occupancy or if a building repair or alteration exceeds a particular threshold. For example, code required seismic upgrades may be triggered if an existing building roof needs to be repaired or replaced. Conversely, seismic retrofit projects may trigger other building code considerations, like handicap access, exits, energy conservation, and removal of hazardous materials such as asbestos. The following list provides a few examples of common building code upgrade triggers found in the IEBC that may apply to URM buildings:

- Re-roofing.
- Change of occupancy or use.
- Repair, alteration or addition.
- Substantial Improvement and Substantial Damage.[16]
- Substantial Structural Damage.[17]
- Disproportionate earthquake damage.

Interpretation of these existing building code provisions, as well as the design of a URM seismic retrofit, will require a design professional experienced with building codes and standards, as well as experienced in designing URM retrofits, to understand how to achieve the required seismic resistance. In this instance, civil engineers with structural engineering expertise are typically best equipped for this type of work. In some states, "structural engineer" is a license or professional registration category, while in other states, the term is used more generically. A seismic retrofit is considered a significant construction activity that requires building permits, thus building departments must review plans and issue permits. Coordination with the technical community—professional consulting engineers, building departments, architects, and contractors—is essential to any successful URM building risk reduction program. However, these professionals cannot implement such measures by themselves. Information provided in other sections of this document makes it clear that key non-technical sectors of the community must be involved and exert leadership.

Note: *For additional information on building code triggers and repairing URM buildings that have been damaged by any event, including earthquakes, please refer to Appendix J.*

[13] *Magna Earthquake Historic Building Damage Windshield Survey*, March 26, 2020
[14] Welliver, Post Magna Earthquake URM Performance, 2020
[15] Welliver, Post Magna Earthquake URM Performance, 2020
[16] FEMA, Understanding Substantial Damage in the International Building Code, International Existing Building Code, or International Residential Code: https://www.fema.gov/emergency-managers/risk-management/building-science/substantial-damage-estimator-tool
[17] FEMA, Understanding Substantial Structural Damage in the International Existing Building Code: https://www.fema.gov/emergency-managers/risk-management/building-science/substantial-damage-estimator-tool

Appendix D: Define Implementation and Build a Budget

At this stage in the strategy, URM buildings have been identified, and the public is engaged and supportive of their retrofits. Various levels of retrofits for the local building stock have been developed in coordination with design professionals and their stakeholders. The next step is for the local government, public, and key stakeholders to agree on the best and most equitable processes for implementing and funding the retrofits. This can be accomplished through both regulatory and non-regulatory measures with numerous options for funding. Funding sources may include existing mechanisms or new funding alternatives.

D.1: Using Stakeholder Input to Define Implementation and Build a Budget

Local planners, design professionals, and public stakeholders may have different perspectives on reasonable retrofit costs and who should bear the burden of those costs. The remainder of this appendix will review various options for URM program implementation and funding mechanisms for different aspects of the retrofit process. The selection of funding and implementation methods must be an inclusive process, relying on previously obtained stakeholder input and continuous engagement of the public once a series of reasonable options has garnered internal support.

The jurisdiction should host a series of funding workshops with key stakeholders, local and state planners, and design professionals with the intent of exploring feasibility and support for different funding and implementation methods. These workshops can provide the opportunity to share information about available resources and create community-sourced solutions to community-recognized risks. As part of a multi-pronged, ongoing engagement approach with local, state, and/or tribal government and citizens, various types of communication vehicles, methods, and messages should be used.

The list of examples below includes potential responses (messages) related to specific activities in the engagement process and is provided as a starting point. Communities may choose additional or different types of messages as they tailor communications to their various audiences, and deliver them through the vehicles best suited to reach local audiences. These vehicles may include websites and social media channels with a local focus, radio, local newspapers, flyers, and postcards/mailers.

- **Responding to stakeholder inquiries:** "We heard you say 'X.' We can do that through X, Y, Z."
- **Collecting stakeholder feedback;** obtain public comment, input, and final comment.
- **Sharing progress reports with stakeholders:**
  - "In order to make retrofitting funding and resources available and attainable, we have implemented the following…
    - Policies.
    - Ordinances.
    - Training programs.
    - Recognition and award programs, etc."

This iterative approach can ensure that local knowledge and citizen priorities are incorporated into any risk reduction measures.

Note: *Reference Appendix G for additional recommendations and resources to support building a budget and defining implementation.*

D.2: Incentives and Funding Opportunities for Retrofit Programs

The following section of this document will explore various funding mechanisms, such as land use regulation, tax breaks, rebates, and grant opportunities, that can support the implementation of a URM retrofit program.

Note: *This section can be substantially expanded through continued partnership between FEMA, the state of Utah and Wasatch Front stakeholders. It is recommended that future efforts by this partnership focus on:*

1. *The development of stakeholder-specific communications informed by social science, DR-4548 (03/18/2020 M 5.7 Magna, UT Earthquake), and post-event social listening analyses to develop the community's understanding of risks and impacts.*
2. *Supporting whole-community engagement to:*
   - **a.** *Encourage local ownership of, and support for, URM retrofits.*
   - **b.** *Facilitate locally based funding strategies and knowledge of FEMA BRIC eligibility.*
   - **c.** *Prioritize available resources.*
   - **d.** *Facilitate equitable implementation of this document's recommendations.*

D.2.1: Planning and Land Use Mechanisms

This section aligns with *National Mitigation Investment Strategy Goal 1, Recommendation 1.3: Use Common Measures to Aid Decision-Making for Mitigation Investment*

The typical community planning process is focused on future growth, transportation networks, housing, and neighborhood development. Seismic hazards are rarely the top priority for a community; however, when an earthquake occurs, it will impact each sector of local community planning. For this reason, the following section identifies opportunities for integration of seismic risk reduction into existing planning processes using available regulatory mechanisms. This would also take into account any seismic risk reduction measures and planned activities already included in the community's hazard mitigation plan, as applicable.

Zoning, permitting processes, and other regulatory tools, although not traditionally thought of as incentives, can be powerful tools to implement retrofits and other building improvement projects. It should be noted, however, that these tools often serve as disincentives to the building owner through increased costs and schedule delays. Pairing regulatory and land use planning tools with financial incentives, like tax breaks and low-interest financing, can minimize these disincentives. The section below includes suggested regulatory approaches to URM retrofit implementation.

- **Site Investigations:** Required by the Community Development Director and City Engineer. Where such an investigation indicates the potential for URM collapse, a seismic mitigation plan must also be submitted with plans to abate or minimize URM vulnerabilities within a pre-determined time period. The report and plan must be prepared by a licensed engineer and be reviewed by the city's engineer. Approval from the city is required prior to permit issuance. Note: There is always a potential for URM collapse given a high enough level of shaking. Any URM in a magnitude 7.0 Wasatch Fault earthquake has a very high likelihood of collapse, but the codes do not require a specific consideration of this event.

- **New Development:** Implement stricter requirements for new development when near a URM. When a new development is within a specified radius (such as 100 feet or 1.5 times the existing building height) of a URM or seismically vulnerable building, a site investigation report will be prepared by a structural engineer. Recommendations contained in the site report will be incorporated into the building plans.
    - Seismic projects are more successful when integrated into an existing project, like neighborhood revitalization, where the project is multi-beneficial. See the example of Port Townsend, Washington, where FEMA HMGP funds were combined with local improvement dollars and the Main Street USA grant program for an economic revitalization of the community's downtown, which included seismic upgrades.[1]
- **Historic Preservation: National Historic Preservation Act:[2]** When Section 106 is triggered by use of federal dollars for environmental review under the National Historic Preservation Act, the city can require that all environmental reviews a) fully address impacts on these landmarks/landmark districts, and b) identify mitigation efforts that could include assistance for seismic retrofits.
- **Establish a Mapped Earthquake Zone:** Define an "Earthquake Zone" overlay on zoning maps by using a consensus-based assessment of USGS National Seismic Hazard Maps, ICC-defined Seismic Design Category contours, or some other well-recognized authority's representation of the earthquake hazard. Within this zone, reports must be prepared to address earthquake hazards. The establishment of a mapped earthquake zone should be coordinated with any URM building risk classification system established in Appendix A of this strategy and incorporate specific types or levels of risk. For example, a liquefaction hazard may drive a building into a higher priority classification. In addition, any building permit applications within this zone will trigger URM mitigation measures to abate or minimize the vulnerability and must include both a target performance criterion and a design hazard-shaking level. The report and plan must be prepared by a licensed engineer and be reviewed by the city's engineer. Approval from the city is required prior to permit issuance.
    - Similar to this approach, a mapped earthquake zone can be used to create a Special District. Fees or taxes collected within this zone can be used to support the creation of a fund that supports retrofit costs.
- **URM Retrofits and Cost-Effective Energy Efficiency Upgrades:** It would be cost-effective for property owners to undertake other building system upgrades at the same time as retrofits (as described in the PACE discussion in Appendix D, Section D.2.2, below). These enhancements often lead to higher revenue for rental and commercial properties due to reduced utility costs. There are also subsidies to offset the costs for these energy and utility upgrades.
- **Transfer of Development Rights[3] (TDR) to Fund URM Mitigation:** TDR allows buildings with excess development capacity (zoned development capacity minus existing development) to sell (transfer) that development capacity from the "sending site" to a project that can use that development capacity (the "receiving site"). The value of those development rights allows the sending site to recoup some of the economic value of unused development capacity. In the case of URM buildings, the selling or transferring of unused URM development capacity could result in a significant revenue stream used to fund seismic retrofits. A few additional notes on TDR programs include:
    - Benefit:
        - TDR is a way to offset retrofit improvement costs, using new private development to fund retrofit needs.

[1] See Port Townsend, WA Mitigation Showcase and EERI Presentation by Tim Cook at 2020 National Earthquake Conference.
[2] Report to City of Seattle from National Development Council, May 2019: https://www.seattle.gov/Documents/Departments/SDCI/Codes/ChangesToCodes/UnreinforcedMasonry/FundingURMRetrofits.pdf
[3] Report to City of Seattle from National Development Council, May 2019: https://www.seattle.gov/Documents/Departments/SDCI/Codes/ChangesToCodes/UnreinforcedMasonry/FundingURMRetrofits.pdf

- Issues to Consider:
  - It is beneficial to add new "receiving areas" that do not compete with other policy priorities and zoning incentives like affordable housing, open space and design enhancements. (Developers of "receiving" sites will typically choose the lowest cost option offered in the TDR market).
  - Prioritization of URM potential relative to other sources. Changes to zoning incentives can make URM TDR potential a more attractive source to buyers and increase its value.
  - Establish a TDR Bank to stabilize TDR credits due to development fluctuations.

Note: *No regulatory tool is effective unless it is enforced and followed up with site inspections. See Appendix D, Section D.2.2, below and Appendix J for resources that support code enforcement.*

D.2.2: Financial Mechanisms for URM Programs

This section aligns with *National Mitigation Investment Strategy Goal 3, Recommendation 3.3: Use and Expand Products and Approaches to Reduce and Transfer Risk*

A URM mitigation program is more likely to be successful if it incorporates financial incentives to ease the cost burden on building owners. This section presents a selection of creative financing solutions, largely drawn from research supporting mitigation programs in Seattle[4] and Oregon[5].

- **Capital Improvement Planning:** Seismic upgrades and retrofits should be integrated into the local capital improvement planning process, viewing retrofits as an expected part of a holistic maintenance process. These funds can also be used as match funds for FEMA's BRIC and HMGP grants.
- **Impact Fees:** Reuse and adjustment of permit fees and sales tax collected on URM retrofits can be allocated to support URM program costs.
- **Opportunity Zones:** Introduced in 2017, the Tax Cuts and Jobs Act provides tax advantages to private investors who invest capital gain proceeds in designated Opportunity Zones.
  - When coupled with Rehabilitation Tax Credits, the two federal benefits could significantly lower the cost of capital to fund retrofits. This could help smaller property owners retain their buildings and potentially limit resident displacement created by retrofit actions.
- **Private Activity Bonds, Conduits or Municipal Bonds:** States and cities, through private activity bonds, are able to borrow on behalf of private companies and nonprofits, lowering borrowing costs for entities that might otherwise turn to corporate bonds or bank loans. They are issued to attract businesses and labor to a region to derive a public benefit, which would qualify the bond for tax-exempt status.
- **Community Development Financial Institutions (CDFI) Consortium:** Typically, these are public-oriented alternative lenders with more flexibility in their lending activities than private banks. The key is to determine if CDFIs can access funding that lowers borrowing costs or provides lending flexibility unavailable through other means.

[4] Report to City of Seattle from National Development Council, May 2019: https://www.seattle.gov/Documents/Departments/SDCI/Codes/ChangesToCodes/UnreinforcedMasonry/FundingURMRetrofits.pdf

[5] Oregon Landslide Guide and Textbook: The Practice of Local Government Planning, Second Edition (Municipal Management Series).

- **Impact Investing:** Foundations or high net wealth donors provide low-cost financing in order to facilitate a public benefit. This double-bottom-line activity provides some limited returns to the investor while meeting a social need. While not yet to scale, there have been examples with Bellwether's housing development and Forterra's community equity borrowing that were funded through impact investments.[6]

- **Property Assessed Clean Energy (PACE):** PACE financing establishes a public surrogate, approved by governments, to lend money to property owners to make clean energy upgrades to their buildings. While facilitated by the public sector, the financial risks are borne by the private party receiving the financing. Repayments on loans are paid via property taxes and then provided to the PACE lender. In this way, it is similar to an assessment district but applies only to specific buildings. PACE financing can be a more expensive but potentially more accessible financing source than other options. It utilizes private lenders and could include seismic retrofits, as already enacted in Washington state's C-PACER program, which now allows for funding of resilience projects.[7]

  - The clean energy roots of the PACE program present an interesting opportunity for addressing multiple building upgrade needs at once. For example, the Shift Zero PACER Task Force[8] is an alliance of public, private and nonprofit organizations focused on moving buildings towards a zero net carbon footprint. Both the clean energy movement and earthquake resilience efforts could facilitate a broad coalition effort to package together complementary projects. By combining (as one example) structural retrofit and insulation improvements to URM buildings, it is conceivable that project efficiencies could emerge (e.g., repairing drywall once, rather than twice).

  - The city of Portland, Oregon, partnered with Enhabit, a nonprofit which specializes in home energy upgrades, to implement retrofits in low income homes. Leveraging existing relationships in the community, Enhabit provided the city with increased capacity to manage grant requirements, market and advertise the opportunity of a residential retrofit program, and conduct training for contractors to help streamline reimbursement requirements.[9]

- **U.S. Department of Housing and Urban Development (HUD) 108 Loan**

  - The Section 108 Program provides the least expensive cost of funds. Through this lending program, which is within the federal Community Development Block Grant (CDBG) Program, HUD borrows funds and relends to the city, which then relends proceeds to project stakeholders. This program allows the city to either pass-through costs to the project or use some of its annual CDBG entitlement grants to offset debt service costs. As loans are repaid, that funding capacity could then be redirected for other city priorities.

  - This approach is best used with affordable housing or community development projects due to federal regulations. Utilizing 108 capacity for URM retrofits would limit use for other projects and reflect a prioritization of URM retrofits.

- **Property Tax Abatement:** Rather than provide immediate financial incentives, state and local jurisdictions can defer their commitment by offering property tax abatement. This approach has the dual benefit of providing property owners with dependable, long-term benefits while providing jurisdictions time to budget for potential reductions in property tax collection into the future.

- **Assessment District:** Assessment financing can be made available to a neighborhood-scale area, and requires approval from property owners. Benefits include lower borrowing rates and potentially longer terms than private financing. This would allow a building owner to spread the costs of the retrofit over a longer term, lessening the impact on cash flow. As one example, the city of Long Beach, California, supported early seismic retrofits by forming an

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[6] Report to City of Seattle from National Development Council, May 2019: https://www.seattle.gov/Documents/Departments/SDCI/Codes/ChangesToCodes/UnreinforcedMasonry/FundingURMRetrofits.pdf

[7] Shift Zero Alliance, Seattle, WA https://shiftzero.org/pace/

[8] Commercial Property Assessed Clean Energy and Resilience (C-PACER) Financing in Washington https://shiftzero.org/pace/

[9] Portland, OR Seismic Mitigation Showcase

assessment district that included all URM buildings whose owners opted to join; the assessment district eventually included 25% of the Long Beach URM inventory. Financing is repaid by building owners, with the public sector collecting funds via property tax payments through the special assessment. This approach leverages public sources of funding (in contrast to PACE's use of private funding sources). With assessment financing, there need to be joint benefits that accrue beyond a single property owner to meet legal and policy tests, such as increased neighborhood resilience and pedestrian safety.

- **Special Valuation Incentive:**[10] Renovations to existing properties often trigger a corresponding increase in property value, which is typically accompanied by a proportional increase in property taxes. This creates an unintended disincentive for building retrofits. Special Valuation Incentives revise the assessed value of historic properties, subtracting rehabilitation costs (for up to 10 years) that are approved by the local review board, thus removing the retrofit disincentive over the medium term. Additional notes on Special Valuation Incentives include:
  - Reduced property taxes increase cash flow to a builder or owner and increase the building's value.
  - According to the Washington State Legislature, "The primary benefit of the law is that during the 10-year special valuation period, property taxes will not reflect substantial improvements made to properties that are eligible for special valuation and designates a local review board that reviews applications. For example, if a property owner incurs qualified rehabilitation costs that equal at least 25% of the building's assessed value within a 24-month period prior to application, those qualified costs can be subtracted from the newly assessed value of the property for 10 years." The Washington State Model Historical Preservation Ordinance has specific language on Special Valuation. [11] [12]
- **Utah Historic Preservation Tax Credit:** The state of Utah offers this 20% state income tax credit for rehabilitation of owner-occupied or rented residential properties. The property owner must spend at least $10,000 to qualify for this credit, and the property must be listed in the National Register of Historic Places. Additional information about requirements for listing properties in the National Register is available online here: https://www.nps.gov/subjects/nationalregister/how-to-list-a-property.htm.
- **Federal Rehabilitation Tax Credit**[13]**:** Federal tax credits for qualifying projects offset federal taxes owed, which reduces the expense of owning the building and increases its value. The following issues should be considered:
  - Many building owners prefer to monetize the credit up front (via specialized lenders) to use as a source of project funding. This process may be too complex and expensive for many owners, and it can be difficult to attract investor attention for small projects (less than $2 million).
  - Cities could assist interested building owners by packaging their projects for investment to help them utilize credits and work with local partners to establish an area-specific fund.
- **Building Owner Funding and Financing.**
- **Existing Public and Nonprofit Programs.**

[10] Report to City of Seattle from National Development Council, May 2019: https://www.seattle.gov/Documents/Departments/SDCI/Codes/ChangesToCodes/UnreinforcedMasonry/FundingURMRetrofits.pdf
[11] Washington State Department of Archaeology & Historic Preservation, Draft Historic Preservation Ordinance: https://dahp.wa.gov/sites/default/files/Model%20Ordinance.doc
[12] Washington State Department of Archaeology & Historic Preservation, Special Valuation Flyer: https://dahp.wa.gov/sites/default/files/SV_flyer.pdf
[13] Report to City of Seattle from National Development Council, May 2019: https://www.seattle.gov/Documents/Departments/SDCI/Codes/ChangesToCodes/UnreinforcedMasonry/FundingURMRetrofits.pdf

- **Private Bank Loan:** Many building owners will work with local banks to finance retrofits. The jurisdiction can work with banks or local lenders to establish a group of local banks willing to provide access to loans for building retrofits, and can also work with building owners to develop packaged materials for lenders.
- **Low-Income Housing Tax Credit:** Administered by the State Finance Commission, this program offers a 4% tax credit for construction that includes affordable housing. The program supports retrofits by providing a tax credit of 4% of the total construction expenses for 10 years. Building owners can monetize the credit upfront by collaborating with investors. The credit is typically coupled with tax-exempt bond financing (such as a Private Activity Bond), which has favorable terms that lower financing costs for affordable housing projects. The financing typically has advantageous rates and terms that reduce debt service costs to the building owner.
- **FEMA Grant Programs**
  - **BRIC:** Each year, FEMA's new BRIC program will competitively award communities significant pre-disaster hazard mitigation grants to buy down risk *before* disaster strikes. The BRIC program emphasizes the resilience of seven community lifelines; URM mitigation would likely fall under the *Food, Water, and Shelter* lifeline.[14] Mitigation projects will need to align with the state hazard mitigation plan, and project developers should be engaged in the mitigation planning process for plan development and updates.

    In the meantime, the following information is available:

    - *BRIC will support states, local communities, tribes and territories, as they undertake hazard mitigation projects reducing the risks they face from disasters and natural hazards. BRIC is a new FEMA pre-disaster hazard mitigation program that replaces the existing PDM program and is a result of amendments made to Section 203 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) by Section 1234 of the DRRA.*
    - *The BRIC program's guiding principles are supporting communities through capability- and capacity-building, encouraging and enabling innovation, promoting partnerships, enabling large projects, maintaining flexibility and providing consistency.*[15]
  - **HMGP:** Following a Major Disaster Declaration, FEMA provides additional funding (beyond the standard disaster recovery support) to invest in mitigation projects to reduce the impacts of future disasters. If Utah receives a Major Disaster Declaration by the President, HMGP funds can be used for URM mitigation, *regardless of the cause of the initial disaster.*[16] The mitigation projects need to align with the hazard mitigation plans, and project developers should be engaged in the mitigation planning process for plan development and updates.
  - Other FEMA Grant Programs: Information about other FEMA grant programs and potential grant-supported mitigation activities is available on FEMA's website at https://www.fema.gov/emergency-managers/risk-management/earthquake/other-grants.
- **Other funding mechanisms that still need exploration*:**
  - Improved mortgage terms.
  - Reduced insurance rates.
  - Loan guarantees.
  - Reduced or waived permit fees.

[14] FEMA, 2020, Community Lifelines: https://www.fema.gov/lifelines
[15] FEMA, Building Resilient Infrastructure and Communities: https://www.fema.gov/bric
[16] FEMA, Hazard Mitigation Assistance Grants: https://www.fema.gov/grants/mitigation

- Tax increment financing.
- Technical assistance.
- Reimbursement of engineering studies.
- Density or intensity bonuses.
- Staged rollout of programs.
- Insurance coverage benefits.
- Other non-FEMA federal programs, such as United States Department of Agriculture Rural Development loan and grant programming.

  *Relevant funding mechanisms should be included in state, local and tribal mitigation plans.

Appendix I provides examples of communities that have successfully implemented, or are in the process of implementing, retrofit programs centered around a subset of the incentives above. Berkeley provides homeowners a tax rebate for successful retrofit projects, and the California Earthquake Authority provides grants for small retrofit projects. Seattle provides significant financing research, which can be leveraged by any jurisdiction interested in pursuing creative financing opportunities for retrofit projects.

D.2.3: Non-Regulatory Support for URM Buildings

There are a variety of non-regulatory opportunities for state and local officials to facilitate URM mitigation, including:

- **Property buyouts:** Some state and federal mitigation grant programs (such as the suite of grants under FEMA's Hazard Mitigation Assistance Program discussed above in Appendix D, Section D.2.1) can be used to pay property owners fair market value to vacate at-risk structures.[17] Often used to buy out at-risk properties in floodplains or active landslide zones, these funds could also be applied to URM structures in areas of high earthquake hazard.
- **Pre-Screening qualified URM contractors and engineers.**
- **Education and outreach:** Regular training offerings to bring contractors and engineers up to speed on retrofit techniques, standards and requirements.
- **Streamlined URM risk reduction program application and administration process.**
- **State Resilience Officer:** To facilitate a statewide coordinated approach to seismic resilience, the creation of a State Resilience Officer position is recommended. This position would be responsible for directing, implementing and coordinating seismic safety at the state level. The State Resilience Officer could collaborate with professional associations that address seismic, building code, land use and resilience issues to focus on targeted and strategic investments that reduce risks posed by earthquakes.
- **Real estate disclosures or covenants:** These are contractual agreements that commonly establish a requirement for disclosure of information and typically run with the land. Generally, they are required to be recorded or otherwise filed into the real estate records of the city or county. In this manner, regardless of who owns the property, the information is available to the public. When agreements such as these are recorded with a county's tax assessor or records office, they can be found through a query of records for the property, so prospective buyers can screen out properties that

[17] FEMA, Hazard Mitigation Assistance Grants: https://www.fema.gov/grants/mitigation

exceed their risk tolerance. To build on these areas, the covenant language states that all owners of record must sign a covenant, indicating awareness of the risks and agreeing to mitigate those risks and inform future owners; see the Seattle Department of Construction and Inspections Potential Landslide Area Covenant form as one example.[18]

In addition to the resources and programs referenced in this section, voluntary retrofit programs present another option for communities interested in mitigating URM risks. The next section provides an overview of such programs.

D.3: Voluntary Retrofit Programs

This section outlines an approach for encouraging the voluntary seismic retrofit of existing URM buildings. This approach builds on the information previously provided related to notification, funding mechanisms, and the classification of existing buildings in determining if a building is a candidate for voluntary retrofit. This voluntary approach will be tied to the discussion below of mandatory retrofits in almost every key area. Many retrofit funding mechanisms (discussed above in Appendix D, Section D.2.2) may be applicable to both voluntary and mandatory risk reduction measures. Retrofit analysis and design criteria will be consistent (but not necessarily the same) across the discussions of both mandatory and voluntary measures. Verification and acceptance protocols for retrofit buildings should be similar, regardless of whether the retrofit is voluntary or mandatory.

Voluntary URM retrofit programs are substantially different from mandated retrofit programs. Voluntary programs mostly focus on outreach and convincing URM building owners to retrofit their URM building(s), while assuring them that they will not be solely responsible for the financial burden of the process.

D.3.1: Key Elements of a Voluntary Retrofit Program

There are many necessary elements to a successful voluntary URM retrofit program. Key among these are a robust URM building inventory database, a strong outreach program to URM building owners, equitable funding mechanisms, and an implementation approach that is easy to understand and relatively straightforward to execute. Underlying or overt factors contributing to a community's interest in participating in a voluntary retrofit program include seeing the need for (and value of) undertaking such a program, as well as its financial benefits.

The following list outlines the necessary elements of a successful voluntary URM retrofit program:

a. The development of a robust inventory database, as discussed in Appendix A, Section A.3.1. This step is critical to the successful implementation of a voluntary retrofit program. If the inventory database is not accurate or complete, many building owners will have questions as to whether this URM retrofit program even applies to their building(s).

b. The community outreach program is another important step in the voluntary program. As noted in Appendix B, Section B.5, one way the relationships with community stakeholders can be expanded and strengthened is by partnering with them to validate the URM inventory against the buildings in their community. This partnering effort can be used to help educate community stakeholders about the importance of voluntary URM retrofits.

c. Potential funding mechanisms related to the URM retrofit process are discussed in detail in Appendix D, Section D.2.2. For voluntary retrofits, tailoring the list of potential funding opportunities to the specific stakeholders involved with voluntary URM retrofits is critical in the overall education and implementation process. Stakeholders considering voluntary retrofit will often be looking for funding sources that provide a maximum amount of return with a minimal amount of administrative obligations.

[18] Seattle Department of Construction & Inspections, Potential Landslide Area Covenant Form: https://www.seattle.gov/Documents/Departments/SDCI/Forms/PotentialLandslideAreaCovenant.pdf

d. Stakeholders considering voluntary URM retrofits will also be looking for a straightforward process in terms of obtaining and implementing a retrofit design. For many stakeholders (such as owners of single-family residences), researching and understanding the retrofit design provisions and interviewing designers and contractors is likely to be a substantial impediment to moving forward with a retrofit. Owners who participate in voluntary retrofit programs will also usually expect an exemption from future mandatory retrofit ordinances as an incentive to undertake the retrofit (at least for a defined timeframe in years). This exemption is subject to the retrofit satisfying a specific performance standard or prescriptive procedure.

Table 20 summarizes features of voluntary retrofit programs for URM buildings, including advantages and disadvantages.

Table 20. Advantages and Disadvantages of Voluntary Retrofit Programs for URM Buildings

Program Description	Advantages	Disadvantages
• Owners are notified if their property is included in the URM database as a voluntary or mandatory retrofit candidate. • Requires owners to provide a response that indicates their intentions to reduce risks. • Notification and response are made available to the public. • Establishes seismic retrofit technical standards. • Owners set their own timeframes for compliance with standards.	• Provides effective disclosure of risks to owners and, in some cases, to tenants. • Flexible timeframes for compliance can result in fewer economic difficulties. • Rates of risk reduction can vary, depending on the owner's resources and demands on the design and construction industry. • Provides an effective management and monitoring system to local governments. • Local governments can always reconsider the program's progress and impose mandatory requirements if it is ineffective.	• Effective in reducing risk only if coupled with strong economic environments and financial, planning and zoning incentives. • Not effective for owners who choose not to cooperate; this can be unfair to cooperative owners. • May prolong overall risk reduction efforts and earthquake risk exposure. • May not consider risks to occupants and passersby or from adjacent buildings. • Volunteer efforts may not be completed to the specified level of upgrade, resulting in a building that does not achieve a community-desired level of protection or compliance.

D.3.2: Advantages of Voluntary Retrofit Programs

The primary advantage of a voluntary retrofit program is the flexibility that it affords both the building owner and the local government (also referred to as the authority having jurisdiction). A successful voluntary retrofit program will help to gain public support for the entire URM retrofit program, including any mandatory portions of the program, if applicable. Other similar programs, such as the Portland and Seattle retrofit programs, do not have a comparable voluntary retrofit portion to build momentum.

D.3.3: Disadvantages of Voluntary Retrofit Programs

Voluntary URM retrofit programs have several unique disadvantages relative to mandatory URM programs. The primary and most obvious disadvantage is the lack of an official mandate for completion. At a high level, the lack of an official mandate for the URM retrofit program may result in a program that is not effective in substantially reducing seismic risk posed by the targeted URM buildings.

If owners choose not to act, for whatever reason, there is little that the local government can do to force cooperation. If financial incentives are not sufficient, or if the technical criteria for mitigation are considered too onerous, owners may simply defer the work until a later time, which could be never.

There are other disadvantages that may not be perceived as major impediments but may, nonetheless, limit the success of a voluntary URM retrofit program. Among these disadvantages is the potential perception, by designers, contractors and building officials, that the voluntary retrofits are less important than the mandated retrofits and, as such, do not warrant their attention.

D.3.4: Example Model Voluntary Retrofit Programs

See Appendix K for references to example model voluntary retrofit programs.

D.4: Mandatory Retrofit Programs

This section outlines an approach to inform stakeholders and decision makers of ways to reduce the risk from URM buildings through specific mechanisms that establish policies for authorities having jurisdiction. These recommendations are intended to focus on efforts that will move mitigation efforts forward both before and after an earthquake. Inherent in the success of a mandatory retrofit program's recommendations is the necessity of having both sound educational and informational materials for the public and stakeholders, as well as voluntary alternatives to incrementally move toward reducing the risks from URM buildings. When crafting such a program, it is important to review examples of other mandatory retrofit programs and the lessons learned from such programs to inform the approach and maximize the potential for success.

URM buildings have long been identified as "poor performers" in earthquakes of all sizes. As described previously, the lack of steel reinforcement often results in significant damage, injuries, and death. This liability should be a prime reason for proactively pursuing policy enhancements to reduce and minimize the costs to communities throughout the state.

D.4.1: Key Elements of a Mandatory Retrofit Program

Mandatory retrofit programs come in many forms and generally entail a long and involved process. They need to address many competing factors and opposing interests. In general, the process involves defining a public policy statement and program that will establish priorities, timeframes, retrofit standards, and the baseline levels of seismic improvements for URM buildings acceptable to the community. Ideally, this process will establish a commitment to risk reduction, coupled with financial resources to help accomplish this goal.

Table 21 summarizes the features of mandatory retrofit programs for URM buildings, including advantages and disadvantages.

Table 21. Advantages and Disadvantages of Mandatory Retrofit Programs for URM Buildings

Program Description	Advantages	Disadvantages
• Requires owners to reduce earthquake risks within established timeframes. • Timeframes for compliance start when the Building Department issues an order. • Establishes seismic retrofit technical standards. • Sets a goal of risk reduction, not total elimination of risks.	• Local governments can effectively enforce the program and reduce hazards. • Building departments can monitor and report progress. • Building departments can control compliance rates by slowing down or speeding up the issuance of orders to building owners. • Compliance rates vary with the number of building occupants, with longer timeframes for smaller buildings.	• Imposes arbitrary and, at times, inflexible deadlines on building owners. • Compliance schedules do not necessarily reflect the limits of the local design and construction industry resources. • Can impose economic hardships on owners and occupants. • Compliance schedules do not consider risks to passersby or risks posed by adjacent or unoccupied buildings.

D.4.2: Advantages of Mandatory Retrofit Programs

Mandatory programs reduce the risk from URM buildings and move communities toward a more resilient state. When a public policy for the retrofit of URM buildings is adopted, building departments and local governments can effectively enforce and monitor the rate of compliance. These programs can be structured over long timeframes and address different building occupancies in a manner suitable for the region. Mandatory URM programs for schools and essential facilities are public statements of support for the safety and well-being of persons in those structures and the importance of their functions in our communities.

D.4.3: Disadvantages of Mandatory Retrofit Programs

Programs requiring compliance for strengthening URM buildings can be costly and disruptive to occupants and operations. Timeframes between policy enactment and mitigation deadlines are necessary, but leave buildings vulnerable to earthquakes in the interim. Gaining access to resources to assist in retrofit work is often time-consuming and complicated.

D.4.4: Example Model Mandatory Retrofit Programs

For communities interested in pursuing a mandatory URM retrofit program, initiating such a program may be daunting. Thankfully, ABAG has compiled a set of example ordinances implemented in the San Francisco Bay Area.[19] It is ultimately up to the local jurisdiction to determine the ideal approach for a community. The ordinances listed below share several attributes that may provide a good outline for success:

[19] Association of Bay Area Governments, Resilience: http://resilience.abag.ca.gov/resilience/ordinances/

1. Official notice to the owner of building(s) included in the mandatory ordinance scope (building owner-related topics discussed in Appendix B).
    a. Information on how to appeal this designation.
2. Official notice to tenants (if applicable; tenant-related issues discussed in Appendix B) regarding:
    a. Status of building as a URM.
    b. Rights during potentially disruptive construction work.
3. Requirements for compliance with the ordinance; for example, engineering assessment, design guidelines governing retrofit, timeline, and definition of "success" (discussed in Appendix C).
4. Definition of sanctions for noncompliance.
5. Building owner reporting requirements to the local jurisdiction for compliance.
6. Resolution:
    a. Successful retrofit and reporting: official removal from URM inventory.
    b. Failure to mitigate or report: process for implementation of sanctions as described above.

Individual jurisdictions may wish to tailor this list to address specific local needs (e.g., historic preservation, financial and other incentives, allowances for hardships, partial or incremental upgrades vs. complete upgrades, etc.). See Appendix K for two examples of Mandatory URM Mitigation Ordinances from the cities of Napa and St. Helena, California. The St. Helena ordinance introduces new retrofit triggers (discussed more generally in Appendix C) related to occupancy changes and additions, alterations, or repairs. In contrast, the Napa ordinance comprehensively requires the retrofit of all URM buildings, with a handful of limited exceptions.

Appendix E: Secure Resources and Implement

E.1: Promoting and Enforcing Retrofits

E.1.1: Stakeholder Engagement

Once the plan for mitigating the risk posed by URM buildings is developed and a budget has been established, communication and collaboration with the public should not end — continuous engagement with and between stakeholders is key to a program's success. It is an important element to establishing and maintaining partnerships, and to streamline enforcement activities by maximizing the program understanding that facilitates adherence to program requirements. Local attention should be garnered when retrofits begin, as they progress, and once they are completed. Each retrofit is a success worthy of celebration and public recognition. The Stakeholder Engagement Strategy (see Appendix G) includes ideas to celebrate success and demonstrate a local commitment to resilience. Enforcement guidance will be developed after the retrofit criteria are finalized.

E.1.2: Inclusive Stakeholder Engagement Strategy

As retrofit criteria are finalized, it is important to spread the word locally through diverse approaches to reach all stakeholders. Example opportunities include:

a. Development and dissemination of typical retrofit details and specifications.

b. Engagement and vetting of regional contractors who are qualified to perform the URM retrofits.

c. Developing and implementing continuing education programs for those responsible for enforcing seismic design principles, including building inspectors, plan checkers, special inspectors and others involved in construction trades. In addition to education and training for enforcement, it is also critical that training and certification be provided to contractors on the installation of products that are frequently used in URM retrofit, but which may be unfamiliar to local contractors, such as epoxy anchors. Jurisdictions may consider implementing a "Train the Trainer" program to certify specific organizations or individuals who have an interest in and capabilities to support the community's training and outreach efforts.

d. Identify officials responsible for certifying compliance with the retrofit criteria. This certification may take on additional significance depending on the type of funding mechanism that is used to fund the retrofit (e.g., federal mitigation grants have specific reporting requirements).

e. Conduct outreach efforts aimed at the local architecture and engineering community to provide information about the retrofit criteria. Outreach can include seminars, workshops and presentations to local chapters of stakeholder organizations (SEAU, EERI, Habitat for Humanity, etc.)

Note: *See Appendix G for additional input and suggestions on education and outreach to key stakeholders.*

Note: *This section can be substantially improved through a continued partnership between FEMA, the state of Utah and Wasatch Front stakeholders. It is recommended that future efforts by this partnership focus on:*

1. *The development of stakeholder-specific communications informed by social science and DR-4548 (03/18/2020 M 5.7 Magna, UT Earthquake) post-event social listening analyses.*

2. *Supporting whole-community engagement to:*
   - **a.** *Encourage local ownership of URM retrofits.*
   - **b.** *Facilitate locally based funding strategies and knowledge of FEMA BRIC eligibility.*
   - **c.** *Facilitate equitable implementation of this document's recommendations.*

Appendix F: Utah URM Stakeholders

This section aligns with *National Mitigation Investment Strategy Goal 2, Recommendation 2.2: Align Program Requirements and Incentives and Goal 2, Recommendation 2.3: Make Funding for Mitigation Investment Easier to Access*

Stakeholder Participation in Retrofit Implementation

Integrating seismic retrofits into existing community efforts, like revitalization and sustainability, supports and builds on the existing capacity of a community to independently address its risk. This approach should emphasize feelings of empowerment in the community, supporting the notion that community members have the needed resources to reduce their vulnerability. The most successful way to implement seismic retrofits is to incorporate the work into planned maintenance and updates to URM structures. Avoiding duplications of work (like including retrofits during re-roofing projects) and streamlining processes, like permitting, are important to the success of the mitigation program.

Public engagement needs to be undertaken as early as possible to maximize stakeholder acceptance and participation. This engagement should be characterized as a good-faith effort of the jurisdiction to provide the community, including renters, home, building, and business owners the opportunity to be involved in their own public safety.

The list below contains stakeholders identified during the 2019 Utah URM Buildings Summit and the 2020 Wasatch Front URM Risk Reduction Strategy Development Meeting, as well as those identified in FEMA 275, **Planning for Seismic Rehabilitation: Societal Issues**. These stakeholders, along with the authors of this strategy, will contribute to the success of URM risk reduction programs in Utah.

Note: *The stakeholder list identified during the 2020 Wasatch Front URM Risk Reduction Strategy Development Meeting very closely matched the list previously identified during the 2019 Summit on URM Buildings.*

- Utah League of Cities and Towns.
- For-profit and public media outlets.
- Insurance companies and the Utah Insurance Department.
- School districts.
- Parent Teacher Associations.
- Utah Association of Building Officials.
- Lenders and banks.
- State and local civic organizations, such as Utah Civic Action Network, Envision Utah, and Community Emergency Response Teams.
- Homeowners and business owners.
- Realtors, developers and property owners.
- State and local politicians.
- BOMA of Utah.
- Utah DFCM.

Appendix G: Stakeholder Engagement Strategy

Table 22 is an outline of the recommended public engagement strategy to garner inclusive support and foster social equity in the implementation of a seismic retrofit program. The second phase of this project is intended to focus on the development of a replicable process to engage the whole community in equitable seismic resilience.

Table 22. Stakeholder Engagement Strategy

STAGE	ACTIVITY	TIMELINE	DONE	DETAILS	OWNER	IDEAS
Define and Identify	URM Summit	June 25-26, 2019	X	Convene local emergency managers, government officials, academics, researchers, leaders of nonprofits and faith-based organizations, journalists, and building design professionals to raise awareness about the URM hazard and identify actions and solutions that should be prioritized to reduce URM vulnerabilities.		
	Kickoff Meeting — Stakeholder Identification	Feb. 13, 2020	X	Develop list of stakeholders to engage in obtaining support for URM retrofits.		
Validate and Prioritize	Pre-Meeting **Education Campaign**			Campaign will provide context of the URM problem and invite the public to be part of the solution. Showcase local URM retrofits to demonstrate the local commitment to resilience (Salt Lake Temple, Squatters Pub, State Capitol, Fix the Bricks homes, etc.).		• Consider engaging the public arts and outdoor industry in this process. • Formal commitment from Mayor and elected officials to support retrofit process. • Reference FEMA 275, *Planning for Seismic Rehabilitation: Societal Issues.* • Reference Background and Chapter 1 of FEMA P-154, *Rapid Visual Screening of Buildings for Potential Seismic Hazards*. • Reference timeline of seismic accomplishments.
	Pre-Meeting **Interviews** with Building Owners, Realtors, Design Professionals, Home Builder Associations, etc.			Conduct interviews with key stakeholder groups to develop mutual partnerships supportive of retrofitting. Personally invite these groups to Meeting 1, ensure the value of their input, and seek their support to develop solution(s). Support is needed to gain internal access to privately owned structures to validate URM inventory.		• Develop interdisciplinary public-private teams to create implementation strategies.
	Engage in Outreach to Generate Meeting 1 Attendance					

Table 22. Stakeholder Engagement Strategy						
STAGE	ACTIVITY	TIMELINE	DONE	DETAILS	OWNER	IDEAS
Validate and Prioritize	**Meeting 1: Stakeholder Engagement for URM Inventory and Retrofit Program Goals**			Goal: Public acknowledgment of the hazard and risk; shape the solution and establish partnerships; and develop URM retrofit program goals. Objective: Obtain buy-in from stakeholders to help validate and prioritize URM buildings.		• Create incentives for registering as URM. • Develop recognition for participating in the Validation Process.
	Develop Process for Public Participation in URM Validation			*Reference FEMA P-154, Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook*		
	Post-Meeting 1: Continuation of **Education Campaign**			Campaign will provide the context of the URM problem and invite the public to be part of the solution. It will invite them to participate in the neighborhood validation process. Showcase local URM retrofits to demonstrate a local commitment to resilience. Consider engaging Natural History Museums, STEM programs and neighborhood gathering places (schools, breweries, etc.).		
	Design Professional **Workshops** for Neighborhood Survey			Train design professionals on Neighborhood Survey and URM Validation process.		
	Meeting 2: **Neighborhood Survey**			Involve public with design professionals in local URM validation.		
	Meeting 2a: Inventory Celebration and URM Prioritization			Involve all stakeholders in celebrating the validation of URM inventory and prioritizing structures for retrofit.		
Define Implementation and Build a Budget	Continue **Education Campaign**			Campaign will provide context for the URM problem and invite the public to be part of the solution. It will invite stakeholders to participate in the funding charrettes. Showcase local URM retrofits to demonstrate a local commitment to resilience. (Consider engaging local planning, neighborhood, business and insurance associations with facilitation support from local artists).		• Build market demand for seismic improvements.
	Host **Workshops** for Home Builders, Remodel Contractors, Homeowners, Building Owners, etc. on Process to Retrofit			Consider offering a certificate program (similar to California Earthquake Authority's Contractor Directory, a list of contractors who have completed training for seismic retrofit).		• Retrofit client classes. • Retrofit contractor education and training programs.
	Meeting 3: Conduct Stakeholder Charrettes for Preferred Funding Options			Review a series of funding options (from tax credits, TDR, to land use and zoning).		• Reference Portland Enhabit work.

Table 22. Stakeholder Engagement Strategy						
STAGE	ACTIVITY	TIMELINE	DONE	DETAILS	OWNER	IDEAS
Secure Resources and Implement	**Continue Education Campaign**			Shift focus to celebrating successes and (in real time) reduction of URM buildings. Showcase local URM retrofits to demonstrate the local commitment to resilience.		• Consider engaging the public arts for murals during construction. • Reference Port Townsend Mitigation Showcase for Commerce and community support of construction. • Develop awards and formal recognition process for retrofitted structures.

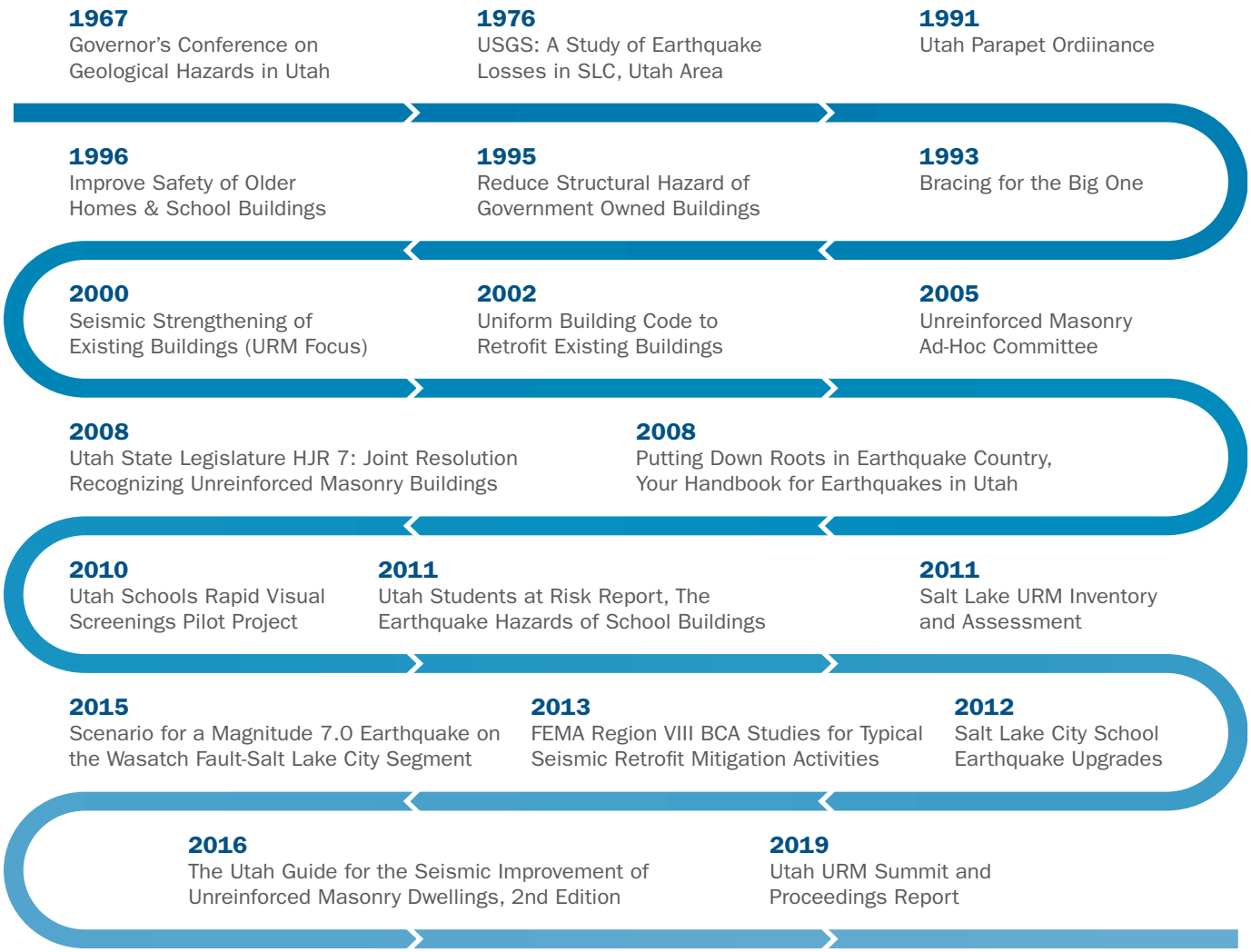
Note: *The Stakeholder Engagement Strategy can be substantially expanded through a continued partnership between FEMA, the state of Utah and Wasatch Front stakeholders. It is recommended that future efforts by this partnership focus on:*

1. *The development of stakeholder-specific communications informed by social science and DR-4548 (03/18/2020 M 5.7 Magna, UT Earthquake) post-event social listening analyses.*
2. *Supporting whole-community engagement to:*
   - **a.** *Encourage local ownership of URM retrofits.*
   - **b.** *Facilitate locally based funding strategies and knowledge of FEMA BRIC eligibility.*
   - **c.** *Facilitate equitable implementation of this document's recommendations.*

Appendix H: History of URM Risk Reduction Across the Wasatch Front

As previously shown in Section 2.4, Figure 5 provides a summary of key URM risk reduction investments and recommendations across the Wasatch Front. The purpose of showing this timeline is to document the local and national commitment to URM risk reduction and to display the history of mitigation investments made across the Wasatch Front. These have contributed to robust successes and lessons learned, informing the development of this Strategy. This appendix provides more information on each of these projects.

Figure 5. Timeline of Past URM Risk Reduction Investment and Recommendations along the Wasatch Front



1967 – Governor's Conference on Geological Hazards in Utah[1]

A Governor's Conference was convened by the Utah Geologic and Mineral Survey in 1967 to review the state's risk due to geologic hazards. The collection of a number of special studies included a consideration of the earthquake hazard in Utah. It noted that the Uniform Building Code's (UBC) recent changes to the zone of seismicity in central Utah (from a 2 to a 3) highlighted a greater seismic risk and included the possibility of the area being subject to magnitude 7.1 earthquakes. Additionally, in considering what more the state should be doing to mitigate earthquake risk, it was recommended that "all public and private buildings where large numbers of people gather – schools, churches, theaters, hotels, apartment houses, office buildings, etc. – should have earthquake-resistant features incorporated into their design by architects in accordance with zone 3 ratings for this region."

1976 – USGS: A Study of Earthquake Losses in SLC, Utah Area[2]

This USGS study focused on the potential earthquake damage to critical facilities in the Salt Lake City area, including Weber, Davis, Salt Lake and Utah counties. The study paid special attention to the damage potential in Salt Lake City, Ogden, and Provo, the three largest cities in Utah, and areas with high URM concentrations. A review of the history of seismic design requirements in the UBC concluded that, prior to 1961, buildings in these areas were only designed for gravity loads and wind forces. From 1961 to 1970, the seismic design guidance placed Utah in a zone 2 category (moderate risk) and from 1970 to present, it is a zone 3 (high risk). This guided the UBC's efforts in classifying the study area using a 1961 date as the dividing point between resistive and non-resistive brick structures. Additionally, it was noted that in larger cities, such as Salt Lake City, regular UBC updates were generally adopted within 3 to 6 months of publication; smaller cities required more time. Also, there was no major community in the study area that had adopted a parapet ordinance to address the dangers of those appendages at that time.

1991 – Utah Parapet Ordinance

In 1991, a statewide amendment to the UBC was adopted to address the known seismic hazard of parapets, chimneys and other building appendages. Sometimes referred to as the Utah Parapet Ordinance, this ordinance required the investigation and correction of these vulnerabilities when a commercial building was undergoing a re-roofing operation. The ordinance applied to buildings constructed prior to 1975, a rough benchmark of when these building elements were first addressed in Utah building codes (Utah Uniform Building Standard Act Rules, Statewide Amendments to the IBC [R156-56-704]).[3] Conformance to this amendment varied widely, with Salt Lake City being one of the more diligent jurisdictions enforcing the ordinance.

In 2000, the USSC created an interagency task force consisting of key Utah stakeholders. This task force worked over a period of several months to create and distribute an informational brochure explaining the ordinance and the procedures necessary to meet the requirements of the law. The brochure gave general information about relative costs and typical detailing, and equipped building officials and others in the building industry with convincing arguments regarding the need to remove these dangerous portions of existing buildings.

[1] Utah: Governor's Conference on Geological Hazards in Utah: https://digitallibrary.utah.gov/awweb/main.jsp?flag=collection&smd=1&cl=all_lib&lb_document_id=30920&tm=1587559274321

[2] USGS: A Study of Earthquake Losses in SLC, Utah Area: https://pubs.usgs.gov/of/1976/0089/report.pdf

[3] Utah Uniform Building Standard Act Rules, Statewide Amendments to the IBC [R156-56-704]: http://utrules.elaws.us/uac/r156-56-704

The Utah Parapet Ordinance was temporarily suspended under HB305 Construction Code Revisions[4] between 2012 and 2014. This was considered a setback and highlighted the need to be aware of proposed legislative changes to the construction codes and ordinances. Beginning in 2016, the amendment was no longer in effect due to the state's adoption of the IEBC, which contains a similar provision.

1993 – Bracing for the Big One *Seismic Retrofit of Historic Houses*[5] (Funding from Office of Historic Preservation and National Park Service)

This publication provides owners of historic homes information about seismic retrofits to improve life safety and how to minimize damage from a strong earthquake. It describes the risks from earthquakes in Utah and focuses on specific retrofitting techniques, as well as documentation and insurance options available for historic homeowners.

1995 – USSC Strategic Plan: Reduce Structural Hazard of Government-Owned Buildings

As part of its creation in 1994, the USSC was mandated to produce a strategic plan for earthquake safety in the state. It identified four objectives, one of which was to improve the seismic safety of buildings and infrastructure. One focus of this objective was to reduce the structural vulnerability of the government's approximately 4,500 buildings; roughly 2,300 were deemed to be essential in a catastrophic event. The USSC recommended detailed RVS (in accordance with ATC-21 and FEMA 154, *Rapid Visual Screenings for Potential Seismic Hazards*) and individual geologic hazards investigations be performed to assess the potential risk to the state.

This strategy was somewhat addressed in 2008 when the Utah State Legislature adopted House Joint Resolution 7 (HJR007): Joint Resolution Recognizing Unreinforced Masonry Buildings[6] (see Chapter 3, Recommendation #2 for more information). While the intent of the 1995 strategy was to focus on essential government buildings, some URM buildings were found to be emergency support facilities that would have directly affected the state's response to a major earthquake.

1996 – USSC Strategic Plan: Improve Safety of Older Homes and School Buildings

In 1996, the USSC issued a report titled "Earthquake Safety in Utah – A Progress Report on Activities for the Period July 1994 – June 1996." The report documented activities to improve earthquake safety in the two years since the creation of the USSC and presented the results of a survey sent to over 650 individuals and entities in both the public and private sectors. The following is an excerpt of one strategy from that report.

Strategy 3.6, *Improve Safety and Operational Ability of Older Public-School Buildings*, produced a number of recommendations and observations, including:

- The State Division of Risk Management's use of a policy of valuation change to determine insurance premiums or claim limits as an incentive for building upgrades.
- Significant replacement of buildings, either completed or in progress, in Salt Lake City, Morgan, Tooele, Beaver, Murray City, Grand, Provo and Jordan school districts.
- Seismic upgrade of 33 Granite School District buildings, or portions thereof, in the past several years, adding shear walls during major interior remodeling projects.
- Jordan School District's ongoing efforts to address seismic deficiencies identified in a 1990 vulnerability assessment. One high school, one middle school and two elementary schools have been replaced; three other elementary schools have been renovated to UBC seismic zone 3 standards.
- Replacement or retrofitting of all high schools by the Salt Lake City School District.[7]

[4] Utah House Bill 305, 2012: http://le.utah.gov/~2012/htmdoc/hbillhtm/HB0305.html
[5] Utah Division of State History/National Park Service: https://history.utah.gov/wp-content/uploads/2018/08/PRES_RES_BigOne.pdf
[6] Utah House Joint Resolution 7, 2008: https://le.utah.gov/~2008/bills/static/HJR007.html
[7] Salt Lake Tribune, 2012: https://archive.sltrib.com/article.php?id=53161695&itype=CMSID

This preliminary focus on addressing the vulnerability of older school buildings is an ongoing effort for the USSC and other school safety advocates in the state. Many existing schools are URM buildings, and some have been replaced, but the state still has an inventory of older school buildings needing to be addressed. See "Utah Schools Rapid Visual Screening Pilot Project" for additional information.

2000 – USSC Strategic Plan: Seismic Strengthening of Existing Buildings (URM Focus)

The December 2000 Progress Report of the USSC identified the following strategies that directly addressed the safety of URM buildings in the state.

- 3.1 — Enforce the state amendment to the UBC, which requires building owners to install roof anchors and parapet bracing when re-roofing buildings. *(It was found that only large, well-staffed jurisdictions, such as Salt Lake City, were enforcing this and some re-roofing was occurring without permits.)*
- 3.4 — Reduce structural vulnerabilities of government-owned buildings.
- 3.8 — Improve the safety of older high-occupancy buildings (250 persons or more) to be structurally sound enough to withstand moderate to large earthquakes.[8]

Beginning in 1999, the USSC began to explore the need for the adoption of model building codes related to the rehabilitation and retrofit of existing buildings. The focus was first on the state's overwhelming need to address URM buildings, but also included other hazardous building types. The USSC partnered with the SEAU in a joint process, informally termed the "Existing Buildings Initiative." The result was a white paper from the seismic committee of SEAU – "Seismic Strengthening of Existing Buildings" – that was presented to the USSC at their July 1999 meeting.

The 2000 Progress Report recommended that both organizations support a resolution for seismic retrofitting measures to be adopted by the state's UBCC. This was subsequently presented to the UBCC for consideration. In September 2000, the UBCC passed a resolution recommending, "local jurisdictions within the State of Utah [should] consider adoption of 'The Uniform Code for Abatement of Dangerous Buildings—1997,' 'The Uniform Code for Building Conservation—1997,' and 'The Guidelines for Seismic Retrofit of Existing Buildings—2000.'"[9]

In September 1996, the USSC presented a request to the Utah State Building Board—similar to a high-priority request USSC made to the Governor one year earlier—that $10.5 million be added to DFCM's annual budget to assess the seismic vulnerability of state buildings and to begin retrofitting those in most critical need.

A survey of 193 older state buildings indicated that 111 of the 193 buildings surveyed by that date needed structural upgrading. Despite the USSC's unsuccessful attempt in 1996 (and earlier in 1995) in advocating for dedicated state funding for progressively remediating the seismic vulnerability of older state-owned buildings, progress is being incrementally made in seismically strengthening selected buildings as part of significant remodeling projects. Standards for seismic safety of new state facilities are routinely enforced by DFCM.

During fiscal year 2000-2001, $36.7 million was appropriated to DFCM for improvement projects—separate from capital development projects—which enabled some seismic upgrades (e.g., seismic bracing when re-roofing). Some of the capital development projects also included seismic upgrades.

[8] USSC, 2000: http://digitallibrary.utah.gov/awweb/awarchive?type=file&item=16755, Pg. 17
[9] USSC, 2000: http://digitallibrary.utah.gov/awweb/awarchive?type=file&item=16755, Pg 18

Also, in September 2000, a committee consisting of representatives from the Structural Advisory Committee of the UBCC, SEAU and USSC published a brochure, *Earthquakes and Roofing—What You Need to Know About Seismic Bracing When Reroofing an Existing Building*. The brochure describes the "Utah Parapet Ordinance" (see "1991 – Utah Parapet Ordinance" above for additional information) and its implications, and is actively used in a statewide educational campaign. Both measures highlighted the difficulties of addressing the URM problem from the legislative perspective.

2002 – UBC to Retrofit Existing Buildings

With the transformation of the International Conference of Building Officials into the ICC, Utah's laws regarding the adoption of specific building codes required changes. Legislation sponsored by Sen. Parley G. Hellewell in 2002 (S.B.55) took the necessary steps to update the appropriate portions of the Utah Uniform Building Standards Act. In addition to making the necessary technical changes, this bill gave the Utah Division of Occupational and Professional Licensing (DOPL), in collaboration with the UBCC, the authority to approve "certain other codes" without the need to adopt them statewide. S.B.55 also gave the political subdivisions discretion to adopt building codes or rehabilitation codes if the applicable code is approved by DOPL.

This legislation resulted in the addition of the following construction standards for the regulation of existing buildings under the Utah Uniform Building Standards Act Rules (R156-56, Utah Administrative Code Issued July 17, 2003):

- 1997 Uniform Code for the Abatement of Dangerous Buildings.
- 1997 Uniform Code for Building Conservation.
- Guidelines for the Seismic Retrofit of Existing Buildings.
- Guidelines for the Rehabilitation of Existing Buildings.

2005 – URM Ad-Hoc Committee

In 2005, the USSC's ad hoc committee on URM buildings developed a resolution outlining the significant dangers of older existing brick buildings within the state. This effort focused on this dormant threat within communities and called for measures to inventory, prioritize and make recommendations to help lessen the significant risk posed by these buildings.

The resolution was approved by the USSC at its October 2005 quarterly meeting and was presented to the Government Operations Interim Committee on Nov. 9, 2005. The USSC resolution prompted extended discussion as legislators asked questions about its need and impact.

The committee proposed that an inventory of the state's URM buildings be based on the second edition of FEMA 154, *Rapid Visual Screenings for Potential Seismic Hazards*. This was envisioned as a means to quickly categorize buildings in need of additional study, as well as to screen out structures deemed safe. This work could then be used to help advise the state and individuals of the magnitude of the potential problem and create a framework to move toward solutions to address the issue before a damaging earthquake strikes Utah. This groundwork eventually resulted in HJR 7: Joint Resolution Recognizing URM Buildings (see the section below for more information).

2008 – Utah State Legislature HJR 7: Joint Resolution Recognizing URM Buildings

In 2008, the Utah legislature passed HJR7: Joint Resolution Recognizing URM Buildings, urging the USSC to compile an inventory of the state's public buildings constructed of URM. Second, the resolution asked the USSC to use these data to "recommend priorities to address the problem in a manner that will most effectively protect lives, property, and the economy of the state." There were no funds allocated for this work.

To initiate the inventory process, the state of Utah's public buildings database was used as the primary source of information. The inventory was completed by volunteers from the SEAU, using the date of construction and visual screening of photographs to classify the buildings.

An interim report intended to advise the legislature was developed but never released. The provisional findings identified 234 state-owned public URM buildings representing approximately 5.2 million square feet of property, and valued in excess of $1.3 billion. This well-intentioned effort was, unfortunately, hindered by a lack of funding and inability to inventory all the buildings initially identified. The USSC tried to sustain the effort over the years but was, ultimately, unable to complete the task.[10]

2008 – Putting Down Roots in Earthquake Country, Your Handbook for Earthquakes in Utah (funded by FEMA and the state of Utah)

Utah's *Putting Down Roots in Earthquake Country* (2008) publication is an adaptation from earlier California versions of the same title. It was prepared by the USSC, UGS, Utah DEM, University of Utah Seismograph Stations and the SEAU, in cooperation with the USGS and FEMA. It is a handbook providing information about the threat posed by earthquakes in Utah, particularly across the Wasatch Front. The handbook explains how to prepare for, survive and recover from these events.[11]

2011 – Utah Students at Risk Report, The Earthquake Hazards of School Buildings (funded by FEMA)[12]

Following a series of failed legislative efforts to fund a statewide RVS survey of all Utah schools, the USSC and the SEAU obtained a FEMA grant to conduct a pilot screening program to help characterize the need.

The FEMA NEHRP funded the development of a mobile-based platform – Rapid Observation of Vulnerability and Estimation of Risk (ROVER) – which automated the FEMA 154 RVS of Buildings for Potential Seismic Hazards. The Utah Schools RVS Pilot Project was funded by $69,000 in grants from FEMA and organized by the USSC and the SEAU, which conducted a ROVER RVS survey of the earthquake safety of 128 school buildings in Utah in September 2010. The findings revealed that 60% of the schools surveyed were vulnerable to risks from an earthquake and should have a more detailed study to assess their adequacy and need for rehabilitation. The report concluded that the pilot study underscored the need to have a statewide inventory and assessment of all Utah schools. It further emphasized the need for all students to be safe in school buildings during earthquakes and that URM schools should be eliminated or retrofitted as soon as possible.

While the report was careful to note that the schools in the pilot study were just a representative sampling, and the survey only identified buildings that needed a more detailed study, some direct concerns were targeted at the buildings in the survey. This had the unfortunate effect of making certain school districts vulnerable to criticism when the report suggested this was a state issue requiring a state-level response.

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[10] Utah House Joint Resolution 7, 2008: https://le.utah.gov/~2008/bills/static/HJR007.html
[11] Utah Seismic Safety Commission, 2008: https://www.utah.gov/beready/documents/roots_earthquake_low.pdf
[12] USSC/SEAU, 2011: https://ussc.utah.gov/pages/view.php?ref=147

After the ROVER pilot project, USSC and SEAU proposed a bill to the Utah Legislature to create a Utah School Seismic Hazard Inventory and recommended conducting the RVS of all Utah schools. HB 423 Public School Seismic Safety Committee (2011)[13] sought the creation of a committee consisting of four school districts and three structural engineer members. The bill did not pass, but in the spirit of moving forward, Utah's Governor added a $150,000 line item to help complete a statewide school survey.

2011 – Salt Lake URM Inventory and Assessment (funded by FEMA)

A FEMA-funded inventory and assessment of URM buildings was conducted in the Salt Lake Valley from 2010 to 2011. The work consisted of refining an existing Salt Lake County dataset of 65,000 "brick" buildings. The purpose was to identify URM buildings that posed a high level of risk following a major earthquake in Utah. The data were used to assist in the refinement of the Utah catastrophic earthquake hazard plan.

This project brought together the local engineering community (SEAU) with a new technology (ROVER) to efficiently inventory over 2,500 of Utah's most vulnerable buildings. It improved the accuracy of Hazus estimates, raised awareness, and underscored the potential impacts of URM buildings in the state.[14] As the project contractor, the SEAU deployed 50 civil and structural engineers to perform RVS on over 2,500 selected buildings using the ROVER software technology. The use of ROVER allowed for the building site data to be directly imported to a web-based accessible site and assigned to individual screeners. Screeners were then able to do field reviews and save work directly back to the database in real time. The project results ultimately lowered the number of URM buildings by reclassifying some structures as brick veneer wood-framed buildings and, therefore, reduced the projected exposure.

2012 – Salt Lake City School Earthquake Upgrades[15] (funded by local bonds)

Two Salt Lake City school bonds, totaling over $200 million, were passed with high voter approval in the 1990s because the city and parents of school-aged children had seen the effects of the 1989 Loma Prieta (San Francisco, California) earthquake and wanted their schools to be safe. This noteworthy effort expanded to $401 million over the next two decades. The funds were used to retrofit and replace the city's 36 school buildings.

The Salt Lake City School District also developed a program to improve non-structural components in schools. This highly detailed effort was unique in its scope and implementation.

This success story was the result of a concerted effort by the Salt Lake City School Board to educate and inform the residents of Salt Lake City of the need for safe schools. They developed outreach efforts to gain the support of employees, community councils, and special interest groups, who in turn supported investment in earthquake safety.

2013 – Region 8 BCA Studies for Typical Seismic Retrofit Mitigation Activities[16] (funded by FEMA)

This report was created to provide BCA information to FEMA Region 8 regarding structural seismic retrofit measures for URM buildings in the Salt Lake City region. The study considered four specific building types: URM residential, URM commercial and mercantile, URM multi-story, and older reinforced masonry shear wall and precast buildings (Hazus building types RM1 and PC1) and six different retrofit examples.

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[13] Utah H.B. 423 Public School Seismic Safety Committee: https://le.utah.gov/~2011/bills/static/HB0423.html

[14] Welliver_Utah-URM-Case-Study-Oregon-Workshop.pdf (eeri.org)

[15] Salt Lake Tribune, 2012: https://archive.sltrib.com/article.php?id=53161695&itype=CMSID & Robert B. Olshansky, Examples of Successful Seismic Safety Advocacy https://www.eeri.org/wp-content/uploads/Olshansky.pdf

[16] FEMA, 2013, Final Region VIII Benefit Cost Analysis Studies Report 05222013

The report concluded that the retrofit cost was relatively low and that seismic-only projects have only marginal benefits to achieve a BCR of 1.0 or greater. Life safety considerations achieve much of the benefit from retrofits, therefore, higher occupant buildings would see higher benefits.

2015 – Scenario for a Magnitude 7.0 Earthquake on the Wasatch Fault–Salt Lake City Segment[17] (funded by FEMA, developed by EERI Utah, and developed for USSC)

This scenario report provides information about the effects of a magnitude 7.0 earthquake on the Wasatch Fault - Salt Lake City segment. It describes how buildings, infrastructure, and the economy would be affected by a large earthquake, and how long it may take the state and its residents to fully recover. The report was developed by the Utah chapter of EERI for the USSC, and was funded by FEMA.

The goal of the report is to help drive public and private actions to increase pre-disaster resiliency, preparing the state and its residents to mitigate, respond to and recover from earthquakes.

The nine recommendations to the USSC include:

1. Inform the Governor's Office and the State Legislature.
2. Inform stakeholders.
3. Assess the post-earthquake operability of critical infrastructure.
4. Promote post-earthquake recovery planning by utility providers.
5. Advocate seismic retrofitting of vulnerable buildings.
6. Encourage adoption of policies for building occupancy resumption.
7. Promote enhancement and application of geologic hazards information.
8. Advocate continued support for critical seismic monitoring in Utah.
9. Advocate disaster resiliency planning.

The development of the report brought together a wide array of advocates with varied experience and a shared vision to clearly explain Utah's earthquake risk to local residents.

2016 – The Utah Guide for the Seismic Improvement of URM Dwellings, 2nd Edition[18] (funded by FEMA and the state of Utah)

The 2016 Utah Guide for the Seismic Improvement of URM Dwellings is an update of an earlier version created in 1996 by the Earthquake Preparedness Information Center. It was prepared to help owners of URM dwellings gain a better understanding of the need for seismic improvement of their dwellings. The document is intended for general informational use by homeowners and small residential contractors.

The guide uses a series of seven model URM building types to illustrate the various structural improvement details needed to reduce earthquake risks. It is intended to help engineers and architects design structure-specific improvements. As one

[17] EERI/DEM, 2015: https://www.eeri.org/projects/earthquake-scenarios/wasatch-fault-scenario/
[18] USSC, 2016: https://ussc.utah.gov/pages/view.php?ref=1281

example, Salt Lake City established a URM rehabilitation program titled Fix the Bricks (see Section 2.1 and Appendix C, Section C.4 for more information), which refers engineers and architects to the details contained in the guide. The Fix the Bricks program provides FEMA funding for bracing residential chimneys and roof-to-wall connections.

2019 – Utah URM Buildings Summit and Proceedings Report[19] (funded by FEMA and the state of Utah)

The Utah DEM and FEMA Region 8 co-hosted a summit in Salt Lake City, with the overarching goal of accelerating statewide progress on URM mitigation. The purpose of the summit, held June 25-26, 2019, was to raise awareness about the risk URM buildings pose to Utah communities, promote mitigation best practices, bring together diverse stakeholder groups, identify actions and solutions that should be prioritized to increase the state's resilience against large earthquakes, use recent earthquakes outside Utah to demonstrate recovery timelines, and highlight mitigation opportunities. More than 100 participants from diverse professional backgrounds participated in the two-day event.

A detailed summary of the summit's proceedings is presented in ATC 137-2, *Proceedings: FEMA-sponsored Summit on URM Buildings in Utah*.[20] The summit included plenary presentations and breakout sessions focused on financial and other barriers to URM-related mitigation, potential solutions and how to gain buy-in.

Project recommendations identified during the summit, and included in the report, focused on financials, communication and outreach, permitting, disclosure and legal requirements. "Lessons Learned" included insights from local and state efforts in Utah and other cities and states in the U.S. (e.g., Portland, Oregon; Los Angeles, California; and California statewide) and international earthquakes (including Christchurch, New Zealand). Participants discussed financial and social equity considerations, realistic expectations of URM retrofit performance, retrofit cost versus URM demolition/replacement, code enforcement, strategic prioritization of projects, and adequate training and staffing of building departments. Communication, public engagement and community awareness about disaster resilience were also discussed. The report concludes with a summary of participant recommendations to mitigate Utah's URM inventory.

HMGP

The definition of hazard mitigation used by both FEMA and DEM is "any cost-effective action taken to eliminate or reduce the long-term risk to life and property from natural and technological hazards." Studies by the National Institute of Building Sciences have shown that every $1 spent on earthquake mitigation measures saves $3 in future damages.[21] DEM administers FEMA's three federal mitigation grant programs connecting state, local, and tribal government representatives with resources to support implementation of hazard mitigation measures in their communities. The BRIC and FMA programs provide grant opportunities before disaster strikes, while the HMGP provides grants to implement mitigation measures following a major disaster declaration.

As of January 2020, the state of Utah had received over $24 million in federal funds and successfully implemented 45 structural and non-structural seismic mitigation projects through the PDM and HMGP programs.[22] Seismic projects represent more than half of the $43 million FEMA has awarded in federal assistance for projects in Utah through the three Hazard Mitigation Assistance grant programs.[23] The sections below describe three successful examples of seismic mitigation projects across Utah. For more information on FEMA mitigation grant programs and eligibility, refer to the current guidance for Hazard Mitigation Assistance at www.fema.gov/hazard-mitigation-assistance.

[19] ATC, 2020: https://www.atcouncil.org/docman/other-documents/271-atc-137-2-proceedings-urm-utah/file
[20] ATC, 2020: https://www.atcouncil.org/docman/other-documents/271-atc-137-2-proceedings-urm-utah/file
[21] National Institute of Building Sciences, 2019: https://www.nibs.org/page/mitigationsaves
[22] Utah DEM, 2020: https://utah-em.maps.arcgis.com/apps/MapJournal/index.html?appid=2a0a3c99a210467eaf12eefbb7cc859d
[23] FEMA E-grants Database, Report exported 4/15/2020

Fix the Bricks

Fix the Bricks is the centerpiece of a FEMA PDM grant awarded to Salt Lake City. Salt Lake City received this funding through a competitive grant application process three years in a row (2016-2018). Homeowners living in URM dwellings in Salt Lake City can receive FEMA funding to cover a significant portion (up to 75%) of seismic retrofit costs.[24]

Fix the Bricks particularly emphasizes two retrofit techniques to enhance life safety: 1) strengthening the roof-wall connection – enhancing the ability of the walls and roof to mutually support each other against collapse, and 2) bracing chimneys to prevent collapse.

Salt Lake City home with braced chimney

Fix the Bricks experiences strong public interest, with hundreds on the waitlist. Utah residents and their government officials are taking their high seismic hazard very seriously, and this program is just one of many successful mitigation efforts in Utah. Chapter 4 of FEMA P-774, Unreinforced Masonry Buildings and Earthquakes, states that "successful URM risk reduction programs benefit from the sustained support and efforts of individuals and organizations that recognize the value of earthquake protection and are willing to work for it."[25]

The majority of URM buildings in Utah have hit the historic threshold (50+ years old). Alterations to historic structures (including earthquake retrofits) are subject to state and federal Environmental and Historic Preservation (EHP) protections. As described in Appendix C, Section C.4, SLCHP staff closely coordinate with the City Building Department and the SHPO. These strong, pre-existing working relationships helped streamline the Fix the Bricks retrofit EHP reviews, which expedited retrofit projects while honoring EHP protections. The pre-identified retrofit techniques were sourced from *The Utah Guide for the Seismic Improvement of Unreinforced Masonry Dwellings*.[26] These techniques were given blanket approval for future projects by the SHPO and SLCHP, which significantly accelerated the project approval process.

Murray School District Retrofit Projects[27]

In 2011, Murray School District conducted a detailed risk assessment of its campuses as a part of a comprehensive capital planning effort. The district then developed a long-term plan, and Riverview Junior High School was determined to be the first priority for seismic risk mitigation. A major disaster was declared in August of 2011, making HMGP funds available to communities within the state. Murray School District successfully applied for available HMGP funds and was granted $910,516 for a seismic retrofit of Riverview Junior High School. The project included roof-to-wall connections and roof diaphragm retrofitting.

In 2013, Utah lawmakers approved a seismic study requiring all school districts that requested bond funding to perform structural seismic investigations on all public school buildings constructed before 1975. Also, in 2013, following the success of the Riverview Junior High School retrofit, Murray School District prepared a Multi-Hazard Mitigation Plan, making them eligible to apply for annual PDM funds. In 2014 and 2015, Murray School District secured two FEMA grants, totaling nearly $2 million, to perform seismic retrofits on four elementary schools in the district. These FEMA funds

Murray School District Retrofit

[24] Salt Lake City Emergency Management, 2019: https://www.slc.gov/em/fix-the-bricks/
[25] Federal Emergency Management Agency, 2009: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes
[26] Utah Seismic Safety Commission, 2016: http://www.slcdocs.com/historicpreservation/information/SI.pdf
[27] https://hazards.utah.gov/geologic-hazards/

supplemented a larger effort by the district to retrofit all 10 Murray School District campuses, utilizing $4 million dollars of local bond funds. Specifically, retrofit measures involved the installation of out-of-plane roof-to-wall connections, in-plane shear connections, and new roof diaphragms.

Seismic Retrofit of the Leonardo Museum

Until 2003, the site of the Leonardo had housed Salt Lake City's main library for almost 40 years. After a new library was planned, the city decided to renovate and remodel the structure to house a cultural center for programming arts, science events, classes, and exhibits. The original building was constructed in 1964 before any significant seismic-related building codes were enforced in Utah. In accordance with the Wasatch Front Regional Council Multi-Hazard Mitigation Plan, the city decided to retrofit the structure to meet current accepted seismic standards during the remodel. In 2007, the city applied for a PDM grant and secured over $1 million dollars of federal funding to assist with the seismic elements of the retrofit. The use of load-bearing, reinforced concrete masonry unit walls with various integral colors and finishes resulted in a structure that is both aesthetically pleasing and economical. This approach allowed the structural walls to serve as the finished exterior surface. The retrofit, combined with other elements in the remodel, led to a Leadership in Energy and Environmental Design Gold Certification.

The retrofit helps increase the safety of an estimated 500,000 annual visitors, students, employees, and volunteers, and provides a model to the community for reuse or retrofitting of existing structures to preserve the character of the downtown area. Although the building is not on the Historical Landmark Register, it is considered a historically significant example of mid-century modern architectural design. The city, FEMA, and project contractors coordinated with the SHPO to ensure that the proper design of the seismic bracing would maintain the historical elements of the building.

Salt Lake City Leonardo Museum

Appendix I: Case Studies and Lessons Learned

Case Studies of URM Risk Reduction Programs in the Western United States

Oregon URM Risk Reduction Efforts

Oregon state Sen. Peter Courtney championed legislation requiring all public schools and emergency facilities to have life safety standards.[1] To prioritize earthquake mitigation, the legislation requires RVS evaluation for:

- All school buildings with a capacity of 250+, and includes public K-12 schools, community colleges, and education service districts.
- Acute inpatient care facilities, fire departments or districts, and law enforcement agencies.

The agencies responsible for the school buildings and emergency facilities must use the inspection procedure defined in *Rapid Visual Screening of Buildings for Potential Seismic Hazards* (FEMA P-154).[2] Buildings deemed structurally vulnerable must be evaluated using the American Society of Civil Engineers Structural Engineering Institute Standard for *Seismic Evaluation and Retrofit of Existing Buildings* (ASCE/SEI 41), as well as any additional screening methods the responsible agency deems necessary.[3] The RVS/ASCE 41 results must then be submitted to the Oregon Department of Geology and Mineral Industries. If found to pose an undue risk to life safety during a future earthquake, the responsible agency must then pursue risk reduction, and "subject to availability of funding," any mitigation actions are required to be completed prior to Jan. 1, 2032 (schools) or Jan. 1, 2022 (emergency facilities).

Portland, Oregon

The city of Portland code addresses URM buildings in Chapter 24.85.[4] Seismic evaluation (using ASCE/SEI 41) triggers for all existing building types are: increases in occupancy (>150), increases in square footage (by 1/3), and major investments (about $184,000). For URM buildings, if the roof is replaced, wall anchorage must be provided. If more than a certain amount is spent (e.g., $42/sf, depending on the number of stories), then the roof must be improved to meet ASCE/SEI 41 requirements. If any building with a URM bearing wall is converted to live/work space, the entire structure is required to conform to the ASCE 41 "BPOE" improvement standard (described in Table 18, Appendix A, Section A.2.2, see also: Portland City Code Section 24.85.040)[5]. Statewide mitigation for commercial and residential URM structures is currently not mandated.[6]

A URM inventory in Portland, Oregon, revealed that the city contains 1,650 URM buildings, not counting single-family structures. These buildings contain 7,200 residential units. More than a third of the total URM buildings (567) are

[1] 2007 ORS 455.400, Effect of seismic rehabilitation provisions on exclusive remedy *https://www.oregonlaws.org/ors/2007/455.400*

[2] FEMA P-154, Rapid Visual Screening of Buildings for Potential Seismic Hazards: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

[3] ASCE/SEI 41-: Seismic Evaluation and Retrofit of Existing Buildings: https://ascelibrary.org/doi/book/10.1061/9780784414859

[4] City of Portland Code, Chapter 24.85 Seismic Design Requirements for Existing Buildings: https://www.portlandoregon.gov/citycode/28673

[5] FEMA Region VIII – Mitigation Division, Existing Unreinforced Masonry Buildings (URMs) in the State of Utah: Draft Findings on Developing Earthquake Mitigation Risk Reduction Strategies for URMs

[6] Yumei Wang, personal communication – March 27, 2020

designated as historic structures. To address this significant seismic risk, Portland convened three URM committees (Building Performance, Finance, and Policy), which deliberated the best approach from 2014-2018. These committees submitted joint recommendations to the Portland City Council in June 2018.

The URM committees' recommendations delineated four risk categories based upon building use and occupancy loading, which generally (but not exactly) track the Risk Categories outlined in ASCE/SEI 7 and the IBC. Each category has its own suggested mitigation measures and timelines for implementation; these categories are described in more detail in Appendix A, Section A.2.2. The Portland City Council took actions, including:

1. Required retrofits of public safety buildings, schools and community centers.
2. Established a new committee to consider future retrofit requirements, specifically for privately owned buildings.
3. Required that URM building owners notify tenants of the risk posed by these buildings and that URM warning placards be posted adjacent to URM building entrances, stating in a 50-point font: *"This is an unreinforced masonry (URM) building. URM buildings may be unsafe in the event of a major earthquake."*

The city of Portland received significant resistance from property owners who were dissatisfied with the requirement that the URM warning placards explicitly label their buildings. The placarding requirement was challenged in the U.S. District Court as a violation of the First Amendment (it was argued that the warnings were placed against the will of the building owners, and therefore represented government-compelled speech) and 14th Amendment (the city cannot impose laws that limit the rights of all U.S. citizens – in this case, the First Amendment – without due process). The plaintiffs prevailed, and the mandatory placarding requirement was repealed. Lessons learned during Portland's URM mitigation efforts are provided below.

The city of Portland developed a URM inventory database that failed to withstand scrutiny in court due to several factors, including:

- Lack of documentation by engineering students conducting the URM identification survey.
- Difficulty in conclusively defining a building as a URM from the exterior (inspectors did not enter buildings).
- The self-imposed discrediting of the data, made by the city website's disclaimer of the database, which read "The city of Portland makes no representations, express or implied, as to the accuracy of this database."[7]

The following bullets provide a summary of a 2019 court ruling against the city of Portland, where the classification of URM buildings faced constitutional scrutiny.[8] The judge's ruling against the city found flaws with:

- **The singling out of URM buildings:** The city's URM Standards Committee identified that soft-story construction, non-ductile concrete, and all buildings in liquefaction zones would also perform poorly in a major earthquake. However, these factors were not included in the city's placarding requirement (underinclusive).[9]
- **The level of reinforcement required to be exempt from URM status:** The city's provisions did not distinguish between URM buildings that had undergone some form of seismic retrofit (despite not meeting standards laid forth in the provisions) from those having never received seismic retrofits (overinclusive).

[7] Masonry Building Owners of Oregon v. City of Portland, Opinion and Order, 5/30/2019, Document 86, Case 3:18-cv-02194-AC, United States District Court, District of Oregon, Portland Division

[8] Masonry Building Owners of Oregon v. City of Portland, Opinion and Order, 5/30/2019, Document 86, Case 3:18-cv-02194-AC, United States District Court, District of Oregon, Portland Division

[9] Masonry Building Owners of Oregon v. City of Portland, Opinion and Order, 5/30/2019, Document 86, Case 3:18-cv-02194-AC, United States District Court, District of Oregon, Portland Division

- **Inventory:** The court concluded that "the URM database is flawed, and erroneously puts the burden on building owners to disprove its accuracy," that it "falsely identifies some buildings as unreinforced," that it "erroneously identifies some buildings as constructed of URM," and that "the methods used to gather information for the database were neither scientific nor reliable."[10]
- **Mandatory Placarding:** The city could not draw a clear and direct link between the mandatory placarding and a) encouraging Drop-Cover-Hold On and b) developing market pressure to retrofit URM buildings.

While defining the classifications for what constitutes a URM may seem straightforward, it is important to explicitly define the qualifying characteristics to ensure a legally sound and robust foundation for a retrofit program. Based on the lessons learned from Portland, when classifying URM buildings, one must clearly define:

- Construction type(s) and material(s).
- Trigger years (year built, local modern code adoption milestones).
- Required retrofits and corresponding documentation needed to be exempt from URM status.

Following the District Court ruling against the city of Portland, the city adopted new measures, such as:

- Engage a broader group of stakeholders. The National Association for the Advancement of Colored People was a vocal opponent of Portland's ordinance because its constituents perceived that mandatory placarding was likely to encourage retrofits, the costs of which would be passed along to tenants who would then be priced out of the already expensive market.
- Emphasis should have been placed on public safety risks (falling bricks onto city streets and sidewalks, etc.).
- The Committee recommended "that the city should not move forward with a mandatory seismic retrofit program" until financial assistance and support is in place.

The second recommendation above echoes feedback from engineer David Bonowitz, who notes, "The public modifier is significant, as URM buildings are notorious for killing more people on adjacent sidewalks than occupants within the building."[11] It follows that this argument, which implies that URM buildings are more dangerous than the other vulnerable structure types in question, must be made explicit (with quantifiable data, if possible) to legally justify prioritizing URM risk reduction efforts over those targeting other structure types also known to be susceptible to earthquake damage. Given the prevalence of URM buildings across the Wasatch Front, the volume of the inventory itself likely goes a long way toward implicitly addressing this point, but further justification is needed. Building a URM mitigation program explicitly around the issue of public safety would align with the Circuit Court's ruling against Portland, which stated that "…promoting public safety is a compelling governmental interest…".[12]

[10] Masonry Building Owners of Oregon v. City of Portland, Opinion and Order, 5/30/2019, Document 86, Case 3:18-cv-02194-AC, United States District Court, District of Oregon, Portland Division

[11] Memorandum from David Bonowitz to Jon Heitz (ATC), Review of Portland and Seattle URM Retrofit Program Recommendations

[12] Masonry Building Owners of Oregon v. City of Portland, Opinion and Order, 5/30/2019, Document 86, Case 3:18-cv-02194-AC, United States District Court, District of Oregon, Portland Division

Washington URM Risk Reduction Efforts

In 2018, the Washington State Legislature directed the Department of Commerce and the Department of Archaeology and Historic Preservation to develop a statewide inventory of URM commercial and multi-family structures (single-family housing was not included).[13] This effort identified over 3,000 "suspected" URM buildings statewide, and is intended to inform URM mitigation efforts led by state and local government agencies, as well as the private and nonprofit sectors.

Seattle, Washington[14]

The city of Seattle established a URM Policy Committee to propose parameters for a mandatory URM seismic retrofit program to Seattle's Department of Construction and Inspections. The Committee's recommendations are:

- URM risk reduction must be mandatory for all commercial and 3+ unit residential URM buildings (with allowance for an adequate appeals process). Residential buildings limited to one or two units are exempt because of their low prevalence in Seattle and their lower risk relative to multi-family buildings.
- Commercial and multi-family URM buildings must be classified into one of three "vulnerability categories" to prioritize appropriate actions for these combinations of use and occupancy; more detail is provided in Appendix A, Section A.2.2. Of note is Seattle's consideration of the potential ground shaking amplification, and liquefaction of, certain soil types found beneath the city. Both geologic phenomena can increase earthquake damage; they are also likely to occur in Salt Lake City during a large earthquake.[15]
- Seattle's URM Policy Committee's recommendations include establishing a retrofit program requiring the following steps:
    1. Notify owners of properties preliminarily identified as URM buildings. Notification should include information on Seattle's URM program goals, requirements and funding or incentive opportunities.
    2. Official engineering assessment of the structure type – using a standardized approach – at the property owner's expense.
    3. Application for permit to complete retrofit work.
    4. Permit approval.
    5. Retrofit completion.
- The Committee recommended the following timeline for URM policy compliance:

[13] Unreinforced Masonry Building Inventory - Washington State Department of Commerce: https://www.commerce.wa.gov/about-us/research-services/unreinforced-masonry-building-inventory/

[14] Recommendations from the Unreinforced Masonry Policy Committee to the City of Seattle: https://www.seattle.gov/Documents/Departments/SDCI/Codes/ChangesToCodes/UnreinforcedMasonry/URMFinalRecommendations.pdf

[15] Recommendations from the Unreinforced Masonry Policy Committee to the City of Seattle: https://www.seattle.gov/Documents/Departments/SDCI/Codes/ChangesToCodes/UnreinforcedMasonry/URMFinalRecommendations.pdf

Timeline for URM Policy Compliance			
	Critical vulnerability URMs	High vulnerability URMs	Medium vulnerability URMs
Notification	year 0	year 0	year 0
Assessment	+1 year	+2 year	+3 year
Apply for permit	+1 year	+2 year	+2 year
Approve permit	+1 year	+1 year	+1 year
Retrofit completion	+4 year	+5 year	+7 year

Table is from page 8 of the Recommendations from the Unreinforced Masonry Policy Committee to the City of Seattle.

The URM Policy Committee offered several suggestions to make the URM policy successful, including:

- **Make the policy clear and easy to understand and implement.**
- **Encourage property owners to retrofit beyond the minimum requirements.**
- **Retrofit as soon as possible to reduce risk.**
- **Develop a coalition of support to ensure successful policy implementation.**

Lessons learned during policy development include:

- **Do not levy generalized fines for noncompliance. Financial challenges are impediments to retrofit initiation, so fines are ultimately a disservice to the program's success and present a potential conflict of interest. Any fines levied should be earmarked for offsetting retrofit costs for the same building being fined.**
- **Emphasize funding sources that already exist, rather than ones that could be developed.**
- **Retrofit costs could result in small businesses and small property owners selling properties to developers, which could result in demolition.**
- **Consider social equity (all quoted from p. 21-22 of Recommendations from the Unreinforced Masonry Policy Committee to the City of Seattle).**
  - "Retrofits are costly, and owners will need to recover the costs of the work. The result will likely be higher commercial and residential rent. This rent increase is, in turn, likely to add to the displacement of these tenants and add to the overall gentrification of our neighborhood."
  - "Community Liaisons, formerly Planning Outreach and Engagement Liaisons, are cultural leaders in immigrant and communities of color. Their outreach was most effective in reaching cultural groups."
  - "Technical subjects are difficult for Community Liaisons to understand and explain to their cultural groups; it is best if city technical staff attend meetings with Community Liaisons to address more complex issues."

- "The neighborhood survey – walkthrough – was a very effective education and outreach tool; a non-threatening approach."
- "Working with cultural groups is more time-consuming than more traditional outreach. For example, presentations take longer if there is a translator, and accommodating cultural norms such as sharing a meal extends meeting times."

Proposed funding ideas include:[16]

- **Transfer of Development Rights:** URM owners can raise retrofit capital by selling their property rights (based upon zoning designations) to developers in other areas of the city who are hoping to build higher than their local zoning permits.
- **Federal Rehabilitation Tax Credit:** Can be monetized (through investor engagement) to "cash out" the tax credit to fund retrofits.
- **PACE financing:** Loan repayment is rolled into property taxes and spread across many smaller repayments.
- **Assessment Districts:** Public financing of a subset of properties (e.g., URM buildings). These districts can access financing at lower rates than those offered by private lenders. Note: projects must exhibit broader benefits beyond any single property (suggest looking at risk mitigation for adjacent properties, sidewalks, roads, etc.).
- **HUD 108 Loans:** Inexpensive lending through the Community Development Block Grant Program. Works well with affordable housing or community development projects.
- **Opportunity Zones:** Private investors can invest capital gains in designated areas of the state, which could provide low-cost capital for retrofits.

Based on the recommendations made by the URM Policy Committee to the city of Seattle, the city intends to pursue some of the mandatory ordinances listed above, but none are finalized.

The nonprofit sector has already become engaged in URM mitigation in Washington. Roughly two-thirds of the 31 red-tagged buildings damaged by the 2001 Nisqually earthquake in Washington were URM buildings, and many had historical significance. Historic Seattle, a local nonprofit, quickly jumped into action and offered $10,000 grants for historic building owners to fund structural stability studies. Historic Seattle's goal was to encourage historic building owners to invest in retrofits rather than demolition. Through its grants, Historic Seattle was able to enhance life safety while pursuing its mission of preserving Seattle's historic architecture.[17]

California URM Risk Reduction Efforts

The Long Beach, California, earthquake of 1933 resulted in widespread damage to URM buildings in the Long Beach area. Consequently, California adopted the Riley Act,[18] which required local governments to create building code enforcement departments responsible for issuing building permits and enforcing construction adherence to building codes. The adoption of the UBC soon followed. URM buildings are incapable of meeting the requirements of the UBC, so their construction was implicitly banned statewide.

[16] Funding URM Retrofits: Report to City of Seattle from National Development Council: http://www.seattle.gov/Documents/Departments/SDCI/Codes/ChangesToCodes/UnreinforcedMasonry/FundingURMRetrofits.pdf

[17] FEMA, 2009, *Unreinforced Masonry Buildings and Earthquakes: Developing Successful Risk Reduction Programs*, FEMA P-774: https://www.fema.gov/emergency-managers/risk-management/building-science/ear

[18] California Legislature (1933). "Session Laws of the California Legislature." Chapter 601, Statutes of 1993, 50th Session.

Moving forward to 1986, California passed Senate Bill 547,[19] which requires local governments whose footprints overlap UBC Seismic Zone 4 (UBC's highest earthquake hazard zone) to:

- Inventory all URM buildings.
- Establish a "loss reduction program" for documented URM buildings by 1990.
- Report mitigation progress to the California Seismic Safety Commission.

Note: *For more detail, see page 4 of FEMA Region 8's Draft Findings on Developing Earthquake Mitigation Risk Reduction Strategies for URMs.*[20]

California City Programs

This section presents three case studies, in increasing levels of rigor, to illustrate the breadth of mandatory URM mitigation possibilities

Earthquake Warning Placard

California Senate Bill 547 mandates that local jurisdictions implement URM loss reduction programs, but provides significant room for local discretion in how these programs are executed. Three case studies are described below to illustrate the diversity of ways in which the law was implemented.[21]

1. **Posting URM risk placards on the outside of buildings:** Many California jurisdictions[22] have taken the step of requiring warning signs be posted at URM entry points to alert entrants and passersby of the potential risk posed by falling bricks in the event of a damaging earthquake. Figure 6 provides an example of signage wording and placement on a building exterior in San Louis Obispo, California. While this approach has seen widespread use in California, a Portland court deemed the city of Portland's attempt to implement a similar requirement unconstitutional; see Appendix I for additional information.

2. **Fines on the property owner:** The city of Oakland mandated compliance with a retrofit level known as Bolts Plus. This approach requires that:

    - Walls must be tied to the floors and roof.
    - Parapets must be braced.
    - Diaphragms must be strengthened.
    - Tall brick walls must be strong backed to avoid out-of-plane collapse.

    Oakland backed up these requirements through disciplinary actions such as:

    - $1,000 fine for missed permit (engineering) analysis deadline.
    - $2,000/month fine for missed upgrade deadline.
    - Other more severe punishments if deadlines continue to be ignored.

[19] California Legislature (1986). "The URM Law." California Government Code Section 8875, CA, USA.
[20] FEMA Region VIII – Mitigation Division, Existing Unreinforced Masonry Buildings (URMs) in the State of Utah: Draft Findings on Developing Earthquake Mitigation Risk Reduction Strategies for URMs
[21] Seattle Department of Construction & Inspections, Summary of CA Programs: Enforcement: https://www.seattle.gov/Documents/Departments/SDCI/Codes/ChangesToCodes/UnreinforcedMasonry/EnforcementApproachesInCACities.pdf
[22] Unreinforced Masonry Buildings: Don't Play the Odds.

3. **Forced vacate order and demolition:** San Diego has made significant progress through mandatory retrofit programs.[23] Of the 884 URM buildings identified in the city, only 18 remain. These have been, or are subject to, referral to the city Nuisance Abatement Unit. Should they not be retrofitted, these buildings are at risk of forced vacation and demolition.

Berkeley

The city of Berkeley assesses a 1.5% tax on real estate transactions. To incentivize earthquake retrofits, Berkeley offers to refund the buyer 0.5% of the purchase price (up to $2,000). In its first decade, this program successfully incentivized 12,000 retrofits.[24] One takeaway from this approach is that local jurisdictions may find it easier to justify offering building owners a portion of future jurisdiction revenue, rather than committing to proactively identifying, appropriating, and providing retrofit funding directly.[25]

Oakland

In addition to the mandatory requirements listed above, the city of Oakland also offered retrofit financial incentives to property owners. Recognizing permitting fees were an impediment to robust progress on retrofits, with fees totaling 10% of total retrofit costs (ranging from $7,000 to $30,000), the city offered the following incentives:

1. A reduced, flat retrofit permitting fee of $250.
2. New Homeowner Voluntary Seismic Strengthening Reimbursement Incentive Program,[26] with reimbursements of up to $5,000 for completed and inspected retrofit projects.

In combination, these efforts reduced the overall retrofit costs and made it easier for homeowners to afford city inspections of the work to ensure its safe execution. Oakland provides an example of balancing strong mandatory requirements with robust financial incentives to reduce the economic burden for building owners.

Other issues to consider include:

- Inventory and adoption of a voluntary standard before a mandatory ordinance. A perspective on this approach is shared below.
  - "Absent the political support for a mandatory ordinance, the act of alerting building owners and providing them with a standard to retrofit allows the willing to take effective action. Absent a standard to point to, most building owners won't know what to ask for from an engineer if they want to do the work. These steps are required for a mandatory ordinance, so you've also done some of the hard work necessary to pass/implement a mandatory ordinance."[27]
- Multi-benefit upgrades. A perspective on this approach is shared below.
  - "We've been working for a while to try and build synergies with the energy, water, decarbonization, wildfire, and building health retrofit practices. These other efforts have the same challenges we have, they just focus on a different goal. We've identified many possible synergies (e.g. chimneys) but haven't yet turned these opportunities into concrete action. More to come…"[28]

[23] City of San Diego, Unreinforced Masonry Buildings: https://www.sandiego.gov/department/unreinforced-masonry-buildings
[24] City of Berkeley Finance Department, Seismic Retrofit Program & Refund Guidelines: https://www.cityofberkeley.info/uploadedFiles/Finance/Home/Files/Seismic%20Refund%20Program%20Guidelines.pdf
[25] FEMA, 2009, *Unreinforced Masonry Buildings and Earthquakes: Developing Successful Risk Reduction Programs*, FEMA P-774: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes
[26] City of Oakland, New Homeowner Voluntary Seismic Strengthening Reimbursement Incentive Program: https://www.oaklandca.gov/documents/new-homeowner-voluntary-seismic-strengthening-reimbursement-incentive-program
[27] Michael Germeraad, Association of Bay Area Governments, personal communication – April 13, 2020
[28] Michael Germeraad, Association of Bay Area Governments, personal communication – April 13, 2020

Appendix J: Post-Disaster URM Risk Reduction Strategies and Recommendations

The 2020 Magna earthquake revealed several issues specifically related to URM buildings. The post-earthquake safety evaluation tagging of buildings, and the establishment of protocols for response to addressing repairs, highlighted the need for more preparations in this area. The unique attributes of URM construction in Utah warrant a review and update of ATC-20-1 *Field Manual: Procedures for Postearthquake Safety Evaluation of Building*s inspection and tagging protocols for Utah-specific construction methods and building types.

The *Post-Earthquake Considerations*, provided below, and FEMA P-2055, *Post-disaster Building Safety Evaluation Guidance,* offer guidance that should collectively be used as a starting point for the improvement of both pre- and post-disaster URM safety evaluation, repair and rebuilding.[1] The following sections discuss these considerations.

Pre-Earthquake Considerations

Preparing for Post-Earthquake Response

The Magna 2020 earthquake highlighted the need for jurisdictions to have plans and protocols in place before an event and to have the ability to quickly respond. It also made clear the need for rapid evaluation of affected buildings. The affected cities and counties needed to deploy first responders to quickly assess the overall damage and estimate the need for additional resources. There was also a need in the days following the event to provide rapid training (ATC 20) of building officials to assess damaged buildings. The need for building departments to process the inspections, respond to the public regarding the extent of damage, and evaluate building owner proposals to repair documented damage, was overwhelming. Additionally, the complications of the COVID-19 pandemic introduced unique inspection challenges. This highlights an important lesson: for a variety of reasons, in-person inspections may need to be suspended, and new methods of data collection, review and tagging will need to be established.

URM residential building construction in Utah has many distinct differences that are not adequately addressed in the standard ATC 20 trainings. Double wythe wall construction is common for single-story homes, which often have no interconnecting ties and no bond beam or wood plate at the top of the wall. Consequently, they pose a unique risk, and procedures for evaluating these buildings for safety may need to be re-examined. On a related note, BHW Engineers determined that existing guidance for post-earthquake chimney inspection proved insufficient during structural engineering inspections following the Magna earthquake.[2]

Finally, it is important that building departments have a robust pre-disaster inspection program (e.g., Salt Lake City's Building Occupancy Resumption Program) to pre-identify areas of greatest concern in a given building; these inspections should emphasize functional recovery.[3] In addition to highlighting mitigation opportunities, these pre-inspections enable businesses to pinpoint the key points of potential structural or nonstructural failure that should be prioritized for inspection after an earthquake. Building Occupancy Resumption Programs facilitate business reoccupation and incremental resumption of operations, thereby accelerating the economic recovery of an earthquake-impacted community.

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[1] FEMA P-2055, Post-disaster Building Safety Evaluation Guidance: https://www.fema.gov/emergency-managers/risk-management/building-science
[2] Welliver, Post Magna Earthquake URM Performance, 2020
[3] http://www.slcdocs.com/building/BORP_March_2014.pdf

Post-Earthquake Considerations

Preparing for Post-Earthquake Assistance.

While most of this document deals directly with mitigating URM risk before an earthquake strikes, there are also some unique, potentially time-sensitive mitigation opportunities that arise in the immediate aftermath of a damaging earthquake. It is imperative to have a plan in place (both on a community scale and, in some cases, on an individual building scale) to make the most of any available response and recovery funding that may create a window of mitigation opportunity.

Following a Presidential Major Disaster Declaration, the FEMA Public Assistance (PA) program typically funded the repair of eligible publicly owned (and some private nonprofit) buildings to pre-disaster condition, or as required to meet locally adopted building codes, depending on certain criteria. However, beginning in 2017, PA policy now requires repairs to meet the latest edition of applicable building codes and standards. In some cases, it may even result in the requirement of retrofits or improvements to the building's structural systems. In addition, through the 406 Hazard Mitigation Program, additional funds may also be available to enhance the facility beyond its pre-disaster condition or code requirements to mitigate future similar damage. This is a unique and logical opportunity to build back better during repairs.

As described in Appendix D, Section D.2.2, HMGP funding is provided to states that have received a Major Disaster Declaration. In fact, HMGP funding can be used to fund earthquake mitigation, regardless of the hazard that caused the disaster. For example, HMGP funding resulting from a flood could be used to seismically retrofit a URM elementary school. Project prioritization with HMGP funding is made by the state and submitted to FEMA for additional eligibility review.

Communities affected by disasters are often recipients of individual and philanthropic donations to support the rebuilding process. Those with a strong vision of how they intend to rebuild will be well-positioned to accept and make efficient use of these donations. While repairs to damaged URM buildings would be helpful, mitigation to prevent future damage to URM buildings could also help ensure a resilient recovery of the community, particularly when aftershocks are taken into consideration.

Following a damaging earthquake, local jurisdictions will be presented with many pressing decisions. These include what level of repairs and rebuilding should be allowed, how to enforce code requirements such as those in the IEBC, and how to accommodate the increased work and permitting needed for repairing and retrofitting buildings. URM buildings pose a particularly thorny problem, and being prepared to make important policy decisions is critical; therefore, time spent beforehand evaluating what impact these decisions will have on the community will be beneficial. For example, by proactively defining repair standards for URM buildings, the state will not need to develop them under emergency circumstances.

Post-earthquake evaluation and repair guidelines also need to be developed to ensure the consistent application of the Disproportionate Earthquake Damage trigger per the 2018 IEBC; this condition is triggered when, generally speaking, a building is damaged in excess of what would be expected given the level of ground shaking. In particular, quantitative methods to establish the 10% reduction in capacity for archetypical URM buildings in Utah will be valuable to help apply this provision with consistency. In consideration of the dramatic workload increase for building departments following a disaster, Sections 402 and 406 of the Stafford Act, as amended by Section 1206 of the DRRA, authorize FEMA to provide assistance for building code and floodplain management ordinance administration and enforcement. This assistance can support assessments for substantial damage compliance for a period of no longer than 180 days after the date of the Major Disaster Declaration.[4] This additional funding from FEMA will benefit communities after a disaster as they work through the process of repairing or replacing buildings to protect the health and safety of building occupants.

[4] FEMA Policy FP 204-079-01: https://www.fema.gov/about/reports-and-data/guidance

Once an earthquake has occurred, there are a number of issues that may arise regarding the repair and rebuilding process. If the earthquake receives a Major Disaster Declaration that includes PA eligible grants, FEMA Recovery Interim Policy FP 104-009-11, *Consensus-Based Codes, Specifications and Standards for Public Assistance*, will apply to PA grants for publicly owned (and some private nonprofit) buildings that have been damaged and are in need of repair. While this FEMA policy would require PA grant-funded repairs to meet the latest edition of any applicable building codes and standards, the Substantial Structural Damage and Substantial Damage provisions found in the IEBC, or IRC, would apply to all buildings, including privately owned buildings and some residential buildings.

Some questions for consideration include:

- Do buildings undergoing repairs require seismic strengthening to higher levels than originally designed?
- Should certain building types be restricted from being repaired without improved seismic performance?
- What levels of code performance should be considered?
- Are functional recovery goals needed for certain types of buildings?

Additional information regarding these and other important considerations and requirements can be found in:

- FEMA Recovery Interim Policy FP 104-009-11, *Consensus-Based Codes, Specifications and Standards for Public Assistance*.[5]
- FEMA P-2055, *Post-disaster Building Safety Evaluation Guidance*.[6]
- IEBC.[7]
- ***Understanding Substantial Structural Damage in the International Existing Building Code***. [8]
- *Understanding Substantial Damage in the International Building Code, International Existing Building Code, or International Residential Code*.[9]
- ASCE/SEI 41, *Seismic Evaluation and Retrofit of Existing Buildings*.[10]
- FEMA P-2006, *Example Application Guide for ASCE/SEI 41-13 Seismic Evaluation and Retrofit of Existing Buildings; with Additional Commentary for ASCE/SEI 41-17*.[11]
- FEMA P-58, *Seismic Performance Assessment of Buildings*.[12]
- FEMA 306, *Evaluation of Earthquake Damaged Concrete and Masonry Wall Buildings: Basic Procedures Manual*.[13]
- FEMA 307, *Evaluation of Earthquake Damaged Concrete and Masonry Wall Buildings: Technical Resources*.[14]
- FEMA 308, *The Repair of Earthquake Damaged Concrete and Masonry Wall Buildings*.[15]

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[5] FEMA Recovery Interim Policy FP 104-009-11, *Consensus-Based Codes, Specifications and Standards for Public Assistance:* https://www.fema.gov/about/reports-and-data/guidance

[6] FEMA P-2055, Post-disaster Building Safety Evaluation Guidance: https://www.fema.gov/emergency-managers/risk-management/building-science

[7] ICC, 2018 International Existing Building Code: https://codes.iccsafe.org/content/IEBC2018

[8] FEMA, Understanding Substantial Structural Damage in the International Existing Building Code: https://www.fema.gov/sites/default/files/2020-07/pa_job-aid_understanding_ssd_International.pdf

[9] FEMA, Understanding Substantial Damage in the International Building Code, International Existing Building Code, or International Residential Code: https://www.fema.gov/sites/default/files/2020-07/pa_job-aid-understanding_sd.pdf

[10] ASCE/SEI 41-17, Seismic Evaluation and Retrofit of Existing Buildings: https://ascelibrary.org/doi/book/10.1061/9780784414859

[11] FEMA P-2006, Example Application Guide for ASCE/SEI 41-13 Seismic Evaluation and Retrofit of Existing Buildings; with Additional Commentary for ASCE/SEI 41-17: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

[12] FEMA P-58, Seismic Performance Assessment of Buildings: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

[13] FEMA 306, Evaluation of Earthquake Damaged Concrete and Masonry Wall Buildings: Basic Procedures Manual: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

[14] FEMA 307, Evaluation of Earthquake Damaged Concrete and Masonry Wall Buildings: Technical Resources: https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

[15] FEMA 308, The Repair of Earthquake Damaged Concrete and Masonry Wall Buildings https://www.fema.gov/emergency-managers/risk-management/building-science/earthquakes

Appendix K: Example City — Level Model Voluntary Retrofit Programs and Mandatory Retrofit Ordinances

As described in Appendix J, many municipalities have already passed local ordinances and implemented mitigation programs to address their URM risk. This brief Appendix is provided to direct state and local officials to example language of local-level URM mitigation programs and ordinances that have been successfully implemented in California. The below examples are not exhaustive; many other such examples exist and can be referenced by communities interested in taking steps to mitigate URM risks.

Voluntary examples:

- City of Berkeley.[1]
- California Earthquake Authority.[2]

Mandatory examples:

- St. Helena, California.[3]
- Napa, California.[4]

[1] Berkeley Seismic Retrofit and Refund Guidelines: https://www.cityofberkeley.info/uploadedFiles/Finance/Home/Files/Seismic%20Refund%20Program%20Guidelines.pdf
[2] California Earthquake Authority Brace + Bolt Program: https://www.earthquakebracebolt.com/
[3] St. Helena Municipal Code: https://www.codepublishing.com/CA/StHelena/#!/StHelena15/StHelena1540.html
[4] Napa Municipal Code: https://qcode.us/codes/napa/

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Appendix M: Project Participants

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