

California Earthquake Authority

South Napa Home Impact Study

Phases 1 and 2 Integrated Findings Report

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LIST OF ACRONYMS AND TERMS

CREIA	California Real Estate Inspection Association
DIY	“Do It Yourself”
FEMA	Federal Emergency Management Agency
HTI	House Type Index
<i>in situ</i>	Latin phrase meaning ‘in place’
MMI	Modified Mercalli Intensity (earthquake shaking impact scale)
OSB	Oriented Strand Board
P-50	A FEMA-produced method and form for home earthquake vulnerability evaluation
PGA	Peak Ground Acceleration
Qualtrics	Online survey software provider
Retrofit	Measures taken to physically remedy specific earthquake vulnerabilities of a house (also described as seismic work, improvements or upgrades)
SBA	Small Business Administration
SPSS	An IBM statistical software package
USGS	U.S. Geological Survey

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Executive Summary

Prepared for the California Earthquake Authority (CEA)

By Sharyl Rabinovici¹

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OVERVIEW

This report summarizes findings of an in-depth California Earthquake Authority (CEA) research project to survey and analyze what happened to single-family dwellings and homeowners affected by the August 24, 2014 South Napa M6.0 earthquake. Through an online survey, interviews, and home inspections, a large amount of new data were collected about the characteristics of Napa area houses and the effects of the quake. In addition, a new approach to home earthquake vulnerability assessment was piloted. The results show a population widely impacted by a moderate event, and individuals who are resourceful and resilient but faced with many challenges in how to handle earthquake vulnerabilities. Insights gained about the beliefs and experiences of Napa homeowners can help CEA further improve its insurance offerings and mitigation programs, as well as advancing the state-of-the-art in earthquake retrofit performance research.

STUDY OBJECTIVES AND APPROACH

The impetus for this study was to identify pre-event retrofitted houses that were affected by the 2014 Napa quake and to collect data about the extent of damage and other event impacts on local households. Multiple types of data were collected in two phases. Phase 1 involved a general population survey which invited owners of City of Napa single-family houses to share information about their homes and their experiences.

Recruitment consisted of a short, targeted marketing campaign using door hangers, media placements, community outreach, and a \$25 gift card incentive for the first 500 participants. A total of 633 eligible community members completed the online questionnaire between March 1st and 21st, 2015. Respondents answered over 50 questions covering the follow topics: house characteristics; types of damage (if any) to contents, interior and exterior; types of service disruption and durations; whether the house was retrofitted in the past and if so how; financial

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impacts; and recovery timeframe and actions taken. Definitions, diagrams and photos were provided to help respondents identify features of their houses as accurately as possible.

Additionally, over 300 survey participants volunteered to be contacted about participating in additional research, about 50 of which reported that their house had retrofit work done before the 2014 event.

Phase 2 recruited a subset of those volunteers to participate in in-depth interviews at their house, along with a simultaneous home inspection. This phase had both technical and social science-oriented research goals. The technical objectives were to document with more detail and accuracy the *features*, *vulnerabilities*, and *outcomes* of a sample of Napa area houses, particularly those with identifiable pre-event retrofit or strengthening work, and to collect information about *costs* of any repairs or subsequent retrofitting related to August 2014 damage. On the social science side, the aims were to investigate the homeowner *beliefs* about earthquake risk and why they do what they do regarding retrofitting and insurance coverage and to document the *experiences* among participating homeowners of the August 2014 event and possible influences on homeowner perceptions, intentions, and recovery behaviors.

Researchers and trained home inspectors conducted 39 site visits between March 7 and April 4, 2016. Each visit lasted one to two hours. Details on the marketing, data collection procedures, survey questions, and interview guide are available in appendices to this report.

A final objective and novel aspect of this study was piloting field use by licensed home inspectors of a relatively new home earthquake assessment methodology. The Federal Emergency Management Agency (FEMA) created an evaluation scoring system, as described in FEMA P-50 *Simplified Seismic Assessment of Detached, Single-Family, Wood-Framed Dwellings* (P-50). This method helps building professionals observe, calculate, and communicate about critical structural and location vulnerabilities of a house through a resulting earthquake hazard “grade.” This relatively low cost, standardized, and accessible measure of earthquake risk could, if it can be made available for reasonable cost, be used by homeowners in making better informed purchasing and remodeling decisions.

This study provided an avenue to observe and get feedback from four professional home inspectors, not only to evaluate the form’s use in the field, but also to document the characteristics of some of the houses in this study with more certainty.

Data from all sources was compiled and analyzed using Excel and SPSS statistical software to arrive at counts, assess co-occurrence of traits and outcomes, and interpret the qualitative information and narratives presented by homeowner participants. Products of the research include this final report that integrates findings from both phases and provide recommendations, several re-usable research instruments provided in the appendices, multiple data sets with the survey and interview responses, and the individual photos and aggregate P-50 inspection information about houses in Phase 2. The research protocol and these materials can serve as a model for future studies of this type by CEA.

SURVEY FINDINGS

House Characteristics and Damage Experiences

Houses with a wide range of characteristics were represented in the study. Although not a random sample, self-reported house features were consistent with US Census data about typical housing characteristics in the Napa area. Modest sized, pre-1960 wood frame houses with a standard height cripple wall and stucco exterior predominated. Raised perimeter concrete was the most reported foundation type (58%). Most respondents said they have one or more garages (91%), with some having very large garages (three or more cars) and a fraction had living spaces above the garage (14%). About two thirds of the houses had chimneys (67%), about half of which were described as masonry.

Survey findings echo results of other studies of the South Napa quake in showing widespread life interruption for local homeowners, with severe and long lasting effects on a significant subset. Only nine percent reported experiencing little to no damage, and a majority faced some monetary impacts of a thousand dollars or more and time consuming clean-up of toppled or broken contents.

Homeowners described many different of types of damage. Most notable was non-structural damage (e.g., contents, minor wall cracking), with over half experiencing things like broken or violently displaced furniture, broken bottles and household items, or falling objects. Over half of respondents mentioned internal wall cracks. Thirty-nine injuries were reported, primarily from broken glass on the floor.

The era built stood out as the house characteristics most associated with worse outcomes. Pre-1950 houses experienced damage at higher rates than newer houses, particularly to chimneys and outside wall surfaces. About half of the pre-1950 houses in the survey reported having chimney damage. Almost one out of three houses built before 1950 received a yellow or red tag from a city building department housing inspection, indicating a potential entry or exit safety hazard. Among houses built pre-1950, one out of four homeowners (37/144) said total repairs exceeded \$25,000.

In terms of utilities disruption, 94% of survey respondents said they had some loss of services, including electricity (78%), land line phone and internet (27%), gas supply (27%), or water (23%). For the most part, these impacts were short lived. In more than half of the houses, services were running again after one to three days.

In contrast, many respondents spent a substantial amount of time on clean-up and repairs. Just under half of survey respondents (48%) said these activities took over a week, and twenty percent said important repairs were still not finished seven months later.

Homeowners also faced challenges in coping, making decisions and trying to carry out repairs, which contributed to these sometimes lengthy recovery timelines. About half of respondents sought assistance information or recovery help, including calling or visiting a FEMA center or applying for a Small Business Administration (SBA) loan. Many commented on the shock and trauma they felt after going through this event. Thirteen percent reported considering selling or relocating, including owners of houses that had no damage or were already retrofitted. About 24% sought information about strengthening their house to avoid future damage, again also people who own retrofitted houses.

Overall, the survey findings demonstrate how costly and time consuming it can be to handle the damage as well as painful life disruption that can happen in a relatively moderate local quake. It also documented a high proportion of un-retrofitted houses with features linked to higher vulnerability. This reality of reality was not in the minds of most Napa homeowners prior to this event. It is likely that many Californians are in the same position.

Retrofit Prevalence and Performance

In the survey, about one in ten Napa homes had earthquake upgrades done prior to the 2014 quake. The most frequently reported types of retrofit work in the survey were anchoring (bolting), chimney removal, and addition of plywood or Oriented Strand Board (OSB) to the “basement” or cripple walls.

Unfortunately for the study aims, 29% of survey respondents skipped the retrofit status question entirely or answered ‘Do Not Know’, suggesting that numerous owners lack information about the earthquake vulnerabilities of their homes. Even among participating homeowners that *did* think their house was retrofitted, many were only able to share vague and unconfident descriptions about what had been done previously and when. This led to questions about how well homeowners were able to self-identify their house’s retrofit status, which limited the opportunity to investigate retrofit performance in this study.

Through the approach of community-based research, this study was able to identify a number of pre-event retrofitted single-family homes that had little to no damage; these are retrofit success stories from the 2014 Napa event. Successful retrofits – those that reduce damage from what would have occurred otherwise -- are harder to detect than tragedies, which are more visible and salient. Social norms may even encourage those who fair better than others to keep quiet on the sidelines while those more in need are cared for. Several homeowners in this study were motivated to do retrofit work in the 2000s after the Napa area experienced another significant quake in 2000, but didn’t want to sound boastful.

Positive outcomes among retrofitted houses were not universal, however. Results were mixed, but retrofitted houses experienced worse outcomes in aggregate for a number of outcome variables. For instance, retrofitted properties had a higher rate of yellow tagging (21%),

compared to fourteen percent among non-retrofitted properties and about fifteen percent of all houses for which retrofit status was reported. Among the 312 houses of known retrofit status with one or more chimneys, the 38 retrofitted properties with chimneys had higher rates of experiencing chimney damage. Four times the rate of retrofitted properties compared to retrofitted ones that a porch slip sideways. The only property in the study with a porch roof collapse had been retrofit previously.

Despite these observations, it is inappropriate to conclude that retrofitted properties performed worse than other non-retrofitted ones in the Napa area in the 2014 event. A large number of factors could have contributed to these counterintuitive results. The first issue is that the survey, and especially the interview data subset, are not random samples. There might have been self-selection into the study by owners of properties that performed relatively worse (than others in the community) because these owners especially wanted to tell their story.

Another issue, potentially exacerbated in a non-random sample, would be any undocumented dissimilarities between non-retrofitted and retrofitted houses that also relate to earthquake performance. Data was collected about some factors such as age, cripple wall height and exterior materials. However, the large number of potential control and damage outcome variables might preclude the use of inferential statistics or multivariate regression, unless the sample size is very large. Other factors could have been owner misunderstanding of the retrofit status of their property, poor or differing quality of workmanship among reported pre-event retrofit work, or misreporting retrofit work done *after* August 2014 as having been done before it.

A particularly important reality to consider is that a wide variety of seismic upgrade work could have led an owner to identify their house as “retrofitted.” A simple categorical classification of retrofit status (i.e., a house is either retrofitted or not) is undoubtedly inadequate to understand how such work can improve outcomes for a house. For example, “retrofitted” houses may have still experienced severe damage because the *type* of retrofit work (e.g., cripple wall anchoring) that had been done was weakly if at all related to the *type* of damage (e.g., porch or chimney separation).

This issue invites several fundamental questions: What is a “retrofit?” What is good “performance?” What types of damage should different types of retrofit work be expected to reduce? These questions must be addressed if the issue of retrofit performance is to be usefully investigated, especially if a goal is for the findings to be understandable to the public. Implications for the type of research approaches that would be advisable in future studies of the empirical, *in situ* performance of single-family home retrofits are addressed in the Recommendations section below.

INTERVIEW AND SITE VISIT FINDINGS

Homeowner Backgrounds, Beliefs and Behavior about Mitigation

Participants showed a high degree of awareness *in general* about earthquakes and other natural hazard risks of home ownership. The interview sample was mostly middle-aged and born in in California or moved here decades ago. Interviewees seemed to associate living in California for a long time with being well-informed and wized about the chances of a large earthquake.

This high awareness about earthquake likelihood contrasted strongly, however, with low rates of mitigation action-taking and lack of knowledge about retrofit concepts and the status of their properties. Few interviewees said earthquake retrofit was a factor in their home search.

Homeowners held a spectrum of views about retrofitting, with most having *generally* positive impressions. People mentioned benefits such as peace of mind and avoidance of minor damage or reduced chances of extreme loss. Those who were emotionally invested in their property, for instance who had invested decades in restoring a historic home, seemed especially interested in protecting their homes. About a fifth of retrofitters reported doing the work themselves or with the help of friends and family, which would reduce out of pocket costs.

On the negative side, doubts and confusion existed about whether or not retrofitting is “worth it.” Skeptics focused on uncertainty or low probability of benefits. Interviewees did not think that retrofitting a house would increase its appraised or resale value. It is possible that cost concerns might cause people who otherwise think retrofitting is a good idea to personally, or even publicly, emphasize drawbacks or dismiss it. Many said they’d like to retrofit but simply felt it was unaffordable.

Overall, this study affirmed that many homeowners are interested in retrofitting but face multiple deterrents and barriers to doing so. This suggests people need help getting through the challenges of committing to and completing a retrofit project, not just basic information about the reasons to do it.

Homeowner retrofit stories collected in this study are an important source of information about the specific difficulties owners experience. Retrofitting is often linked to events, such as the discovery of earthquake vulnerabilities during home purchase, other major renovation work, or after a damaging earthquake event that caused fear or necessitated removal, replacement, or repairs. Different types of information could be helpful in these different situations. For instance, owners could benefit from empowerment in looking for and negotiating over seismic issues when buying a home, cost-effective ways to incorporate seismic improvements into other renovation projects, or how to plan for and carry out incremental retrofitting work over time. Owners that are ready to embark on a project need technique for finding qualified contractors, avoiding scams, or supervising workmanship quality in progress.

Earthquake Insurance Perceptions and Behavior

Homeowner perspectives towards earthquake insurance were investigated through five questions in the survey and expanded discussion and hypothetical questions during the interviews. About ten percent of participating homeowners carried earthquake insurance at the time of the 2014 Napa event, which is in line with CEA statewide rates. Respondents with CEA earthquake policies were specifically excluded from the interview research in Phase 2, but a handful of interviewees had insurance in the past or currently with non-CEA partner companies.

Interviewed homeowners showed high *general* awareness of the existence of earthquake insurance but a low level of knowledge about specifics, especially newer policy options. For example, most interviewees erroneously thought that deductible levels are fixed at ten percent and did not know that renter's or contents coverage were available. Only a small fraction of homeowners recalled the annual mandatory offer sent by their insurance company.

Homeowners relied mainly on word of mouth for information about insurance and to derive their impressions of its usefulness and affordability. This means that out of date or incomplete information can easily spread and perpetuate in a community, especially in the wake of an event when the earthquakes come up more in conversation. Only a few sought personalized information about earthquake insurance, despite being in an area affected by significant quakes in both 2000 and 2014.

Fifty-one respondents in the survey reported submitting a claim, which is the majority of respondents that had earthquake insurance. Very few received a payout. Ninety-seven homeowners in the survey said they sought out information about earthquake insurance since August 2014.

Interviewees were asked about what would make insurance for earthquake losses more appealing, and where homeowners like them would most likely turn for more information. There was strong interest in contents coverage and policy offerings more seamlessly integrated with and comparable to the terms of their homeowners' policy. As for information sources, participants emphasized internet sites but also suggested the local newspaper and partnering with local organizations and businesses in the community that do related work. In the Napa case, that could include vintner, historic preservation, school, and environmental groups.

FINDINGS ON FIELD USE OF FEMA P-50 FORM

Four California Real Estate Inspection Association (CREIA) member home inspectors participated in completing FEMA P-50 forms for 39 homes during the Phase 2 site visits. Home Inspectors used the P-50 form to collect thorough data about the characteristics and vulnerabilities of the inspected houses. Important insights from this effort included how to

make P-50 home evaluations easier for home inspectors to use and the importance of developing an evaluation service that is affordable and attractive to the public. For instance, more careful training and practice in calculating the Seismic Hazard score is needed, and the order of data entry should be changed to match the typical sequence of a home inspection visit. This speaks to the importance of CEA's efforts to create an automated application for the P-50 form.

Homeowner interviews identified a high level of interest in affordable, high quality, third-party assessment of seismic vulnerabilities and potential mitigation steps. Participating home inspectors discussed practical barriers to bringing that kind of service to market during a two-hour focus group. Inspectors felt pricing would need to be a fraction of the cost that home owners are already accustomed to paying for inspections at time of sale. Also, inspectors need to be able to obtain professional insurance for this different kind of inspection. Overall, inspectors seemed optimistic that if practices are sufficiently standardized and inspectors can be uniformly trained and evaluated on their abilities to deliver the service, insurers will be willing to underwrite inspectors and willing inspectors will be able to carry out consistent and high quality evaluations.

RECOMMENDATIONS FOR FUTURE RETROFIT PERFORMANCE AND HOMEOWNER EARTHQUAKE IMPACT RESEARCH

This study adds richness to our understanding of the impacts of earthquakes on single family houses and homeowners in Napa. Results may be indicative of perspectives and challenges faced in other areas of the state. Also, a new approach was pioneered in the form of a voluntary post-event survey combined with site visits with a home inspection and qualitative interview. These methods provided important details about both damaged and undamaged houses and how a significant event influenced homeowner thinking.

A major take-away is how little understanding many homeowners have about earthquake retrofitting and insurance, and the importance of social influences on retrofit and insurance perceptions and behavior. The case studies conducted in Phase 2 also shed light on challenges for households to invest in mitigation even if they want to, and the many, sometimes lengthy aftershocks earthquakes can create in peoples' lives. It is sobering to consider that the South Napa earthquake of 2014 is just one event that created shaking across a limited area.

The full report discusses several broad, long term priorities for improving future field research into retrofit prevalence and performance. The most important steps are to develop consensus around the set of measurable house characteristics that are the major risk indicators, a typology of retrofit features and their expected benefits, and a typology and system for measuring outcomes for homeowners and houses that covers a wide range of earthquake impacts. Ideally, these essential building blocks of retrofit research should draw upon and be

usable by disciplines and ultimately communicable to multiple audiences. Researchers should continue to seek ways to involve the public more in earthquake recovery and retrofit performance research, because the outcomes of importance go beyond fallen bricks, porch slips, and dollars spent to the psychological, financial security, and collective actions of all people and businesses that earthquakes affect.

On a more detailed level, some specific limitations of this study can be addressed through alternative research design features. Increasing the sample size of houses under study, either by surveying in many locations or more houses in a single community, will enable more use of statistical inference. Randomly selecting the set of houses to study will provide more accurate rate information about beliefs and behavior as well as reduce the chances of selection bias. It may also reduce overall survey costs by shifting budget from marketing to strategic survey recruitment.

A key to understanding the benefits of retrofitting in practice is to collecting longitudinal (time series) data, namely, to do before and after studies of the same houses. This will require creating data bases of houses, collecting initial data and then tracking the retrofit and maintenance status and the state of the house and household over time. When doing this, it is also advisable to include both retrofitted and non-retrofitted houses, because the latter are much more numerous and serve as important controls.

Not all of the above design features can be used in every future study, but some of them can be used in combination, or in multiple studies of different types, to powerful effect. If study of retrofit performance is approached using diverse types of data and methods, we are more likely to grasp the full range of issues at play and more reliably advance our state of understanding.

Another outcome from this study are action opportunities for CEA as it continues to refine its portfolio of programs to motivate interest and action-taking about household earthquake resilience. Discussions with homeowners suggest some messages that could be effective in motivating and *sustaining* attention to earthquakes and the search for personalized risk information. Recommendations are to:

- Point out how common and significant non-structural and contents damage can be.
- Show data about the length of time that critical repairs can take.
- Gently share stories about the psychological trauma that earthquake survivors go through.
- Urge people to make *their own* informed decisions rather than relying on others.
- Point out helpful actions homeowners might be able to do for themselves or get “in-kind” help to do from a friend, neighbor or family member.
- Tap into the emotional connection people have with their houses and neighborhoods.

- Convey more nuance as to what constitutes a retrofit and what different retrofit work is supposed to do.
- Encourage owners to develop a retrofit plan and to carry out incremental projects.
- Use straightforward, everyday language while still treating owners with respect.
- Strive to increase the frequency of encounters people have with the topic and the number of sources from which they receive information.

For owners who are already interested in retrofitting or insurance, the communication need is more about helping people make conscious decisions and follow through. Because earthquake resilience decisions are heavily influenced by social networks and information exchange, CEA has the opportunity to leverage these processes in getting more accurate information across to more people. To do that, CEA can:

- Capitalize on information flow in existing social networks where trust is high and related issues are already discussed.
- Maintain frequent communication efforts using a balance of both traditional and digital media.
- Seed the community with well-informed, local communicators and give those leaders the resources they need to become effective advocates.
- Publicly reward and recognize owners that successfully complete retrofit projects.

Bottom line, Napa area homeowners who took the time and energy to share their experiences have helped to demonstrate that while owners face many challenges, there are also numerous opportunities to help them progress through different steps towards their resilience end-goals. Through its mitigation research program, CEA is better poised to realize its mission to assist in that important process.

Chapter 1 — Overview of Study Objectives, Approach, and Context

This report summarizes findings of an in-depth California Earthquake Authority (CEA) research project to survey and analyze the performance of single-family dwellings affected by the August 24, 2014 South Napa M6.0 earthquake.

The Napa quake represents an invaluable real world learning opportunity for anyone interested in promoting earthquake resilience, particularly in the state of California. In terms of CEA's mission, the earthquake mitigation field is notably lacking in observations about the performance of single-family dwellings of a variety of eras and materials from events of different magnitudes. This is partly a natural consequence of the infrequency of larger earthquakes, but it is also an artifact of inadequate records about the retrofit status of houses in communities throughout California and elsewhere.

A specific research need that this study sought to address is outcomes for seismically retrofitted houses along with data about the features of the house and any previous seismic upgrade work that had been done. Such information enhances our ability to understand factors affecting how much reduction in damage different retrofitting steps can achieve. Without it, homeowners do not have the kind of information they need to make the best possible decisions for themselves about if, when, and how much investing in retrofit work could benefit them compared to how much it costs. It is true that the South Napa earthquake of 2014 is just one event that created shaking for a limited geography. However, it is a highly relevant data point that can inform the effort to increase the state's earthquake resilience.

The research project began with the goal of identifying pre-event retrofitted houses that were affected by the 2014 Napa quake and to collect data about the extent of damage and other event impacts on those households. The strategy evolved into a two-phased approach. Phase 1 consisted of a general population survey designed to invite owners of City of Napa single-family houses to share information about their homes and their experiences. The specific objectives of Phase 1 survey were to:

1. Document damage impacts, service disruption and homeowner experiences from the August 2014 event.
2. Identify pre-event retrofitted properties in the Napa area.
3. Find homeowners willing to participate in further on-site research about their properties and experiences.

Following a short, targeted marketing campaign that employed door hangers, media placements, community involvement, and a \$25 gift card incentive to the first 500 participants, a total of 633 eligible community members completed the online questionnaire between March 1st and 21st, 2015. Respondents answered over 50 questions, providing a comprehensive set of data about single family houses and household impacts from the August 2014 event.

The survey data collected provide insight into the types of houses that experienced damage, the types of damage experienced (if any), how many (if any) of the houses were retrofitted, what type of retrofits were completed, what services (if any) were interrupted, and interruptions to use of the house, for instance if the house was yellow or red tagged or not by the city.

Regarding the third objective, the survey identified a pool of over 300 seismically retrofitted and non-retrofitted single-family dwellings within the City of Napa whose owners agreed to be contacted about participating in additional research. Importantly, about 50 of those homeowners reported that their house had retrofit work done before the 2014 event.

Phase 2 went into further depth about a subset of homeowners via in-depth interviews and home inspections conducted during a site visit about a year later. The research questions in Phase 2 included both technical and social science-oriented aspects. The technical objectives were to assess the *nature* and *performance* of any identifiable pre-event retrofit or strengthening work, collect information about costs of any previous retrofit work and any repairs or subsequent retrofitting related to August 2014 damage. On the social science side, the specific aims were to investigate the *understandings* among participating homeowners about earthquake risk and risk management opportunities (e.g., retrofitting, insurance coverage) and document the *experiences* among participating homeowners of the August 2014 event and how these may have influenced homeowner beliefs, intentions, and behaviors.

Researchers and trained home inspectors were paired together and conducted approximately 39 site visits between March 7 and April 4, 2016. Each visit last between 1 to 2 hours and collected more detailed information about each property and documented the perceptions and decisions processes of the owners related to earthquake mitigation. For those seeking more detail, Appendices A and B respectively outline the marketing, data collection procedures, and analysis steps undertaken. Appendices C and D respectively show the survey questions and interview guides that were used in interacting with homeowners.

Post-event information of this type are rare in general, and therefore have high potential to contribute to improving public education and preparedness programs, engineering practices, and disaster policies more broadly.

This is the first study to our knowledge that concurrently employed qualitative interviewing and house inspections as research tools to understand mitigation perceptions, action-taking and outcomes. Armed with this data, CEA can learn not only about the houses but also the experiences and perspectives of Napa homeowners before and after a significant quake and the *relationship* between houses and owners. These are key but understudied phenomena in shaping the real world risk landscape. Better understanding of how events influence perceptions about retrofit, earthquake insurance, and other risk decision making is essential to enhancing programs to mitigate earthquake risk exposure, encourage preparedness, and speed individual household and community recovery.

Another unique thing about this study is the naturalistic use of a relatively new home assessment methodology by licensed home inspectors. The Federal Emergency Management Agency (FEMA) created an evaluation scoring system and form, known as FEMA P-50 *Simplified Seismic Assessment of Detached, Single-Family, Wood-Framed Dwellings* (P-50). This document was designed for use by building professionals to observe, calculate, and communicate about critical structural and situations aspects of a property and the resulting earthquake hazard level. For the first time, a relatively low cost, standardized, and accessible measure of earthquake risk is being created for use by homeowners in making purchasing and remodeling decisions. CEA's Hazard Reduction Discount Program (HRD) is interested in using P-50 assessments as part of the documentation needed to secure an insurance discount.

While the P-50 method is well vetted by top experts in the engineering community, use of the form in the field is still new and experimental to some degree, and its use by home inspectors is just beginning. To be relevant in home buying and renovation decision making, homeowners must be able to find qualified professionals in their communities to perform the assessment at reasonable cost. CEA has invested in training home inspectors to conduct FEMA P-50 evaluations. This study provided an avenue to observe use of the form by four of those trainees, not only to evaluate the form's use and the inspectors' understanding of the form and the inspection, but as part of documenting the characteristics of the houses with more certainty.

This summary report is organized as follows. Following a brief description of the South Napa earthquake and what is known about its impacts from other studies, Chapter 2 describes the characteristics of the participating homeowners in both phases and their houses, including pre-event retrofit status. Chapter 3 provides a rich account of the kind of retrofit work done prior to August 2014 in the represented houses and the stories that homeowners told about how they think and what they or previous owners have done, if anything and why, about retrofitting.

Chapter 4 addresses the key research questions about retrofit performance. First laid out are findings on the self-reported damage and service disruption impacts of the August 2014 event based on the survey. It also describes damage types, repair costs and psychological and other intangible impacts. This chapter also evaluates the evidence for factors that might associate with the types and overall degree of damage and impact.

Chapters 5 deals with earthquake insurance, what homeowners know, think, and recommend about it as well as how the event might have changed their views. Chapter 6 adds detail from the survey data about service disruption and other things owners did following the event. Chapter 7 discusses what was learned by piloting the use of the FEMA P-50 form by home inspectors.

Readers should note that throughout the report, actual quotes from the anonymous participants and the case numbers of participants related to specific concepts are given in blue

text. This is done to provide readers, insomuch as is feasible, with the raw qualitative data and counts that support each conclusion being presented.

After re-articulating the importance of improving our understanding retrofit performance, Chapter 8 offers conclusions from the study as a whole. Recommendations are provided on three topics: broad, long term priorities for improving future field research about retrofit prevalence and performance research, specific alternative study designs that can address key challenges in this type of research, and opportunities for CEA to improve messaging and program offerings related to motivating action-taking to enhance household earthquake resilience in California.

Chapter 2 — Characteristics of Represented Houses and Homeowners

ABOUT THE HOUSES REPRESENTED IN THE OVERALL STUDY

This chapter begins with a breakdown of the characteristics reported by owners about their houses in the survey phase. Respondents were asked ten general questions about the size, age, foundation type, outside wall coverings, roof type, crawl space or cripple wall first-floor framing height, whether there is a slope, and the presence of garages or chimneys. Many of these structural and material traits are key variables known to relate to seismic vulnerability and expected damage types and severity.

Table 1 provides a summary of house characteristics for all survey respondents ($N=633$). The N for some traits varies owing to missing data from a small number of respondents who saw but did not answer a particular question; percentages are reported relative to the actual N .

It should be noted at the outset that all the survey data are self-reported by the homeowners, many of which likely have little to no expertise or special knowledge of the construction, real estate, or building trades. Also, to the extent that respondents did not understand a concept or understood a *question* differently than intended or than other respondents, self-report answers will deviate from the values that might be observed by an expert.

Table 1. Housing characteristics self-reported by participants in the March 2015 survey.

<i>Characteristic</i>	<i>Summary Values</i>	<i>N</i>	<i>Percent of Actual N</i>
Year Built	1980 or later	619	23.1%
	1950 -1979		51.1%
	1949 or before		24.8%
Total Square Footage	500 to 1000 square feet	621	7.7%
	1001 to 1500 square feet		31.2%
	1501 to 2500 square feet		49.1%
	2501 square feet or more		29.1%
Roof Type	Composite or asphalt shingles	605	75.3%
	Clay or concrete tiles		13.5%
	Tar and gravel		4.5%

Characteristic	Summary Values		N	Percent of Actual N
	Wood shingles or shakes			2.2%
	Other			2.0%
	Slate			1.5%
	Metal sheeting			1.0%
First Floor Framing Type	Wood		603	64.8%
	Concrete			22.1%
	Wood and Concrete			11.3%
	Other			1.8%
Foundation Type	Raised perimeter concrete		591	61.9%
	Wood posts			15.2%
	Concrete (slab on grade)			14.9%
	Raised perimeter masonry or brick			3.7%
	Other			2.9%
	Raised perimeter stone			1.4%
Has a Crawl Space	No		604	62.8%
	No basement			22.8%
	Yes			10.8%
	Don't know			3.8%
Located on a Slope or Hill	No		588	89.0%
	Yes			11.0%
At Least One Chimney	Yes		587	72.7%
	No			27.3%
If Chimney, Chimney Type	Masonry Only		427	67.0%
	Other			33.0%

<i>Characteristic</i>	<i>Summary Values</i>		<i>N</i>	<i>Percent of Actual N</i>
Outside Wall Material	Stucco		586	55.6%
	Horizontal wood boards			24.9%
	Other type of exterior finish			8.2%
	Wood shingles			5.0%
	Plywood sheathing			4.4%
	Horizontal aluminum or metal sheathing			1.9%

Age and Size Distributions Were Typical of Napa Area Houses

Represented houses ranged in age from the pre-1900 era to very new (post-2000). Almost half of the houses were built between 1950 and 1980 (48%), and 251 (38%) were built prior to 1960. Year built is relevant to assessment of seismic risk owing to differences in the rigor of the building codes in use and enforcement practices at the time of construction. Significant remodeling and additions, done to code with permits or without, can alter the associations between age and seismic vulnerability. A small amount of homeowner recollections about past renovation are reported below.

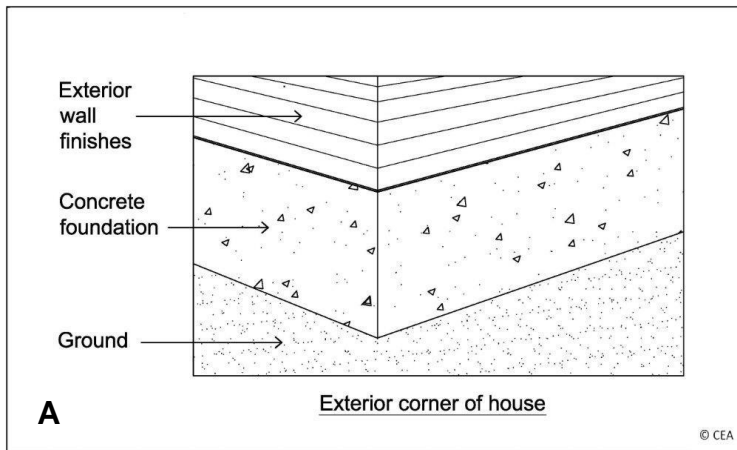
The total floor areas of most of houses surveyed (78%) were modest by American standards, between 1000 to 2500 square feet, but consistent with US Census data about the typical housing characteristics in the Napa area.

Predominantly Wood-Frame Construction and Relatively Uniform Site Conditions

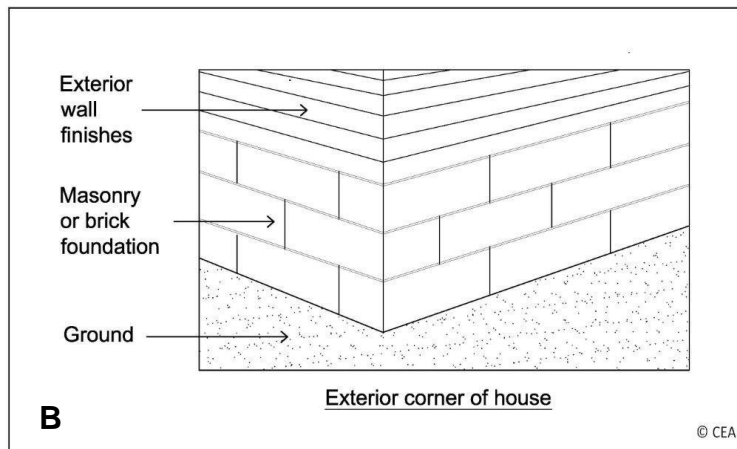
Framing and foundation types and materials are critical to understanding seismic hazard as well as to the cost and difficulty of relevant retrofit approaches. More than half of the houses in the survey (62%) were reported as wood first floor framing type; twenty-one percent were concrete (slab on grade) and eleven percent were wood and concrete (mixed) framing. Raised perimeter concrete was the most reported foundation type (58%). This is an example of a question where a series of drawings were provided to help respondents identify their foundation type as accurately as possible (**Figure 1**). Admittedly even with these diagrams this is likely a difficult question for many house owners to answer, as stucco, landscaping or external materials might shield these areas of the house from view. A conscious choice was made to keep the technical descriptive terms in the question as a form of homeowner education.

Figure 1. Example diagrams provided to help survey respondents identify their foundation type.

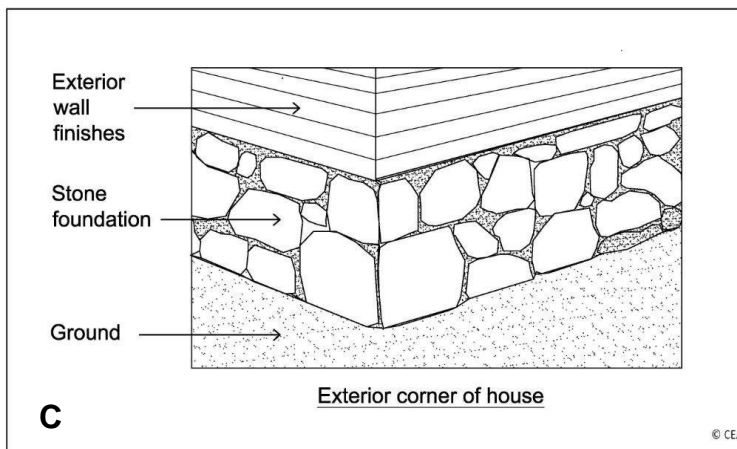
Panel A = Raised perimeter concrete.



Panel B = Raised perimeter masonry.



Panel C = Raised perimeter stone.



Twelve percent of respondents reported the first floor to be or below the ground level less, and nearly half said it was 0 to 2 feet from the ground (49%). A quarter of the houses were described as having a first floor height between 2 to 4 feet from the ground (25.6%) and 9.2% more than 4 feet high (a vertical irregularity).

In contrast to those observations, only one-tenth of respondents reported having a house with a crawl space, a proportion notably inconsistent with the first floor height estimates provided in the prior question. This suggests a critical lack of familiarity with “cripple wall” both as a term and as a concept, an issue which will be further discussed in Chapter 3.

The outside wall material for about half of the houses was reported as stucco (52%). Less than one-fourth of the houses reported horizontal wood boards or wood siding (23%). Most respondents said they have one or more garages (91%), with some having very large garages (three or more cars) and/or living spaces above the garage (14 %). More than half of the houses have chimneys (67%), and 45% of the chimneys were described as masonry. Almost three fourths of houses were reported to have a composite or asphalt shingles and the next most category was “clay or concrete tiles” (13%).

Most respondents said ‘No’ to the question about whether their house is located on a slope (82.6%). This seems reasonable given the typically flat, river valley terrain of the study area. Notably, most of the respondents that reported being on a slope did not answer the slope direction question (only eleven percent of persons who saw this question attempted to answer it). This might be because of the complicated nature of the concept and/or the diagrams presented to describe it. This is a further example of a terminology and conceptual barrier to communicating with homeowners about potentially important structural and site features.

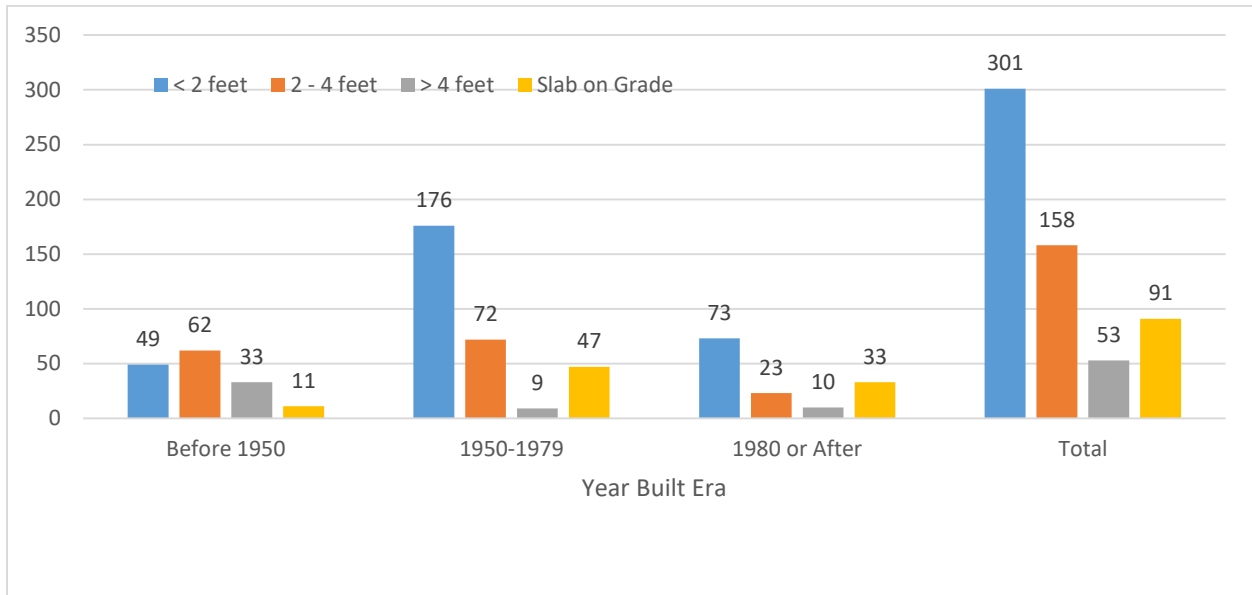
Ten Different Basic House Types Based on Era and Cripple Wall Height

Age and cripple wall height are considered two of the most important factors defining a wood frame single family dwelling’s degree of vulnerability to earthquake shaking. The term “era” is here defined as the self-reported timeframe in which the house was built, either before 1950; 1950-1979, or 1980 or later. Era is relevant to the codes, methods, and materials used at time of construction as well as the likely degree of degradation or maintenance.

Cripple walls, the distance from the ground to the base of the first floor framing, especially above 4 feet, are related to the ease with which a house can twist and slip off its foundation. Cripple wall height, was reported in the survey as one the following four categories: < 2 feet, 2 - 4 feet, > 4 feet. Elsewhere respondents were asked about the foundation types, which allowed the “under 2 feet” category to split into two types: wood-frame very low cripple walls and “Slab on Grade” / no apparent cripple wall.

Using these features, each house in the study was classified into one of ten House Type Indices (HTI). These represent unique combinations of era and cripple wall height along with two categories representing non-wood frame or concrete slab houses regardless of era.

Figure 2 gives a breakdown of counts in the survey sample by era and cripple wall height.



Self-Reported Information about Pre-Event Retrofit Status

Table 2 presents facts about the self-reported retrofit status as well as descriptive information for the 12.2% of all respondents that said they believed their house had been retrofit prior to the August 2014 quake. Notably, 29% did not answer this question or stated that they ‘Do Not Know’ whether their property had been retrofitted prior to August 24, 2014.

In an effort to identify possible retrofit work for respondents that answered ‘Do Not Know,’ the survey also asked about types of major remodeling work done prior to the event that might indicate measures for or lead to improved seismic performance.

A very high percentage of retrofitters (almost 80%) reported the work was done when they owned the property, which likely played a large role in their ability to affirm that some work had been done. Anchor bolts or braces was the most commonly reported type of work done. The table below reports the percentages of retrofit work as a fraction of the *total* study population, so that the general rate of retrofit type in the community can be viewed. Overall, 8.9% of all respondents reported that anchor bolts had been installed.

Table 2. Self-reported pre-event retrofit status and characteristics of any retrofit work reported as a percent of the entire survey sample.

Note: Percentages may not total 100 owing to rounding or multiple-answer question format. Also, percentages are based on the total number of persons (N) who validly answered each question.

Characteristic		N	Percent
Retrofitted	Yes	575	13.4%
	No		65.2%
	Don't know		21.4%
Kinds of Strengthening Work Done (check all that apply)	Plywood or OSB was added to basement walls	633	2.8%
	Plywood or OSB was added to the garage walls		1.6%
	Plywood or OSB was added to the crawl space walls		1.9%
	Anchor bolts, bracing, or foundation plates installed		8.9%
	The garage structure or frame was made stronger		1.4%
	The chimney was strengthened, braced, or removed		3.8%
	FEMA flood retrofit		0.0%
	Other		4.4%
	None of the above		1.4%
Major Remodel Done before August 2014	No	556	60.4%
	Yes		34.2%
	Don't Know		5.4%
Types of Major Remodeling Done (all that apply)	New connections from foundation to wood framing, such as bolts or steel brackets	190	5.7%
	Adding a new porch or replacing a porch		5.4%
	Adding a new frame around the garage door, a new garage, or an attached carport		3.5%
	Replacing some or all of the foundation		3.3%
	Remodeling of basement or crawl space walls		2.2%

<i>Characteristic</i>		<i>N</i>	<i>Percent</i>
	Improving or finishing an original basement		0.5%
	Creation of new basement space (digging out)		0.5%
	Other		8.7%
	None of the above		56.4%

Table 3 shows additional characteristics about the reported retrofit work. Over half of retrofitthers reported that the work was done by a paid contractor, but a significant fraction, one fifth, used a “Do It Yourself” (DIY) approach. Despite concerns that respondents would be afraid to answer the question about involvement of building permits in the work, 55.8% responded affirmatively. Additionally, 42.9% reported an engineer was involved in designing the retrofit. Follow-up research would be useful to validate whether self-reported answers to these questions are accurate.

Table 3. Self-reported characteristics of pre-2014 retrofit work.

Retrofit Was Done by Current Owner	Yes	75	79.2%
	No		15.6%
	Don't know who owned the house when the work was done		5.2%
Who Retrofitted	Paid contractor	75	55.8%
	Owner, family member, or friend (DIY)		18.9%
	Don't Know		14.3%
	Other		11.7%
Was a Building Permit Involved	Yes	75	55.8%
	Don't know		24.9%
	No		19.5%
Was Any of the Work Designed by Engineer	Yes	75	42.9%
	Don't know		29.9%
	No		27.3%

ABOUT THE HOUSES IN PHASE 2

Phase 2 provided the opportunity to collect in-depth information about a subset of houses and their owners who had expressed willingness in the survey to be contacted about further research. Exclusion criteria were applied to remove from the Phase 2 recruitment pool any persons who had an incomplete or unusable address or contact information, or held a CEA earthquake insurance policy at the time of the August 2014 event (only 13 out of 633 respondents). The latter exclusion was necessary to ensure no confusion or conflicts of interest involving potentially active claims.

Houses built 1980 and later and for which retrofit status was unknown were excluded in order to increase the chances of reaching houses that genuinely had pre-event retrofit work. The final group of 200 Phase 2-targeted homeowners were organized into four recruitment batches to prioritize visits to houses that would best address the research aims. The targeting criteria related exclusively to *pre-event physical circumstances of the property*. Site visits targeted older wood frame houses (pre-1970) with moderate to high cripple walls and pre-event retrofitted properties. Houses reporting slab on grade / concrete foundations were the lowest priority because of the study's focus on cripple wall retrofit effectiveness and houses relevant to CEA's current mitigation programs. The Phase 2 recruitment pool thus contained six of the ten Housing Type Index categories.

Post-event outcomes relating to types and degree of damage were explicitly *not* used in the selection process. Significant information about retrofit performance is lost if data is only collected about the most damaged properties. It is critical to the research question identify and analyze any retrofits that *succeeded* in avoiding damage. Ideally, researchers should also analyze otherwise similar non-retrofitted houses as a control group, as this can yield important insights into the *differences* in damage attributable to retrofitting compared to leaving a house as is.

Year Built, Retrofit Status, and Cripple Wall Heights in the Phase 2 Sample

In total, 39 houses and their owners participated in Phase 2 site visits and interviews, or one in five of the total recruitment pool. Consistent with the research priorities, all four targeted groups were reached, with the highest represented group being pre-1950 retrofitted properties (see **Table 4**). The smallest count occurred in the 1950 – 1979 era pre-event retrofitted group, but this was due to the fact that this group had only 11 houses from which to recruit. **Table 5** shows the ratios of potential to actual interviews completed, to give a sense of how representative the data might be of the overall surveyed group. **Figure 2** shows this information graphically. About half the houses had pre-event retrofit work and half did not.

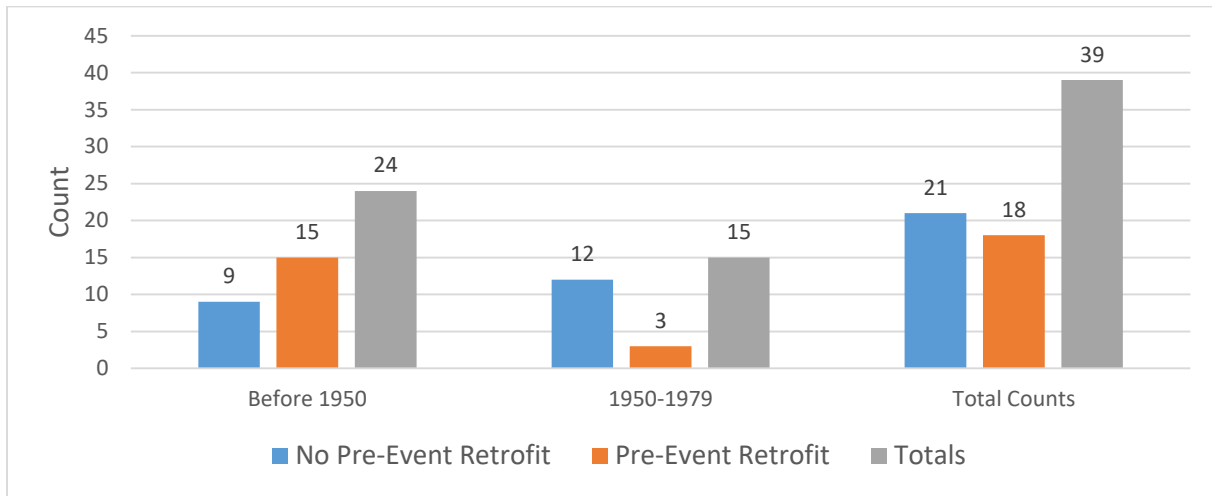
Table 4. Percentage of Phase 2 sample by self-reported retrofit status and era.

		Self-Reported Retrofit Status		Totals
		No Pre-Event Retrofit	Pre-Event Retrofit	Percent by Era that Participated in Phase 1
Year Built / Era	Before 1950	23%	38%	62%
	1950-1979	31%	8%	38%
Totals	<i>Percent by Retrofit Status that Participated in Phase 1</i>	54%	46%	100%

Table 5. Breakdown of the final Phase 2 recruitment pool and represented houses by self-reported retrofit status and era built.

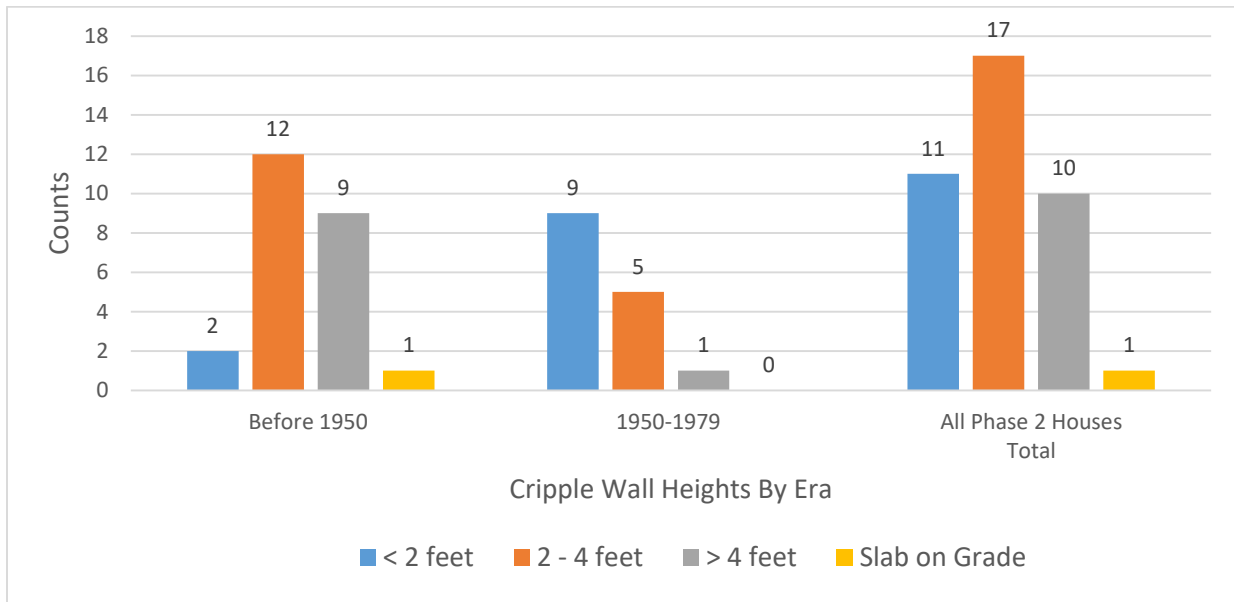
		No Pre-Event Retrofit	Pre-Event Retrofit	Totals
Before 1950	<i>Count in Phase 2 Eligible Group</i>	48	37	85
	<i>Count that Participated in Phase 2</i>	9	15	24
	<i>Percent of Era Group that Participated in Phase 2</i>	19%	41%	28%
1950 - 1979	<i>Count in Phase 2 Eligible Group</i>	104	11	115
	<i>Count that Participated in Phase 2</i>	12	3	15
	<i>Percent of Era Group that Participated in Phase 2</i>	12%	27%	13%
Total	<i>Count in Phase 2 Eligible Group</i>	152	48	200
	<i>Count that Participated in Phase 2</i>	21	18	39
	<i>Percent of Era Group that Participated in Phase 2</i>	14%	38%	20%

Figure 2. Breakdown of houses represented in Phase 2 by retrofit status and era of construction.



Successfully, a mix of six House Type Index cases were represented. **Figure 3** shows that about half of the Phase 2 sample had cripple wall heights of two to four feet. Nearly all of the four feet and higher cripple walls were in pre-1950 houses.

Figure 3. Breakdown of houses represented in Phase 2 by era of construction and cripple wall height.



Additional Traits of Houses the Phase 2 Sample

The interviews provided additional information about the range of characteristics of houses in Phase 2. Among the traits not addressed in the survey was historic status. Several owners of very old (pre-1900) (Case 40) and the owners of at least six formally registered historic properties were interviewed (Case 486, 11, 23, 349, 527, 555).

The City of Napa features an active heritage appreciation and preservation community and mindset. The most prominent effort is a program called Heritage Napa, which is administered by the City of Napa and the Napa Community Redevelopment Agency and funded by a grant from the California Office of Historic Preservation (Napa, 2009). Some houses are individually registered while others are located in a special district, which imposes certain added planning requirements. For instance, one owner said that because the house was historic they could not replace the chimney with other materials, and were obligated to make it look as close as possible to how it was before. (Case 555) Further significance of historic status on owner thinking about the traits of the house as well as the option set and process for doing upgrades and repairs are discussed later in Chapter 8.

Partly because of their age and the relatively small sizes of houses in the area, a number of Phase 2 houses had been substantially remodeled (Case 27) or added on to in ways that may or may not have affected the structural characteristics of the house, for better or for worse. One owner thought that a porch added onto the home 20 years after it was originally built may not have been properly done. (Case 40)

Lastly, the interview sample included a few houses with unusual occupancy types or uses. Three houses were renter-occupied. One included historic property was built as a residence but is now used for events as a business, putting it in an ambiguous category relative to planning requirements (Case 349). Another is on perpetual lease to the county of Napa as a social service delivery facility. (Case 527)

P-50 Form Data about Houses in the Phase 2 Sample

The FEMA P-50 form contains seven sections that address different aspects and ways to communicate about the seismic vulnerability of a house. A house starts with a “structural score” of 100 and in each section, traits of the house may be associated with penalty points that reduce the score from there. When a structural score is combined with a site-specific hazard score that is determined by the position of the property relative to known faults and other seismic sources of risk (e.g., landslide or liquefaction potential), to rate the house with an anticipated seismic performance “grade.” Grades range from A (excellent performer) to D- (poor performer) in half grade increments (i.e., + or -).

It was possible to summarize data from 33 out of 39 P-50 forms completed by inspectors in this study. **Table 6** provides the range of structural scores and hazard zone scores for 33 of the houses in the Phase 2 sample. Even in this small sample, structural scores showed a wide range from a low of 36.7 (D-) to a high of 93.9 (A-), with an average score of 75.3. The median structural score fell in the 75.0 to 84.9 bin, and there were equal numbers of houses (nine each) in the three highest highest-performing structural score bins.

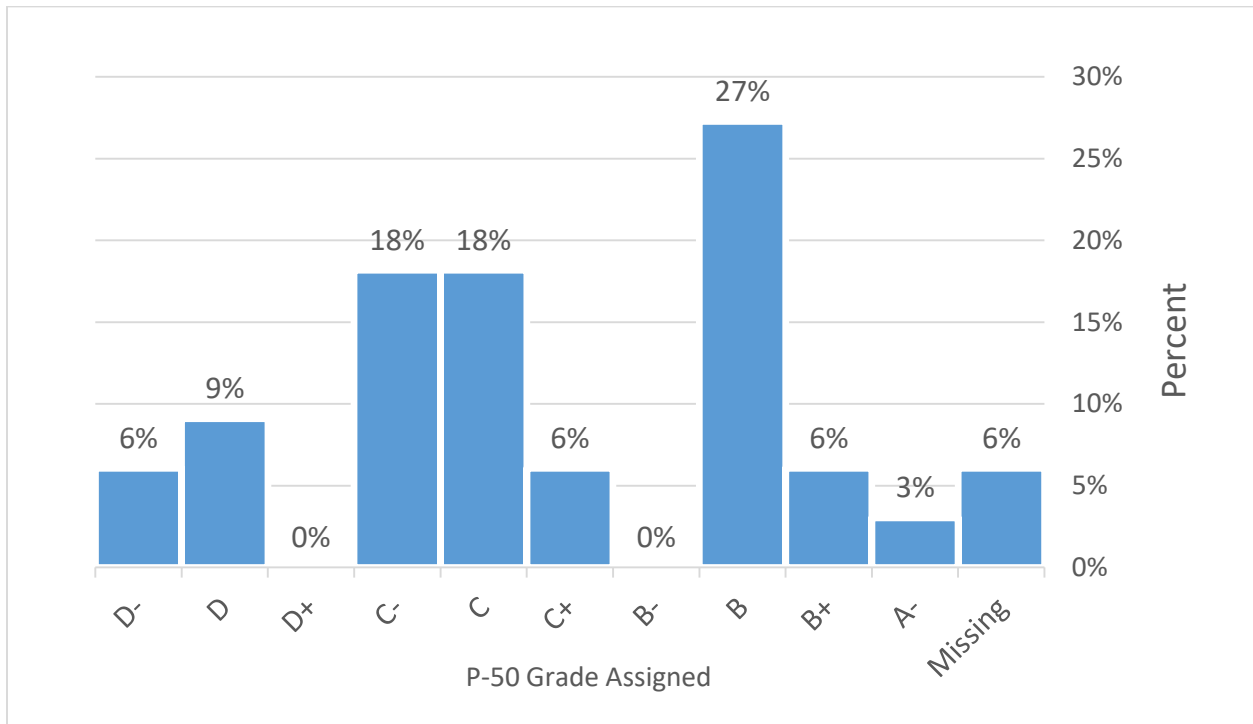
Seismic hazard scores assigned by the inspectors ranged from 4 to 12. The most common hazard score was 10. The hazard score for all of the houses should have been the same because they are all in the same geological zone; however, some inspectors were not able to get the information to calculate the proper score, so there is question to the accuracy of this portion of the data.

Based on the variability in hazard and structural grades, there was also a wide distribution of anticipated performance grades (see **Figure 4**). But again, because of the issues with assignment of hazard scores, the observed grade distribution cannot be taken as fully accurate.

Table 6. Structural and hazard scores in Phase 2 by era of construction and cripple wall height.

			Seismic Hazard Score				Structural Score Totals and Percent
			4	8	10	12	
Structural Score Ranges	1.0 - 45.9	Count	0	0	1	0	1
		Percent	0.0%	0.0%	3.0%	0.0%	3.0%
	46.0 - 64.9	Count	1	1	3	0	5
		Percent	3.0%	3.0%	9.1%	0.0%	15.2%
	65.0 - 74.9	Count	3	1	5	0	9
		Percent	9.1%	3.0%	15.2%	0.0%	27.3%
	75.0 - 84.9	Count	1	1	6	1	9
		Percent	3.0%	3.0%	18.2%	3.0%	27.3%
	85.0 - 100	Count	1	1	6	1	9
		Percent	3.0%	3.0%	18.2%	3.0%	27.3%
Hazard Score Totals and Percent		Count	6	4	21	2	33
		Percent	18.2%	12.1%	63.6%	6.1%	100.0%

Figure 4. Counts of P-50 anticipated seismic performance grades of the 39 houses in Phase 2 sample.



ABOUT THE HOMEOWNERS IN PHASE 2

The qualitative interviews gathered some information about the *interviewees* themselves. Existing risk analysis and behavioral research demonstrate that demographic traits and personal history are highly relevant to the choices and risk trade-offs people make.

To begin, interviewees were primarily over age 40 and married/partnered now or formerly. Many had grown children ([Case 40](#)), and only a few families had children currently living in the house ([Case 7](#)). Education levels were almost entirely college or above, with a number of professional degrees.

As to employment status and career fields, many interviewees were retired or on the verge of retirement, possibly with just one member of the household still working. Many worked from home or did free-lancing ([Case 407](#)). This makes sense because persons with these characteristics are more likely to have the time and availability to participate in weekday, daytime studies. But in this case, these traits may also be associated with the kind of people attracted to the Napa community—a place where self-determined kinds of people tend to move, perhaps slightly later in life, because they can live more affordably in this somewhat small but still world-renowned town.

Most of the interview sample were born in and grew up somewhere in California (e.g., Cases 162, 407, 497, 595). The rest mostly moved to California or Napa specifically several decades ago, in many cases from the central USA (Case 38, 527, 27). Interviewees seemed to associate living in California for a long time with being well informed and wized about the risk of earthquakes.

Participants showed a high degree of awareness in general about earthquake and other natural hazard risks of home ownership. Many expressed a feeling of living here on the “rim of fire” with “eyes wide open.” (Case 11, 162, 527, 555, 27) Not surprisingly, most interviewees had personal experience with past events. Interviewees mentioned going through Loma Prieta in particular (Case 162, 497, 23, 480, 27) but also Coalinga or Northridge. One person’s grandmother was a 1906 San Francisco quake survivor who became a life-long earthquake safety advocate (Case 480).

For some, this background seemed associated with an attitude that earthquakes are an unavoidable aspect of life. Numerous participants quipped something to the effect of, “*Where else can you live that doesn’t have risk?*” References were made to tornados, hurricanes, and flooding. Paraphrasing from one owner: “Earthquakes are a non-issue. I’m 68, I’ve lived [in California] a long time. I’ve experienced multiple earthquakes and they have been survivable. I know that I survived them but other people did not. You just take your chances.” (Case 407).

For others, living in earthquake country evidently is a concern and something they have done or want to do things about. In the first instance, awareness successfully translated into active personal preparedness behaviors or involvement in community resilience issues more broadly. A few people discussed lifelong habits of securing contents, installing cabinet locks, and refraining from having anything heavy hanging loose. One person discussed running regular family earthquake drills when their children were young (Case 555). Someone else had a strong motion instrument on their property (Case 527). A few people played roles in the aftermath of the event, including one that personally visited hundreds of homes in Napa (Case 527) and others than volunteered to help their church or school become better prepared.

For the more fatalistic, earthquake risk could play a role, not on its own but in combination with other factors, in wanting to move elsewhere. The better-informed and handier a person felt they were seemed to translate into higher motivation and success at looking into the earthquake resilience properties of their home.

It was not clear whether people had considered the relative earthquake risk, accurately or otherwise, among different places they had lived in California. Some mentioned that they may have underestimated Napa risk level relative to other California locations they’d lived, or in comparison to other threats such as flooding for which they have insurance, albeit mandated (Case 555). “I previously felt more at risk near Hayward fault than in Napa.” (Case 27)

Two other notable traits among the interviewee sample deserve mention. One is the prevalence of participants who described themselves or their immediate family members as

“handy.” (Case 7, 27) Several had direct experience in personally performing or managing home renovation projects, including retrofit work. A few had in depth experience with real estate investing or land use issues in the area. These types of knowledge and skills played a role in how the person thinks about home renovation difficulty and cost, as well as how people reacted to the quake and did or did not do post-earthquake inspection and minor repairs (Case 27).

Lastly, the interview sample included many people who are deeply attached and emotionally invested in their house (Case 11, 480, 555). This was expressed as a high degree of personal connection to their property, and a desire to continue living there for a long time. People who had worked on the house themselves, restoring or upgrading it over time, were very aware of its features, what things cost what or were how rare. Doing this work, often as a team with their spouse and with significant investment of time and money, made that connection very personal. “[We don’t want] to move because of the 33 years of work that has been put in.” (Case 480)

Chapter 3 — Retrofitting Beliefs and Narratives

This chapter reports on the perceptions, explanations, and stories that participating homeowners were able to share about how they view retrofitting in general—what it is, what is good or bad about it, and their rationales for why they’ve acted as they have. Towards the end, further details are provided about the experiences of interviewed homeowners that purchased retrofitted houses or carried out their own retrofit projects. The key take-aways from this chapter are:

1. Retrofitting was *not* a well-understood concept for all but the most construction-savvy homeowners.
2. A specific aspect of homeowner confusion about retrofitting is the type of retrofit work that has been done and what sorts of damage each kind of retrofit work is likely to prevent.
3. Homeowners had a spectrum of views about retrofitting, starting with broad general positive feelings but split opinions on whether or not a retrofit would be helpful or “worth it.”
4. Opinions about the value of retrofitting to any particular individual may be affected by perceptions by whether that person thinks it is affordable or attainable. If a person thinks doing a retrofit is cost-prohibitive, they might tend to underplay its value.
5. Retrofit status was not a major factor in home purchasing decisions for most of the interviewed owners.
6. Lack of retrofit uptake is likely affected by both hard to dispel myths and difficult to change truths about retrofitting:
 - Retrofit projects are perceived as costly, which may or may not be true.
 - Retrofit projects are perceived to involve uncertain costs, which may deter an owner that is interested in retrofitting from pursuing more information about what kinds of work might be recommended, for fear of receiving “bad news.”
 - Retrofit benefits are perceived as limited and uncertain, which may or may not be true.
 - Developing an intention to retrofit is a complex process with many steps and stages and months or years of effort during which a homeowner might become stalled.
 - Retrofit projects are intimidating and perceived as difficult to carry out for all but the most construction-savvy homeowners. This may tip the balance towards a perception that the upfront costs and hassle outweigh the long term benefits.

All these factors work against a homeowner who is open to seeking information to better understand their risk exposure, even if that homeowner has cost-effective and financially feasible opportunities to improve their household's earthquake resilience through mitigation.

HOMEOWNER UNDERSTANDING OF PRE-2014 RETROFIT WORK

As noted in Chapter 2, the survey suggested a modest amount of retrofit work had been done on single family homes (12.2%) in the Napa area before the 2014 event. Because of the study design, however, this should not be interpreted as the true rate of retrofit work on wood-frame single family homes in the area. Survey participation was voluntary rather than a random, representative sample, and the survey marketing specifically stated an interest in previously retrofitted properties. The actual retrofit rate might be higher *or* lower. In both the survey and interviews, evidence exists that some homeowners may have limited understanding of the retrofit status or retrofit work that's been done, not to mention about the age or quality of that work.

The most frequently reported types of retrofit work in the survey were anchoring (bolting), chimney removal, and additional of plywood or Oriented Strand Board (OSB) to the "basement" or cripple walls (referring back to **Table 2**). However, homeowners varied widely in accuracy and confidence when answering survey questions about retrofitting. Among those who self-reported a pre-2014 retrofit, some homeowners appeared to competently categorize their house as having had some retrofit work, and showed capability to describe the type of retrofit work done in the context of the overall construction history of their house. They used words like *sill*, *bolts*, *bracing*, *sheer wall*, *crawl space*, and *post and pier*. (Note: the phrase *cripple wall* was not used in any comment in the survey, and rarely in the interviews.)

Here is one example of how a homeowner explained the nature of the structure in detail: "[The home was moved to a new site in 2001. It had previously been set on floating piers on blocks, but was moved onto a monolithic concrete slab foundation with a reinforced CMU \[concrete masonry unit\] block wall raised basement.](#)" (Case 337)

The most common "retrofit types" mentioned by interviewees were also repair or replacement of the foundation (Cases 162, 40, 607), bolting, and removal of a chimney, or occasionally all of the above (Case 480). The first two and potentially all retrofit categories overlap. It was sometimes unclear when owners discussed foundation work whether it did or did not involve efforts to bolt, brace, or add sheer strength to the cripple wall.

Unfortunately for the aims of this study, the data may contain inaccuracies in retrofit status identification of more than one type and for several reasons. As for the scenario of falsely identified "retrofit" properties, nine owners with houses built after 1980 answered that their home was "retrofitted," possibly because they understand it to be built to modern codes.

The more serious error, from the standpoint of trying to assess retrofit performance, is if the survey approach failed to identify a house as retrofitted prior to 2014 when it in fact had been. This became a concern when the data showed that many homeowners did not answer or responded “Do Not Know” when asked about the retrofit status of their house. Many respondents chose to use the “Other” response option and wrote about it in the description section rather than using one or more of the retrofit type check boxes. Elsewhere in other parts of the survey, answers from some of these respondents indicated possible strengthening work that had been done.

A few owners showed self-awareness and admitted to their lack of understanding of their house’s retrofit status. Several newer owners claimed ignorance: “[We purchased the house in May 2014, so we are unaware of what types of measures were taken.](#)” (Case 566). The level of knowledge and confidence might depend whether the home was retrofit prior to purchase or by the homeowner. One theory is that homeowners who did the work themselves would be the most informed and confident in their knowledge, but the sample size in this study is not sufficient to explore that point.

Even among participating homeowners that *did* think their house was retrofitted, many were only able to provide vague and unconfident descriptions about what had been done previously and when. At the extreme, one homeowner said they “[don't know \[what kinds of strengthening work were done\] – just what contractor said.](#)” (Case 38)

Other respondents may have unintentionally erred in answering the retrofit question. One possibility is thinking the question did not pertain to the specific type of retrofit work they were aware of for their house. In the survey, at least eleven houses not reported as retrofitted were nonetheless described in comments as having a chimney braced, removed or replaced prior to 2014 ([Cases 433, 314, 750, 318, 301, 336, 718, 821, 783](#)). In two of those cases, those repairs occurred *after* chimney damage experienced in the 2000 earthquake, so it’s difficult to claim a lack of awareness that the work was earthquake-related ([Case 361, 42](#)).

Some participants may have been confused about what kind of work – either in nature or *extent* -- constitutes “a retrofit” for purposes of the question. Overall foundation improvements and support beam additions in particular seemed to be ambiguous. One owner in Phase 2 ([Case 471](#)) said they replaced the foundation, but hadn’t indicated that the house had been retrofitted. In the survey, some owners responded that they had rebuilt or added a garage ([Case 514](#)) or deck, patio or entry stairs, within the past decade or so, including new connections to the house ([e.g., Cases 164, 48, 844, 299](#)). While such improvements would likely meet contemporary code standards, these houses were not reported as having had a retrofit. A few participants reported water heater strapping as retrofit work ([e.g., Case 869](#)).

Other “Not Retrofitted” houses had experienced renovation or expansion of just part of the house, which may have resulted in a “partial” retrofit. Some owners showed confusion about the *extent* of work that would qualify the house as “retrofitted.” One owner commented that

their “Not Retrofitted” house had, “Shear walls installed during new construction to existing back room (Case 329). Another said, “Some but not all of the perimeter was bolted when floors were open for new plumbing work in about 2005.” (Case 841) It is also likely that recent additions would be of higher structural quality, and it is not clear how these houses should be treated. “I had a room added with a concrete slab which was built with earthquake fittings in the concrete. It is attached to my end of the house which could explain the lesser damage on this end of the house.” (Case 350)

Several aspects of the survey wording and study design might also be contributing factors to misidentification of retrofit status. People may have misinterpreted the question as only being relevant to retrofit work that *they themselves* had initiated. If they were not sure when the work had been done, some may have answered “No” or “Do Not Know” because they lacked specific, direct knowledge. One “Do Not Know” respondent stated in survey comments: “I did notice my house is bolted to the foundation. It was this way when I moved in many years ago. [It is] unknown if it was original.” (Case 449). Two other respondents stated that their foundation was bolted or tied down, but they were not sure when this happened (Cases 47, 884).

The interviews shed additional light on the difficulties owners had in reporting what kinds of retrofit work had been previously done. With more time to think, homeowners might have clearer recollections. One homeowner said the house was not retrofitted in the Phase 1 survey but in the interview said the house was retrofitted in 2011 during a renovation. (Case 168)

This discussion brings up important questions for advocates for improving earthquake resilience. *What are the typical and range of current beliefs and attitudes about retrofitting in the broad populations of single family homeowners? How much do typical homeowners actually understand about what retrofitting is?* The answers to these questions are likely related to a third topic: *Why do they pursue, or not pursue, information about the retrofit status of their properties, and how can those behaviors be positively influenced?*

HOMEOWNER IMPRESSIONS OF RETROFIT VALUE AND NET BENEFIT

Most homeowners in the interviews had overall favorable opinions about earthquake retrofitting. Many benefits and positive aspects were mentioned, ranging from emotional to physical to financial. In list form, owners with retrofitted houses, and some without, viewed retrofitting as able to:

- Provide emotional benefits such as peace of mind
- Reduce damage and loss in future quakes, particularly at the extremes of small, repeated contents damage and catastrophic outcomes such as total demolition

- Maintain the property's current value.

Emotional benefits seemed to be the most frequent and often first benefit mentioned. Interviewees spoke about peace of mind (Cases 861, 435), protecting their mental health (Case 595), and enhancing their pride of ownership and identity as a conscientious person. For this later benefit implied that their decision to retrofit was a reflection of the value they place on the home, and even the desire to preserve community identity and the historic beauty of the home (Case 11). Interestingly, one participant talked about realizing peace of mind benefits not just before but during and after an event (Case 7). Another said they had a very strong desire to do “anything it took to retrofit” (Case 480)

Loss avoidance was also seen as a benefit, particularly to avoid small, repeated costs (i.e., a retrofit might reduce shaking damage from more frequent less serious events) and extreme outcomes (i.e., where a large event might have caused the house to be a total loss). Improved safety was also brought up (Case 435, 595), but not often first. This may indicate an appropriate view that retrofit benefits have different likelihoods of occurring. They may not necessarily deliver much added safety, but retrofitters liked that it minimizes chances of damage, “giving a better chance of the walls staying up” (Case 607) and assuring the “ability to stay and live in the house.” (Case 595)

A few homeowners showed a nuanced understanding of a retrofit's potential to deliver benefits. One interviewee stated it well: “I am not cocky enough to think of this place as earthquake proof (Case 555). Another stated, “I feel secure about the house being in good shape—not that it would not have any problems, but it would be a good survivor next time around (Case 349). One owner of a non-retrofitted houses said a retrofit has “no drawbacks or down sides” because it “would have helped prevent or lessened contents damage.” (Case 38)

Almost no interviewees said they think that retrofitting a house would increase its appraised or resale value. One person mentioned increased retail value, but only thought about that in retrospect, namely, it was not a motivation for the retrofit work they'd done. (Case 23) For most, a retrofit seems to be about maintaining value, not adding to it. One retrofitter interviewee said they do not believe that a retrofit would add value to the marketability of a home, citing that earthquake damage from the 2014 event have not impacted the real estate market in Napa. (Case 527) The fact that retrofitting might not raise the property value was not seen as a reason not to do it: “I wanted to make the house more stable and safer, regardless of whether it increases the value. (Case 497)

Some owners mentioned that a retrofit could *protect* the value of the house (Case 435), not just for a future time of sale but for also asset protection into retirement because it is *their nest egg* (Case 595) or their estate worth that they can pass on to children (Case 555). No mentions were made of the potential *downside* of increasing the taxable value of the house.

One owner was excited that retrofitting was so cost-beneficial for their type of house. The homeowner felt they got great advice from a friend's dad and architect that brace and bolt is one of the cheapest ways to secure the house. (Case 861) Another expressed appreciation for the opportunity to reduce costs by doing it concurrent with other improvements. "When doing a retrofit you can also insulate and put in better sheer walls." (Case 349)

Opinions were split regarding whether retrofitting is particularly important to owners that have a high equity percent or are close to retirement. Some owners replied clearly that their level of equity in the house was not a part of their decision to retrofit (Cases 349, 27). Other retrofitters said it was a factor, but not necessarily in intuitive ways. "The lower the equity, the higher the risk." (Case 435)

Interviewees were also asked about any perceived downsides to earthquake retrofitting in general. Not unexpectedly, cost was a major concern, but costs seemed to be viewed in relation to perceived benefits. Some people want to retrofit and think it would be worth it but can't because they believe they can't afford it. Others simply felt that retrofitting is unattainably expensive. "It's only affordable if you are well off". (Case 168)

Interviewees expressed differing views on whether a retrofit is "worth it." Some, whether or not they could afford it, focused on skepticism or a perception that retrofit benefits are uncertain or possibly not large enough in relation to the likely cost. "You can't tell if the retrofit work has a significant effect and it's costly." (Case 168). "The benefits are not guaranteed to happen." (Case 497). A few simply reasoned that retrofitting is not needed, because damage did not happen in the past. (Case 435)

Views on the cost-benefit question were also divergent among non-retrofiters in the interviews. "I've given it a lot of thought but lack the funds. Believe me, I'd love to have a home I felt safe in. I don't any longer." (Case 471) "I understand that my house needs some work but the cost is too exorbitant." (Case 162) In contrast, a more skeptical non-retrofitter said, "It's doubtful whether a retrofit would have helped much. Our foundation was in such poor condition beforehand; a retrofit may have reduced damage but would have been very expensive." (Case 486)

Retrofitters mentioned downsides that they think others perceive, not that they believe themselves. No one mentioned regretting their decision to have a retrofitted property. One retrofitter did say it did make them feel like an oddball having a retrofitted house. "People that do retrofits are an anomaly and it does not seem to be a social norm that others are willing to follow" (Case 480). This might be a factor in spreading the perception that retrofitting does not make sense. Another noted how motivation seemed to fade among many friends along with memory of a recent event. (Case 38)

Two interviewees mentioned the difficulty of finding someone trustworthy and affordable to do a retrofit (Case 607), particularly after the 2014 event when local contractors were busy and raised their prices. (Case 607) Retrofitting to some owners did not seem, on balance, to

psychologically or financially compare well to other home upgrade opportunities. In the years since purchasing, several homeowners mentioned the inclination—and pressure—to pursue aesthetic, cosmetic, comfort, and home value-enhancing renovations over (invisible) earthquake safety improvements. (Cases 874, 407)

FACTORS IN NOT RETROFITTING

In addition to the rich information on retrofit perceptions among the interviewees, survey respondents who answered “No” to the pre-event retrofit question were provided a list of possible reasons why their house may not have been retrofit in the past. Respondents were asked to choose whether each statement was important, not important, or not applicable to their own situation. The instructions for this question were carefully worded to maintain neutrality as to whether a retrofit makes sense for any particular property or owner.

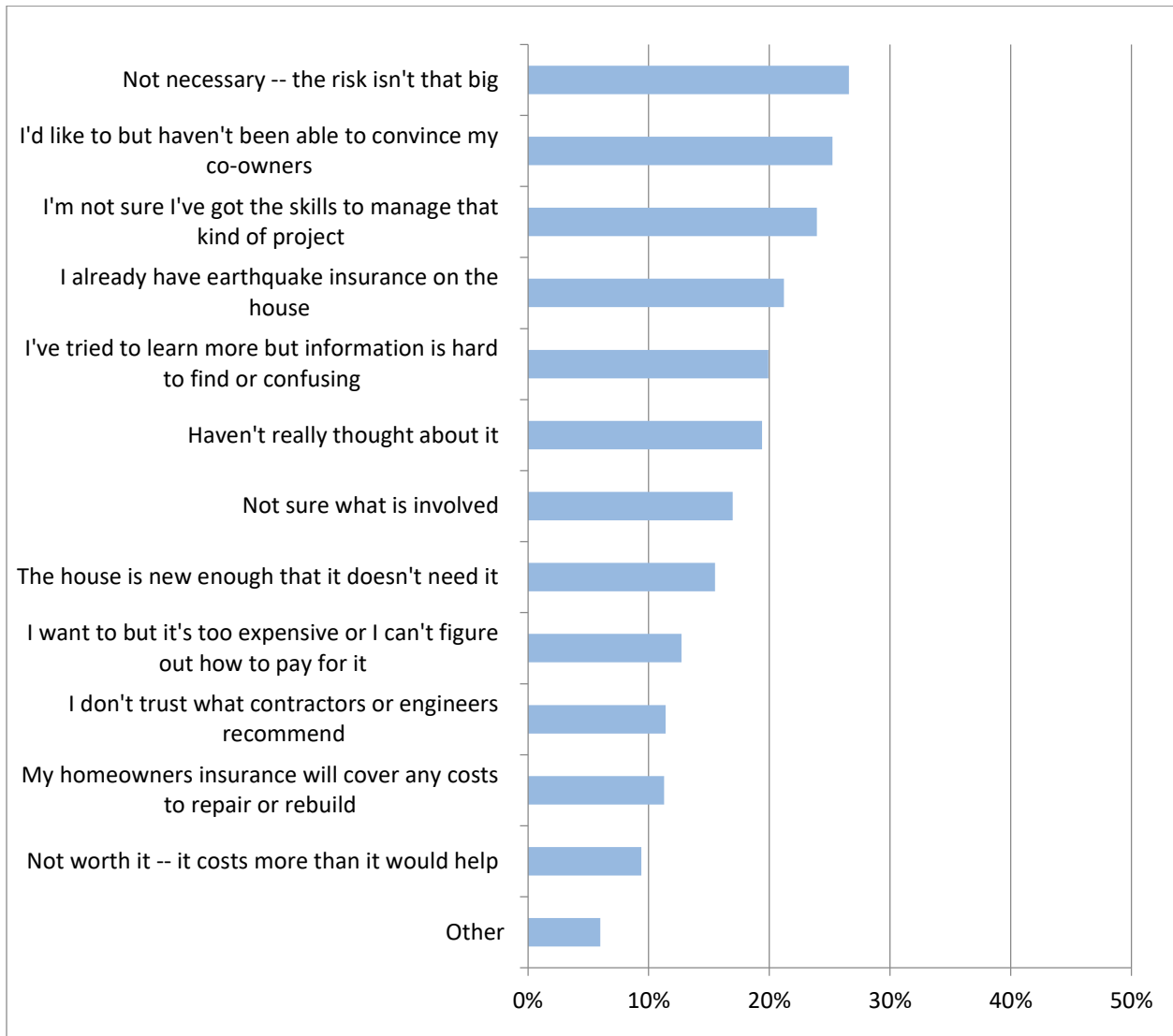
With an N of over 430 observations and twelve conceptual statements, this is one of the most detailed pieces of research undertaken to date examining self-attributed reasons for not having invested in earthquake mitigation. Additionally, the item options were strategically arranged to explore the potential relevance of stage-based theories of behavior change for self-protective behaviors (Armitage and Conner 2000; Lindell and Perry 2000). Stage theories of behavior change would predict homeowners to have different beliefs, needs and barriers to mitigation depending on their stage of engagement and action on the issue.

Overall, responses to these questions affirm that numerous factors are relevant to a homeowner’s thinking about mitigation and their ultimate retrofit status. “Not Important” was the *least-selected* answer for *all* the items. Also, the twelve sentiments listed seemed to well cover the range of obstacles people perceive: few people had anything to add in the answer option “Other.”

These data affirm for the idea that many non-retrofiters feel favorable about or want to mitigate their properties but face multiple barriers to doing so. Lack of *need* for retrofitting was not reported as a prominent factor. As shown in **Figure 6**, “Not necessary – the risk is not that big” was the highest rated “Not Important” statement. “I want to but it's too expensive or I can't figure out how to pay for it” was the item most frequently cited as important, at 46% (**Figure 6**).

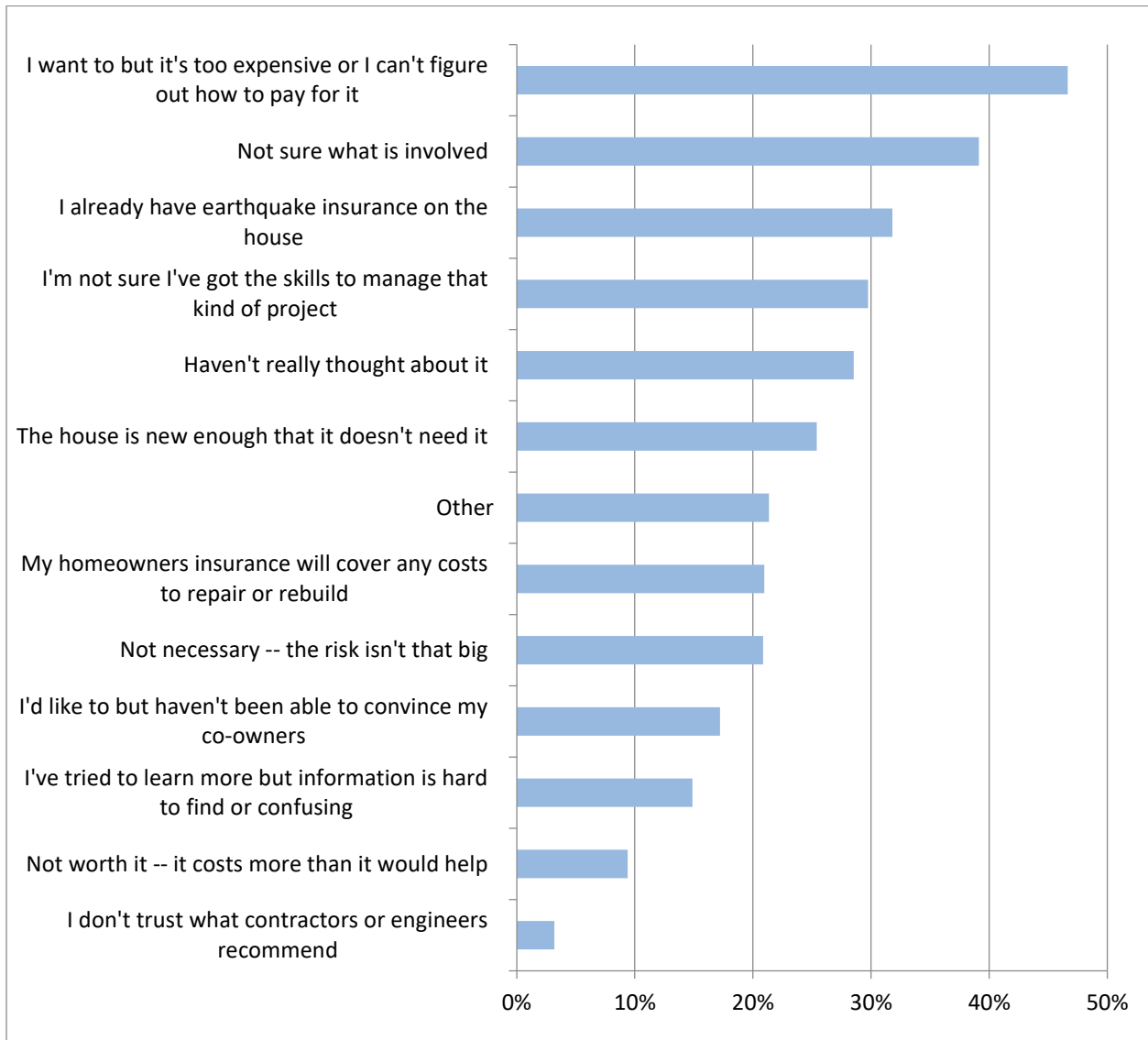
Regarding the economics of mitigation, there seemed to be little evidence of concern about mitigation not being cost-effective. However, affordability and inability to pay for it was cited as important by nearly 50% of respondents. This was the highest ranked statement in the “Important” category.

Figure 5. "Not Important" reasons why house is not retrofit (ranked from most to least cited) among non-retrofiters in the Phase 1 survey.



At the same time, several features of the response set suggest low issue salience or a general lack of consideration of the issue among many respondents with houses they believe had not been retrofitted houses prior to the August 2014 South Napa event. As seen in **Figure 6**, 'Haven't really thought about it,' and 'Not sure what is involved' were noted as important factors for 28.5% and 39.1%, respectively.

Figure 6. " Important" reasons why house is not retrofit (ranked from most to least cited).

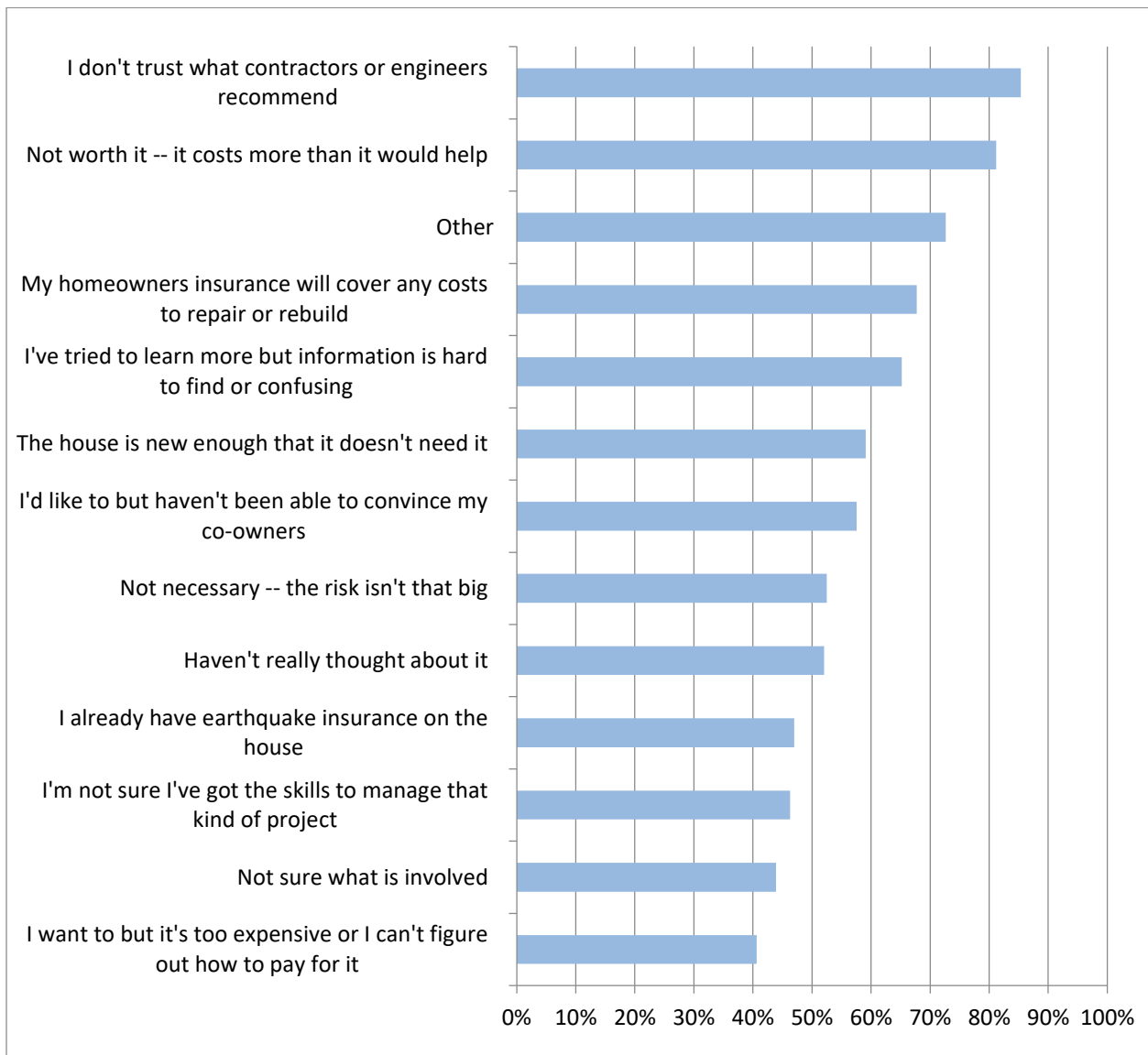


As shown in **Figure 7**, over 86% rated as 'Not Applicable' the statement, "I don't trust what contractors or engineers recommend," which contrasts with other qualitative research with building owners that suggests distrust in engineers as a major factor in the resistance to investment in mitigation (Rabinovici 2012). This could be interpreted as evidence that they've never made it far enough in the process to receive a recommendation. It might also mean that distrust of the building professionals is not a major barrier for single-family dwelling owners as it is for more among landlords and other more sophisticated real estate owners.

The data also suggest a mix of misperceptions may be at play, especially with regard to insurance. 'I already have earthquake insurance on the house' was reported as important by 31.8% of respondents for this question. This is incongruous with statewide insurance uptake

rates which are closer to 10%, and could be an artifact of self-selected interest in and participation in the study. Still, persons who answered this question this way may or may not be aware that insurance and mitigation different roles that mitigation and insurance play relative to their overall household resilience. Twenty-one percent erroneously stated that “My homeowner’s insurance will cover any costs to repair or rebuild” was important as to why their house is not retrofitted.

Figure 7. " Not Applicable" reasons why house is not retrofit (ranked from most to least cited).



All these facts substantiate a long-held belief in the earthquake policy arena that a sizable proportion of homeowners are mistaken, ignorant, or otherwise inattentive to issues

surrounding earthquake insurance, and in particular how their homeowner's insurance relates to earthquake risk.

Contrasting with that, some evidence in these questions pointed to accurate beliefs. Twenty-five percent responded that "The house is new enough that it doesn't need it," which seems rational (at least on the surface) given the age distribution in the response set where 23% were built in 1980 or later and the additional major remodel work claimed by 30% of the total 633 (not mutually exclusive) set of respondents.

Finally, one of the most unique items in this section sought to investigate an important notion from the hundreds of empirical studies done to test the Theory of Planned Behavior (Bandura 2001): a person's sense of *self-efficacy* to perform a behavior can be as or more important as to whether it is carried out than that person's perceptions of either the risk or the remedy. Ultimately, 30% of respondents to this question answered that their doubts about their own capability to carry out a mitigation project was an important factor for their situation. "Not sure what's involved" was also high (39%) in terms of reported importance.

RETROFIT STORIES: THE WHO, WHEN, WHY, AND HOW

Participants in this study who own retrofitted houses presented four different broad narratives about how they arrived in that position. The person, family, or household had either:

1. Bought a house that had been retrofit before they purchased it;
2. Initiated a retrofit as part of the negotiations around time of purchase or shortly thereafter, based on information that came to light during the buying process;
3. Initiated a retrofit later in ownership as an independent project or as part of some other major renovation work; or,
4. Initiated a retrofit because of a damaging earthquake event that either frightened them or necessitated removal, replacement, or repairs.

Just because someone purchased a house that has already been retrofit does not mean that the person knew this to be the case. Many interviewees said earthquake risk was a non-factor in their home search, including some people who purchased houses that had already had some retrofit work done. (e.g., [Case 527](#))

Some owners stumbled into the issue, and were simply pleased to find that the house they were interested in had been retrofitted in some way. In other words, earthquakes were not a factor in searching for a property but when they found it was already retrofitted, they were happy about it ([Case 38](#)), even in a case where it was done midcentury. ([Case 874](#)) In contrast, one owner said earthquake hazard was not a factor in their decision making, even though they knew the person they were buying the house from and that person was moving away in part

because of the trauma of the 2000 earthquake and had updated the chimney because of damage at that time. (Case 595)

Other home hunters became aware of their future house's vulnerabilities or retrofit status during a property search. Even still, this may or may not have been intentional or have much of an effect on their house buying decisions. For a few, it became a negotiating point or condition in the sale, or instilled a desire to do earthquake upgrade work if possible. "If the chimney had not been reinforced already, I would have considered reinforcing it." (Case 435) "I would have retrofitted if it hadn't been already." (Case 38) One homeowner bought the house in derelict condition and the reason for purchase was to restore its high value potential. The owner did a retrofit as one of the first things as part of protecting that investment. (Case 349)

Some interviewees did tell stories of doing detailed research or negotiating over earthquake issues at the time of purchase, especially in terms of inadequate foundations. One used USGS paper maps to look for houses on bedrock. (Case 480) Another homeowner negotiated with seller over the foundation and the split cost of retrofit work (Case 40). A third had the seller pay for improvements when previously installed bolts were found to be loose, along with replacement of the foundation and other major remodeling. (Case 7)

Others were motivated to seek a retrofit by information obtained during or as part of the context of purchasing the property. "The house was structurally unsound prior to purchase so they were going to do construction anyhow, so why not do earthquake work as well." (Case 555) In another case, the buyer's bank required the existing stone and mortar foundation to be replaced as condition of sale in 2004 (Case 740). The retrofit measures were part of complete replacement of foundation and basement wall at that time.

Interviewees had conflicting views on the role of real estate agents and home inspectors in giving them advice about earthquakes at the time of purchase. On balance, most said that realtors, home appraisers, and inspectors did not bring up, urge them to investigate, or help them resolve any vulnerability issues regarding the houses they were about to buy. "Our inspector was vague about the seismic evaluation of house when I bought it up." (Case 874) "Earthquakes issues did not come up with our real estate agent. The previous owner was an architect even and did not do any earthquake work." (Case 11) The realtor did not offer any specific information related to earthquake risk and prevention (Case 407) Another interviewee said their realtor "always mentioned earthquakes as an aside but quickly dismissed the idea of retrofitting because of the cost." (Case 407). One owner expressed frustration that they had to rely on the real estate appraisal and trust the words of contractor. (Case 471)

On the positive side, one owner said their realtor recommended inspection of the foundation, which led them to retrofit. (Case 349) Another said their broker was very upfront about the status of the house because it was an issue. (Case 435)

In cases where retrofit work was initiated sometime later by the current owner, it may either have been done as a DIY project (e.g., Case 11) or with a contractor as part of other home

renovations (Case 168, 497, 7, 27, 607). In terms of when the work was done, the interview sample included both recent and decades-old retrofits. In a significant number of cases, retrofit work was done decades ago (30 years or more (e.g., Cases 11, 480), but there were several homeowners reported newer projects in more recently purchased houses or in conjunction with major remodel work (Case 607—2008, Case 7—2001, 27--2009). One owner did some retrofit work by themselves, then followed up with additional work at the suggestion of a handyman. (Case 11)

Finally, regarding the fourth type of “story” told by retrofitted property owners, this study supports the idea that past earthquakes not only necessitate but contribute to the choice to do retrofit work. Several interviewees told stories of previous owners that replaced or removed chimneys after the 2000 earthquake (Cases 595, 435—at a cost of around \$10,000). Some owners were in that circumstance themselves, including one that used FEMA money to assist in paying for the work (Case 595). Other examples include damage to foundation and chimney in the 2000 earthquake that led an owner to replace and remove them at a cost of \$34,000 (Case 527), and another owner had to replace their foundation. (Case 23)

Overall, the 2014 event served as a wake-up call for many in the Napa community, both about the level of earthquake risk in the area and the specific features of their properties. One interviewee explained, “I did not know that structure was not bolted to foundation until after the earthquake. (Case 398) Twenty-five percent of surveyed owners said they sought out information about what can be done to strengthen their house or avoid future damage, and ten percent said they had made plans for or completed some kind of retrofit work (e.g., Cases 17, 518, 830, 841). The impact of the event on retrofit and insurance purchase decisions is further addressed in Chapter 6.

Chapter 4 — Damage Impacts and Retrofit Performance

This chapter reports on the range of damage experienced by survey respondents and the subset of interviewees who elaborated on damage impacts in further detail. Importantly, it also explores potential associations with these outcomes and retrofit status to the degree to which it could be determined, as well as house characteristics such as era built and cripple wall height.

Key points from this chapter include the following:

1. The August 2014 Napa event, despite its moderate size, had widespread impacts on wood-frame single-family houses in the community. Ninety-one percent of the survey sample experienced some degree of loss or damage. Nearly every house in the survey reported some kind of nonstructural and content damage.
2. Some more serious types of structure-related damage happened to porches, chimneys, and in a few cases foundations. Repair of internal wall damage was sometimes associated with very high costs when lath and plaster-style walls needed replacement.
3. Financial impacts were mostly modest with some high loss cases. The majority of survey respondents experienced under \$5,000 in costs to their household but one in five reported losses of \$15,000 or more.
4. Time to recover also varied widely. About two thirds of respondents had completed all important repairs and clean-up by eight days later. However, six months into their recovery, twenty percent of surveyed homeowners still hadn't completed necessary repairs. Reasons included financial barriers and the difficulties of finding an available contractor. The interviews eighteen months after the event revealed that some owners had *still* not completed repairs.
5. Regarding retrofit performance, even with this relatively large and uniquely rich data set, it is not possible to draw firm conclusions about how pre-event retrofits affected home outcomes. Damage varied widely among both non-retrofitted and retrofitted houses. The August 2014 event caused major damage to a significant number of non-retrofitted houses. There were also retrofit success stories, where houses with a retrofit work done prior to the August 2014 event experienced little to no damage. However, a small number of retrofitted properties suffered significant damage and many non-retrofitted houses performed well. A large number of outcome comparisons found retrofitted houses performed no better and in some cases slightly worse than non-retrofitted ones.
6. These mixed results should not be taken as evidence of the true value of retrofitting. Possible confounding factors and explanations for the apparent lack of retrofit benefit include the following.

- Because participants were not randomly recruited² to the survey, owners of retrofitted houses with more extreme damage outcomes may have self-selected into participating because they especially wanted to “tell their story.”
- Many surveyed homeowners were not able to report their retrofit status at all, and these houses had to be excluded from the analysis.
- As discussed in Chapter 3, homeowners that did report their retrofit status may have inadvertently been incorrect in either direction.
- Homeowners reported many different types of retrofit work done in the past and the types of damage in retrofitted properties may not have any logical relationship to the type of retrofit work done.
- The quality, appropriateness, and recency of reported pre-event retrofit work may have varied, which would make retrofitted properties less comparable to each other in terms of their expected performance.
- The size and variety of house characteristics represented in the sample do not make it possible to control for other house characteristics known to relate to earthquake performance, such as foundation type, slope, cripple wall height, ground shaking experienced, and year built.
- The 2014 Napa event represents only one possible “test” of how a retrofit might perform over its relevant lifetime, considering that earthquakes of different and potentially larger sizes will continue to occur in this area for years to come.

Consequently, more nuanced, longer term research approaches will be necessary if the performance *in situ* retrofitting of single-family wood-frame houses is to be better understood. Specific suggestions about this are addressed in Chapter 8.

SELF-REPORTED DAMAGE FROM AUGUST 2014 EVENT

Consistent with other studies, the survey showed that the 2014 Napa event had widespread impacts on single-family homeowners in the community. Only nine percent of the sample reported experiencing little to no damage, and a majority faced some monetary impacts and time consuming clean-up of toppled or broken contents.

Homeowners in both the survey and interviews described many different of types of damage. Most notable was high rates of minor non-structural (e.g., contents, minor wall cracking)

² Random recruitment involves contacting a fixed number of potential subjects at random. No one particular person would have any greater chance than another of being contacted. The goal of this method is to recruit a set of participants that is as similar as possible and thus “representative” to the overall population of interest.

damage were reported, with over half experiencing things like broken or violently displaced furniture, household items, wall hangings, and shelving. Over half of respondents mentioned internal wall cracks. Thirty-nine injuries were reported, with 84.6% of those respondents saying they experienced things falling off of walls or out of cabinets. **Table 7** presents a summary of overall survey responses for each of the nine damage outcome questions in the survey.

Table 7. Summary of self-reported damage from the August 2014 South Napa event.

<i>Characteristic</i>	<i>Responses</i>	<i>N</i>	<i>Percent</i>
Someone Injured or Hurt On Site	Yes	590	6.6%
	No		93.4%
Damage – Things That Were Inside (check all that apply)	Things like books or dishes fell off shelves	633	77.2%
	Paintings, mirrors, or artwork fell off the wall		58.5%
	Furniture, or other large items tipped or broke		52.3%
	Computer, TV, or other electronics damaged		38.9%
	Other (primarily additional descriptions of damage types mentioned elsewhere)		20.5%
	Little to no damage		8.9%
Damage – Inside Structure (check all that apply)	Small cracks or breaks in the inside ceiling, walls	633	55.4%
	Bigger cracks in the ceiling or walls		22.0%
	Damage to floor coverings		12.1%
	Other (primarily additional descriptions of damage types mentioned elsewhere)		7.5%
	Damage from a water leak		6.8%
	Damage from a fire		0.2%
	No damage to the inside ceiling, walls		20.7%
Damage - Windows or Doors (check all that apply)	1 or more window/door could not be opened	633	15.1%
	1 or more windows broke		9.5%
	Glass in a sliding door broke		1.1%
	Glass in a regular door broke		0.9%

<i>Characteristic</i>	<i>Responses</i>	<i>N</i>	<i>Percent</i>
	Not noticed any damaged windows or doors		64.4%
Damage to Chimney	Yes	424	28.3%
	No		71.7%
Damage- Outside Wall Surfaces	Yes	584	36.1%
	No		63.9%
Type of Outside Wall Damage (check all that apply)	Small cracks in the stucco finish	633	18.6%
	Big cracks in the stucco finish		10.6%
	Other (primarily additional descriptions of damage types mentioned elsewhere)		5.1%
	Large pieces of stucco finish fell off		4.7%
	Shingles or sheathing came loose but still attached		2.7%
	Large pieces of shingles or sheathing fell off		0.8%
	No outside wall damage		0.5%
Tagged by the City	Green	581	11.0%
	Yellow		13.8%
	Red		1.2%
	The building was not tagged.		74.0%
Other Kinds of Outside Damage (check all that apply)	1 or more doors to the outside could not open	633	4.5%
	Garage door frame moved sideways or racked		3.2%
	A porch roof moved sideways (racking)		1.8%
	House slid or toppled off of the foundation		1.5%
	A porch roof collapsed		0.3%
	Other (primarily additional descriptions of damage types mentioned elsewhere)		13.6%
	No outside damage of these types		63.8%

Data about what happened to the outsides of houses affirm one of the most visible take-aways from the South Napa event: masonry chimneys on single-family houses in the area were severely impacted. Twenty-eight percent of those surveyed reported experiencing chimney damage. Over a third of respondents also reported damage to outside wall coverings, the most common type being small to large cracks in the stucco. Significant and life threatening outside damage was rare. One or more windows or doors that would not open (a possible concern for safe egress) was reported by 15%.

The survey dataset includes eight houses that received red tags from an official inspection. Another 13.8% received yellow tags while 11% said their house was inspected and received a green tag. The remaining three fourths of the houses were not inspected (presumably because no immediate re-entry threats were present or perceived). Yellow tag damaged (yellow tag status reflects safety of accessor proximity issues) varied from foundation slips to broken chimneys to porch separation and detachment of trim. There were no red tagged houses in Phase 2, but the interviews did involve nine houses that received yellow tags.

Homeowners in the survey comments as well as in the interviews echoed and elaborated on the kinds of damage reported in the survey and its implications for their households. Their answers reflect the many different *types* of costs that earthquake-affected households can incur.

Contents breakage and clean up was a problem for nearly all interviewees. Dangerous shattered glass sometimes covered the floor. Replacement of broken items such as picture frames, window or special cabinet panes, and glassware became necessary (Cases 38, 607). Television, stereo, and computer equipment were in some cases damaged. In two cases, large items of furniture fell over in positions that could have injured someone (Case 497, 7). In an unusual story from the interviews, an aquarium located on the second floor fell off a table and shattered, leaving dead expensive, exotic fish all around and thousands of dollars in water damage (Case 23).

Replacement costs might include food that spilled out of refrigerators and cabinets or spoiled in a fridge without power. Time spent cleaning up, and the associated physical difficulties and inconvenience, were a burden for some, and occasionally necessitated contracting out. Many interviewees said they leaned on friends and family, some of whom might need to travel, miss work, or pay babysitters in order to help.

Not surprisingly, some of the broken contents were heirlooms, collectors' items (Case 168), or other irreplaceable things with sentimental if not also economic value. Lost data on a damaged computer postponed or derailed current work projects, even if the hardware itself could be replaced (Case 435). Many interviewees reported experiencing "cosmetic" interior wall cracks that served as visible reminders of the event which unnerved people. [Interior cracks were also a common type of repair left unfinished, even 18 months after the event.]

Things outside the home were also impacted. One hot tub repair cost more than \$3,000 (Case 435). A beloved broken garden fountain took months and hundreds of dollars to fix. Pool decks, garage pads, freestanding garages and carports, fences, stone retaining walls, and other property features were also damaged.

The most dramatic and in general costly damage reported was to chimneys, porches, and foundations. Chimney damage ranged from minor to major cracking (Case 162), toppling of the stack above the roofline (Case 607), pulling away from the house (Cases 11, 162), and complete collapse (Case 407). Crumbling bricks led to safety risks and debris in driveways, yards and sidewalks. In one case, falling bricks from a chimney moderately damaged a car (although auto insurance covered that expense). (Case 497) A cracked beam and cracks in the roof to that same house were not covered.

In the interviews and survey comments, homeowners reported chimney repairs that cost from under \$3,000 to on the order of \$60,000 to \$80,000. In one case, the repairs reached that upper level of expense without even counting the homeowner's own labor and time spent managing the project (Case 555). Long repair delays cost one owner significant money because the house was empty and unrented. (Case 349)

At least five interviews were conducted with people whose porch separated, pushed away, or "disintegrated" from the house (Cases 7, 11, 40, 607, 874). Under one house, piers added by homeowner decades ago were knocked out of alignment (Case 555). Another owner discovered after the porch separated from the house that they needed a total foundation replacement, which cost \$300,000 (Case 11).

FINANCIAL AND RECOVERY TIME IMPACTS

This spectrum of damage outcomes resulted in widespread replacement and repair costs as well as loss of valuable time. **Table 8** presents the overall data from the survey on economic impacts and length of time until essential repairs and clean-up were completed. It should be noted that survey participants in their comments and many interviewees also expressed that the event emotionally affected them for days and months, which although less tangible, can have real economic consequences (this topic is briefly addressed briefly at the end of this Chapter in a section on psychological impacts).

Table 8. Summary of survey data on financial impact and time for completion of clean-up and essential repairs caused by the August 2014 South Napa event.

Characteristic	Responses	N	Percent
Estimate of Total Dollar Impact of Event on Household	\$0 to \$500	546	23.3%
	\$501 to \$1,000		12.5%
	\$1,001 to \$5,000		27.1%
	\$5,001 to \$15,000		18.0%
	\$15,001 to \$25,000		6.8%
	More than \$25,000		12.4%
Clean-Up and Time Until Essential Repairs Done	Less than a day	526	16.7%
	1 to 7 days		35.0%
	8 to 21 days (about 2 or 3 weeks)		11.4%
	22 to 90 days (about 1 to 3 months)		10.3%
	91 to 180 days (about 3 to 6 months)		5.1%
	Important repairs are still not finished		20.0%
	Do not intend to repair or replace those parts		1.5%

Regarding financial impacts, 36 percent in the survey reported the total dollar impact of the event on their household as under \$1000 (Table 8). Forty-five percent reported economic impacts in the range of \$1000 to \$15,000. At the upper end, 19% of respondents faced tens of thousands of dollars of work and extensive, lengthy repairs. Not surprisingly, six out of seven red tagged and 38 percent of yellow tagged houses reported “More than \$25,000” in total household dollar impact.

Figure 8. Estimate of Total Dollar Impact of the August 2014 South Napa event on household.



Peoples' stories from the interviews shed some light onto the circumstances of higher loss households. The highest outliers faced either more significant damage, or multiple instances of moderate damage (such as contents breakage, lost equipment, or extensive crack repairs and repainting to inside walls). One owner needed to remove and replace their porch at a cost of around \$10,000 ([Case 40](#)). Another went months without a kitchen that was estimated to cost \$150,000 to repair, and that person now has to walk away from their home. ([Case 486](#))

Based on comments in the survey and interview data, there are several reasons to believe that these reported "costs to household" may underestimate total losses. If a homeowner does not complete repairs or replace certain items, out of choice or because they cannot afford them, the owner might not know or necessarily volunteer that as part of their dollar estimate. A non-trivial fraction, 16.5%, of survey respondents said that important repairs are still not finished. If the estimated repair cost is \$25,000 or more, even if the repairs are important, they may still not be finished. ([Case 11](#)) Owners might also discover, as at least one did, additional earthquake-related damage six months after the quake. ([Case 497](#))

EXPLORATION OF RELATIONSHIPS BETWEEN RETROFITS AND OUTCOMES IN THE AUGUST 2014 EVENT

A central aim of this study is to explore how pre-event retrofits may have affected the amounts of damage to Napa single-family homes in the August 2014 event. This section assesses the variety of evidence collected about how pre-event retrofits relate to damage, financial and recovery outcomes.

Outcomes of Retrofitted Compared to Non-Retrofitted Houses

This study identified many examples of pre-event retrofitted single-family homes that had little to no damage; in other words, many retrofit success stories came out of the 2014 Napa event. This is true even though successes can be harder to identify and document than tragedies that garner more visibility in the wake of a disaster. Social norms may even encourage those who fair better than others to stay modest and keep quiet on the sidelines while those more in need are cared for. Below are a few stories from participating owners of retrofitted properties whose houses did well.

One owner indicated they had braced the chimney, shored up the garage, installed Oriented Strand Board (OSB) to all exterior walls, and put additional support piers in the crawl space to support second floor weight during a previous remodel (Case 27; a B+ on the 2016 P-50 evaluation). In the interview, the owner was pleased they had done this “relatively inexpensive retrofit work” and felt they had little to no damage or psychological effects from this event compared to others.

Another interviewee explained that their house was red-tagged in the 2001 Napa earthquake and subsequently they retrofitted it “down to the studs.” About the 2014 event, the owner described lots of loud creaking and groaning but said “the house held together well.” (Case 420)

“Thankfully I had no damage because it had been retrofitted.” (Case 38) This owner did not know any details about how the house had been retrofitted, just “what a contractor said” previously.

Positive outcomes among retrofit houses were not universal, however. The study revealed some instances and ways that self-reported retrofitted properties might not have fared as well as hoped. Notably, in at least one case, a house that the owner said had cripple wall anchor bolts and plywood still fell off its foundation and suffered other severe consequences, including

one red tagged property. (Case 563) That house was built in the 1910's and has a low (less than 2 feet) cripple wall. Here is how the owner described the impacts:

“When the house fell off the foundation, the skirting or pony walls collapsed and fell to the ground. The house broke off from gas and water lines when it fell off the foundation and onto the electric lines. All utilities were shut off for a period of time. We now have temporary water and a temporary electric power pole in the front yard.”

Here are two additional accounts from owners of retrofitted properties that experienced significant damage.

One owner said the “house shifted on its foundation *even though it was bolted down* [emphasis added]. All four corners were damaged, the east wall buckled, and the house was leaning to the west.” (Case 518) This property was yellow tagged, and eight months later important repairs were still not yet done and that person was still unable to move back in. [Note: This owner did give conflicting information in the survey about their house's retrofit status, saying in one question that their house was not retrofitted, but elsewhere that the house was bolted down.]

Another homeowner that indicated their house had anchor bolts and/or bracing had significant damage (Case 874) in the form of a dislocated (possibly racked) front porch and the house slipping on its foundation. This resulted in a yellow tag and repairs that were still not complete as of March 2016, with an estimated cost well over \$25,000.

Survey data showed a higher rate of yellow and red tagging among retrofit properties (for those that retrofit status is known) compared to non-retrofitted ones. As noted above, one retrofitted property was red-tagged (Case 563). Seventeen out of the 77 retrofitted properties (22%) were either yellow or red tagged, compared to thirteen percent of non-retrofitted properties and about fifteen percent of all houses for which a retrofit status was reported (Table 9). Sixteen houses (20.8%) of house self-reported as having a pre-event retrofit were yellow tagged. (e.g., Cases 32, 115, 167, 243, 246, 414, 433, 451, 514, 558, 740, 869) This is higher than the rate of yellow tags reported in the overall survey sample (13.8%).

Table 9. Tagging status by retrofit status.

Tagging Status via Post-Event Inspection				
		Self-Reported Retrofit Status		Totals
		Not Retrofitted	Retrofitted	
Yellow Tagged	Count	43	16	59
	Percent	11.6%	20.8%	13.2%
Red Tagged	Count	6	1	7
	Percent	1.6%	1.3%	1.6%
Yellow or Red Tagged	Count	49	17	66
	Percent	13.2%	22.1%	14.7%
Totals		371	77	448

Significant structural issues, though rare in the Napa earthquake and also in this data set, did occur for some retrofitted properties. Four times the rate of retrofitted properties compared to retrofitted ones had a porch slip sideways (**Table 10**). The only property in the study with a porch roof collapse had been previously retrofit. Two other owners of retrofitted houses said porch columns shifted visibly about three to four inches but the structures remained usable and intact.

Table 10. Significant structural issues and damage by retrofit status.

Significant Structural Damage				
		Self-Reported Retrofit Status		Totals
		Not Retrofitted	Retrofitted	
A porch roof moved sideways (e.g., askew or racked)	Count	3	6	9
	Percent	.8%	8.2%	2.1%
A porch roof collapsed	Count	0	1	1
	Percent	0.0%	1.4%	.2%
House slid or toppled off of the foundation	Count	7	2	9
	Percent	2.0%	2.7%	2.1%
Garage door frame moved sideways or racked	Count	15	4	19
	Percent	4.2%	5.5%	4.4%
1 or more of the doors to the outside could not be opened	Count	24	3	27
	Percent	6.8%	4.1%	6.3%
Totals		354	73	427

For less severe damage types, analysis similarly showed mixed results regarding how retrofitted properties fared in the August 2014 Napa event compared to non-retrofitted ones. Two important things should be noted before reviewing the findings below. First, comparisons of retrofit status were only conducted for the 451 of houses for which retrofit status was reported (i.e., of known retrofit status). The use of all houses, including those with “Do Not Know” or missing values for retrofit status, would reduce validity of the comparison.

Second, even with this sample size, it is not appropriate to rely on inferential tests for significance of association in this data set. Reasons include the large number of possible related factors (e.g., house age, materials, and cripple wall height) for which it is not possible to control, the large number of outcome variables being considered relative to the sample size, and low rates in the sample for many of the relevant outcomes.³

Within this context, on the negative side, retrofitted properties had slightly higher rates among houses of known retrofit status of experiencing one or more types of damage beyond the cosmetic and non-structural. Thirteen percent of retrofitted houses had some damage of a potentially structure-related nature, compared to eight percent of retrofitted houses and around nine percent in the overall sample.

Retrofitted houses had higher rates of larger cracks on ceiling and walls as well as damage to floor coverings, and windows (**Table 11**). Lath and plaster wall materials may have played a role. One owner of a retrofitted house described moderate cracks in lath and plaster on both first and second floors (with repair estimated by an SBA inspector at \$11,500). Another said in two rooms greater than one fourth of the plaster wall surface fell off, requiring complete replacement (leading to a sheetrock or shear wall retrofit). One retrofitted house lost four rafters and had large holes in interior dry wall.

³ The survey asked homeowners about a large number of possible damage outcomes, often using “check all that apply” question formats. It is not statistically appropriate to test for differences in outcomes across all the variables. Some of the tests would come out statistically significant by chance alone (in other words, there is a very high chance of finding evidence of differences that aren’t really true). This is generally considered a more important type of error to avoid than *not* finding evidence of a difference that is actually true. Furthermore, breaking the data up into ever smaller groupings decreases the feasibility of doing inferential tests at all. Many tests are not usable with small sample sizes that do not provide a chance for wide representation of true world conditions to occur. The results are mathematically certain to be unreliable. That being said, small sample size data is better than no data, and findings can be used to generate important hypotheses to investigate in future studies, with distinct research designs targeted to assess particular theories or issues.

Table 11. Rates of interior damage types by retrofit status.

Types of Interior Damage				
		Self-Reported Retrofit Status		Totals
		Not Retrofitted	Retrofitted	
Small cracks or breaks in the inside ceiling, walls, or finishes	Count	233	46	279
	Percent	62.8%	60.5%	62.4%
Bigger cracks (wider than a match stick) in the ceiling or walls	Count	87	29	116
	Percent	23.5%	38.2%	26.0%
Damage to floor coverings (for instance cracked floor tiles or ripped wood flooring)	Count	50	15	65
	Percent	13.5%	19.7%	14.5%
Damage from a water leak	Count	29	4	33
	Percent	7.8%	5.3%	7.4%
Damage from a fire	Count	1	0	1
	Percent	.3%	0.0%	.2%
Totals		371	76	447

In the survey comments, descriptions of interior damage for *non-retrofitted* houses seem to involve many mentions of fixture displacement and breakages such as:

- A bathroom light fixture entirely blew out of the wall and was hanging by the electrical wire.
- A bathroom pedestal sink that was attached to wall broke loose and drain connection was broken.
- A toilet and sink dislodged.
- Built in kitchen cabinets came away from wall, two ceiling lights were damaged beyond repair, and a ceiling fan was missing a blade.
- Shower doors that shifted and dented the bathtub or now don't close.
- Doors out of plumb and un-openable windows.
- Leaks around a skylight.
- Water heater was shaken askew, valve broken, or chimney dislodged, in some cases even if strapped or braced (e.g., securing measures came loose).
- A wood mantel piece and built in bookshelves popped away from the wall.
- Two houses with damaged gas lines.

In general, retrofitted and non-retrofitted houses performed similarly in terms of door or window breakage (**Table 12**). The one exception is that retrofitted houses had slightly higher

incidence of one or more windows broken and broken glass in a sliding door. However, both were rare outcomes in this quake which makes detection of random differences more likely.

Table 12. Occurrence of door and window damage by retrofit status.

<i>Door and Window Damage</i>				
		Self-Reported Retrofit Status		Totals
		Not Retrofitted	Retrofitted	
1 or more windows broke	Count	38	12	50
	Percent	10.4%	16.0%	11.3%
Glass in a sliding door broke	Count	4	2	6
	Percent	1.1%	2.7%	1.4%
Glass in a regular door broke	Count	5	0	5
	Percent	1.4%	0.0%	1.1%
1 or more windows or doors could not be opened	Count	66	13	79
	Percent	18.0%	17.3%	17.9%
Totals		367	75	442

Overall, retrofitted houses reported a higher rate of exterior wall damage occurrence (42%) than non-retrofitted houses (35%) (**Table 13**), but non-retrofitted houses had higher rates of each specific type of exterior damage, except for retrofitted houses were reported to have two and a half times more shingles or sheathing coming loose but still attached. A few hints existed of significant exterior wall damage to retrofitted houses. One owner of a retrofitted house commented in the survey that cracks in their exterior wood work resulted in over \$20,000 of repairs. Another re-stucco the entire house exterior because there were too many cracks to patch, though it's difficult to tell if this was an aesthetic preference or necessity.

Table 13. Occurrence and types of exterior wall surface damage by retrofit status.

Occurrence of Exterior Damage				
		Self-Reported Retrofit Status		Totals
		Not Retrofitted	Retrofitted	
Had Damage to Outside Wall Surfaces	Count	130	35	165
	Percent	34.9%	46.1%	36.7%
Totals		373	76	449
Types of Exterior Damage				
Small cracks in the stucco finish	Count	81	15	96
	Percent	62.8%	44.1%	58.9%
Big cracks (wider than match stick) in the stucco finish	Count	45	10	55
	Percent	34.9%	29.4%	33.7%
Large pieces of stucco finish fell off	Count	20	5	25
	Percent	15.5%	14.7%	15.3%
Shingles or sheathing came loose but stayed attached to the building	Count	10	6	16
	Percent	7.8%	17.6%	9.8%
Large pieces of shingles or sheathing fell off	Count	3	1	4
	Percent	2.3%	2.9%	2.5%
Totals		129	34	163

Among the 312 houses of known retrofit status that had one or more chimneys, the 38 retrofitted properties with chimneys had higher rates of experiencing any kind of chimney damage (**Table 14**) (Note: the retrofit for each property may or may not have involved the chimney).

Table 14. Rates of chimney damage types by retrofit status.

<i>Had Some Kind of Chimney Damage</i>				
		Self-Reported Retrofit Status		Totals
		Not Retrofitted	Retrofitted	
Chimney damage occurred	Count	64	19	83
	Percent	23.4%	50.0%	26.6%
Totals		274	38	312
<i>Chimney Damage Types by Retrofit Status</i>				
Small cracks but only in the part of the chimney above the roof	Count	10	4	14
	Percent	15.6%	21.1%	16.9%
Small cracks all over the chimney	Count	10	2	12
	Percent	15.6%	10.5%	14.5%
Chimney still standing but the part above the roof was badly damaged	Count	15	7	22
	Percent	23.4%	36.8%	26.5%
Chimney still standing but all the whole chimney was badly damaged	Count	13	4	17
	Percent	20.3%	21.1%	20.5%
The whole chimney peeled away from house	Count	8	3	11
	Percent	12.5%	15.8%	13.3%
The part of the chimney above roof fell off or toppled over	Count	15	5	20
	Percent	23.4%	26.3%	24.1%
Totals		64	19	83

The damage described above obviously had consequences for the financial burden on owners after the event as well as the amount of time it took to resolve any problems that the earthquake had created for the household. However, here the data also suggest that many retrofitted properties faced difficult challenges. Nineteen percent of the highest economically-impacted houses in the study were already retrofitted, compared to twelve percent of non-retrofitted properties (**Table 15**). Retrofitted properties also had higher rates of time until essential repairs were complete (**Table 16**) and had more repairs left unfinished (31%) compared to non-retrofitted properties (19%).

Table 15. Reported total cost to complete all necessary repairs following the August 2014 South Napa earthquake.

Approximate Total Value or Cost to Repair All Damage				
		Self-Reported Retrofit Status		Totals
		Not Retrofitted	Retrofitted	
\$0 to \$500	Count	80	15	95
	Percent	22.8%	20.5%	22.4%
\$501 to \$1,000	Count	46	6	52
	Percent	13.1%	8.2%	12.3%
\$1,001 to \$5,000	Count	99	17	116
	Percent	28.2%	23.3%	27.4%
\$5,001 to \$15,000	Count	66	10	76
	Percent	18.8%	13.7%	17.9%
\$15,001 to \$25,000	Count	18	11	29
	Percent	5.1%	15.1%	6.8%
More than \$25,000	Count	42	14	56
	Percent	12.0%	19.2%	13.2%
Total		351	73	424

Table 16. Approximate time until all important clean-up and repairs were completed.

Time to Complete All Important Clean-Up and Repairs				
		Self-Reported Retrofit Status		Totals
		Not Retrofitted	Retrofitted	
Less than a day	Count	57	9	66
	Percent	16.8%	12.9%	16.1%
1 to 7 days	Count	123	18	141
	Percent	36.3%	25.7%	34.5%
8 to 21 days (about 2 or 3 weeks)	Count	42	4	46
	Percent	12.4%	5.7%	11.2%
22 to 90 days (about 1 to 3 months)	Count	32	10	42
	Percent	9.4%	14.3%	10.3%
91 to 180 days (about 3 to 6 months)	Count	12	7	19
	Percent	3.5%	10.0%	4.6%
Important repairs are still not finished	Count	66	22	88
	Percent	19.5%	31.4%	21.5%
I do not intend to repair or replace those parts of the house	Count	7	0	7
	Percent	2.1%	0.0%	1.7%
Totals		339	70	409

Data Limitations and Other Possible Explanations for Retrofit Performance Findings

A large number of factors could have contributed to these counterintuitive results about retrofit performance. The following possible explanations show why it is inappropriate to conclude for this sample that retrofitted properties performed worse than other non-retrofitted ones.

The first issue is that the survey, and especially the interview data subset, are not random samples of the population of interest. Far from it, as noted previously, the general public was recruited on a first come-first served basis using an extensive marketing campaign that emphasized an interest in pre-event retrofitted properties. Even with the modest monetary incentive, it takes time and motivation to fill out a survey. This could lead to self-selection into the original sample of properties that performed particularly worse (compared to other properties in the community) because these owners especially wanted to “tell their story.”

Another issue, potentially exacerbated in a non-random sample, would be any undocumented dissimilarities between non-retrofitted and retrofitted houses that also relate to earthquake

performance. When comparing outcomes of non-retrofitted and retrofitted houses, the ideal would be to control for other house characteristics that relate to earthquake performance, such as foundation type, slope, general condition or state of repair, cripple wall height, and year built. Data were collected about some of these factors, but even with a relatively large data set, the number of control variables and the number of damage outcome variables means there may be very few observations in any particular combination of outcomes or features. This eliminates the ability to use inferential statistics or multivariate regression.

Third, as introduced in Chapter 3, some owners likely misunderstand or were ignorant of the retrofit status of their properties. Several different types of classification errors might result, so the direction of the resulting bias is ambiguous and not ascertainable. If owners that answered “Do Not Know” or “No” actually had retrofitted houses, that would dilute any potential improvements in performance when houses of different self-reported retrofit are compared. The “Do Not Know” issue was partly addressed by doing the outcome comparisons with only the subset of houses explicitly reported as either retrofitted or not. However, some owners that reported a retrofitted or non-retrofitted house may have reported their status wrong.

Another factor could be that different ages, appropriateness, thoroughness, and quality of workmanship among reported pre-event retrofit work could have varied. This would make retrofitted properties inherently less comparable to each other in terms of their expected performance. Some homeowners in the study may have been confused by the time-specific nature of the retrofit questions in the survey, misreporting retrofit work done *after* August 2014 as having been done before it.

One of the most compelling explanations for the mixed findings on retrofit performance is the wide variety of upgrade work that could have led an owner to identify their house as “retrofitted.” A simple categorical classification of retrofit status (i.e., a house is either retrofitted or not) is undoubtedly an inadequate approach to understanding how such work affects a house. For example, “retrofitted” houses may have still experienced severe damage because the *type* of retrofit work (e.g., cripple wall anchoring) that had been done was weakly if at all related to the *type* of damage (e.g., porch or chimney separation).

This issue invites several fundamental questions: What is a “retrofit?” What is good “performance?” What types of damage should different types of retrofit work be expected to reduce? These questions must be addressed if the question of retrofit performance is to be adequately investigated. One homeowner ([Case 471](#)) experienced a wide array of disruptive non-structural damage, such as cracked windows that needed replacement and dangerous displacement of heating units, but it is not clear whether a cripple wall retrofit would have prevented those types of impacts.

These numerous possible explanations for the conflicting results about retrofit performance have implications for the type of research approaches that would be advisable in future studies of the empirical, *in situ* performance of single-family home retrofits. Most of these points are

addressed in Chapter 8, but two—the need for more careful and nuanced classification of retrofit type and the possibility that differences in ages and cripple wall heights performed differently warrant brief additional attention in the next sections.

The Need to Classify Retrofit Types

Defining clear sub-categories of single-family wood frame home retrofit work will enable a far more realistic look at retrofit effectiveness. The data in this study can advance the thinking about what an achievable, meaningful typology might look like. A retrofit classification system should make sense to an engineer and also be understandable and useful by a typical homeowner.

Questions asked in the survey would permit the following kinds of retrofit work to be distinguished. Any particular house might have more than one type of retrofit work done.

1. Sheer wall supports (e.g., Plywood or OSB) or bracing of the basement and/or crawl space
2. Anchors or bolts, possibly with blocking
3. Foundation replacement or repair, or post and pier improvements
4. Chimney removal or bracing
5. Porch improvements (replacement, improved connections between house and appendage)
6. Garage strengthening

Although it was not within the scope of this study to analyze the damage outcomes based on this more refined delineation of retrofit types, this could be done in the future, and follow-up studies focus on development of clear retrofit type categories in light of this need.

Engineers will surely note that in practice, retrofit work is customized to a house and an owner's particular taste and budget. An important consideration is how to consider "partial" retrofits, for instance if anchor bolts were installed on half of the cripple walls but not for the entire perimeter of the house. The quality of the work and the materials used may also matter, or the amount of time such materials have been exposed to the environment or how well the house has been maintained. These are issues for detailed, empirical and theoretical engineering study.

Other Factors Affecting Damage Outcomes

Owing to the large number of important traits, it is not possible to create multiple regression models to control simultaneously for numerous potential factors. Instead, a series of cross-

tabulations can be used to look at co-occurrences. Clear features shone through as associated with worse outcomes, especially the age of the home, and for houses with wood-frame construction how high the first floor is above the ground. Houses with slab on grade foundations also outperformed cripple wall houses regardless of age.

Age of house and cripple wall height were also associated with damage outcomes in this study. Houses built before 1950 tended to have worse outcomes. Pre-1950 houses were more likely to experience damage as well as more types of damage, including chimneys, outside wall surfaces. Almost one out of three houses built before 1950 received a yellow or red tag from a housing inspection, indicating enough damage to make the building less safe to enter and occupy. Chimney damage was also particularly concentrated in these older houses, with about half of the pre-1950 houses in the survey reporting some type of chimney damage. Among houses built pre-1950, one out of four homeowners (37 out of 144) said total repairs exceeded \$25,000.

Foundation type and cripple wall characteristics also seemed to matter. Wood-framed houses with higher first floors tended to experience worse outcomes, especially compared to houses with slab on grade houses. Wood framed houses with higher cripple walls were also more likely to experience *more types* of damage.

Bottom line, future studies of retrofit performance need to collect high quality data about and control for combinations of characteristics such as year built and cripple wall height that are so clearly related to earthquake performance (in some way similar to the House Type Index proposed in this study). The ability of homeowners to *accurately* report about these types of home features should also be explored.

HOMEOWNER OPINIONS ABOUT RETROFIT PERFORMANCE

The Phase 2 interviews afforded an opportunity to hear about the post-event impressions of retrofit performance among a sample of Napa owners, including those with and without a retrofitted house themselves. Most participants judged retrofitting positively—either they were glad they had it or wish they did.

A few interviewees openly credited their low level or lack of loss to a retrofit. One owner felt it was “obvious that the retrofit worked well” (Case 23) or “had a huge effect.” (Case 874) When that person saw other similar but non-retrofit houses that performed poorly, they called to thank their contractor after the earthquake, and made a point to recommend a retrofit and that specific contractor to others.

Many homeowners showed understanding that a successful retrofit does not necessarily prevent all possible damage. One homeowner installed a new foundation in 2001 which they

believed to be anchored and braced. That work seemed to perform as intended, as the only indication of structure-related damage was one broken bracing block. However, on the inside the owner's rehabilitated original plaster work was severely cracked, and both porches separated from the house by about two inches (Case 7). Still, this owner felt "the foundation work made a world of (positive) difference."

Interestingly and in contrast, the concept of *luck* or *good fortune* was a repeating theme among homeowners of retrofitted houses that did well. Many did not voluntarily attribute their good outcomes to the fact that their house was retrofitted. (e.g., Cases 471, 874, 435, 27) This was especially true when owners took a comparative perspective (Case 7), as in the case of an owner with a retrofitted chimney who says he was lucky (Case 435) compared to others whose chimneys were not retrofitted.

Owners may have been reluctant to discuss retrofit successes for fear of being perceived as bragging, rude, or insensitive. Some that experienced the benefits of a retrofit said they consciously avoid the topic. One owner said they did not discuss the earthquake and how well their house had performed, especially in professional settings, for fear of rubbing it in. (Case 527) Another said he does not like to talk about the retrofit work he has had done on the chimney. (Case 607)

Colloquially, it seems natural to use the word *lucky* to describe a positive outcome, but the term also implies that outcomes are determined by fate and forces outside of one's own control. Even though there may be a probabilistic element to when and where an earthquake strikes, it is hard to argue that a person's is independent from their choice of property or choices about whether to retrofit. Yet, this is what many people implied.

Human beings benchmark their experiences relative to other people, and want to show resilience. As people try to find meaning in a traumatic event, everyone seeks a way to feel fortunate. (Case 861) However, standing out can also be a social risk. There is comfort and security (even legally) in doing what most other people do. These personality and social psychological issues complicate the task of convincing owners about retrofit benefits, and may have implications for effective communication about retrofit benefits. It is critical to educate owners about what *is* and *is not* controllable about their earthquake risk.

One way to make homeowners perceptions about retrofitting more accurate is to engage them in affirming true, or debunking mistaken, beliefs about factors that do contribute earthquake damage. Homeowners in Phase 2 put forward a variety of lay theories about why they or other members of community experienced the damage that they did. Some of the mentioned causes of earthquake damage, which may or may not have merit, were:

- Aggregate brine and salt water used in cement foundation for many older homes around Napa might make them more vulnerable. (Case 7)
- The current drought might have affected the soil underneath the house. (Case 471)

- Clay drying up and shrinking since the 1970's might have made foundation weaker or imbalanced. (Case 555)
- The fact that the house is on bedrock is why they had little damage. (Cases 162, 480)

In one notable instance, one homeowner thought their retrofit made the damage worse. Their thinking was that “the bolting caused interior damage because house was made more brittle.” (Case 486)

Other homeowners showed awareness of true factors involved in earthquake risk.

- The fact that a porch was built differently than the house's foundation was the reason why it was damaged. (Case 40)
- Wood-frame houses (like mine) are stable in general and can move “like a basket” with an earthquake once bolting is in place. (Case 527)
- Although the strapping broke during earthquake, it kept the house from moving off foundation. (Case 11)

Many interviewees said they fully expect a bigger earthquake in the future (e.g., Cases 435, 480, 555). Future earthquake possibility can even be a motivation to do more retrofit work on an already retrofitted house, or to keep earthquake insurance (Case 555).

PSYCHOLOGICAL IMPACTS

Psychological impacts of the Napa earthquake were a major topic of discussion in the interviews. It was often the first impact mentioned. This section reports on some of the thoughts and feelings of the interviewees, in recognition of the significance of these emotions to their experiences.

Although not universal (Case 27), many interviewees described profound fear during and immediately following the event itself. The words people used included; scary (Case 168), horrific (Case 435), terrible (Case 595), terrorizing, (Case 39), terrifying (Case 607), and traumatizing (Case 861, 38). The shaking was like “like a bomb went off.” (Case 595) **Figure 9** shows a word cloud created using the words interviewees said most frequently on this topic.

Not insignificantly, the impact of the earthquake on pets was very frightening and important for some people. One person's dog was sleeping in a crate that a dresser fell on (Case 595), another person's cat was injured (Case 471), and pets hide or run away, sometimes for days.

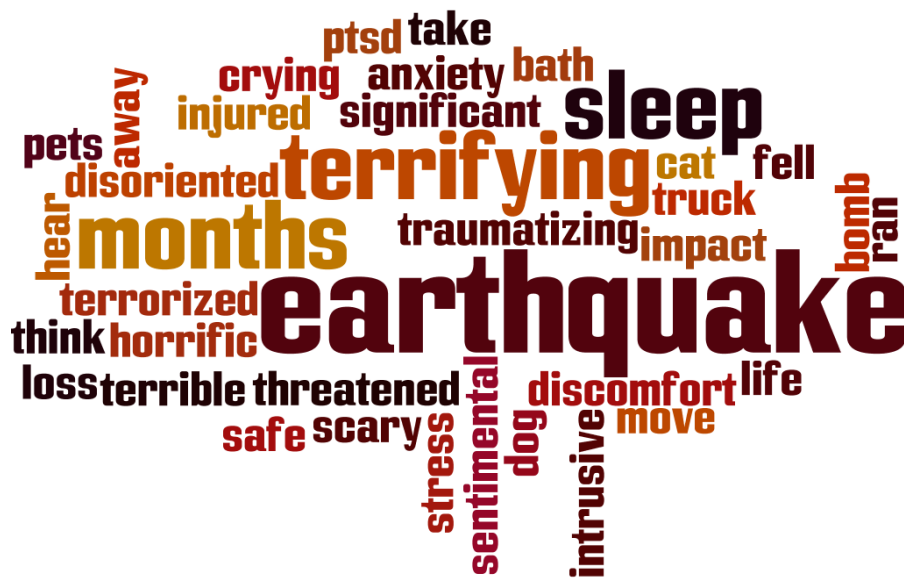
Some spoke about the trauma continuing for months and beyond. The loss of sentimental belongings haunts the physical space of the house. Lack of sleep or difficulty sleeping was mentioned, as was fear of loud noise and a sense of PTSD (Case 168). “When I hear a truck

move, I still think it's an earthquake." (Case 162) One owner said they felt disoriented for six to eight months (Case 874), while another still feels anxious (Case 497).

Some of the emotional impact lingers because, simply put, life is uncomfortable in the wake of a major earthquake. One interviewee shared, "I couldn't take a bath for days, and it was hard to find a place in house that is safe to sleep." (Case 435). Access to clean water was interrupted for days for many in Napa. People with damage face the financial and logistical stresses of arranging and overseeing repairs that might linger for months to more than a year. Even for people with wealth on paper, finding liquid cash can be challenging. (Case 349) The process of applying for assistance can be intrusive and feel humiliating.

It was evident and natural that some people used humor to cope, especially when discussing the event and talking to peers afterwards (Case 39, 168, 874, 11).

Figure 9. Word cloud expressing psychological impacts mentioned by interviews.



Chapter 5 — Earthquake Insurance Behavior and Perceptions

This study introduces two new sources of information about homeowner perspectives towards earthquake insurance. In the survey, respondents were asked five questions related to earthquake insurance. Keep in mind the emphasis of Phase 1 was on damage and retrofitting behavior and outcomes. It was also important in the questionnaire to avoid the impression that the survey was a marketing rather than research endeavor.

The interviews afforded an opportunity to more deeply explore a small sample of Napa owners' perceptions and actions about earthquake insurance. As explained in Chapter 2, CEA policy holders were excluded for consideration for Phase 2 of this study, but three non-CEA policyholders were interviewed. Additionally, a few stories surfaced of interviewees that had had earthquake insurance in the past but no longer.

This Chapter describes what owners recently affected by a significant earthquake in their community had to say when asked about earthquake insurance. This is a snapshot of what those owners might think about insurance at other times in the lives, and is also in no way representative of broader public opinion in Napa or elsewhere. Still, these are informative stories for anyone interested in insurance uptake, what influences insurance perceptions and behavior, and how experiences with a recent local event might affect these things.

Highlights from this Chapter include the following:

1. Results in the survey mirror CEA statistics on a statewide level in that under ten percent of homeowner respondents carried earthquake insurance at the time of the 2014 Napa event. About forty homeowners, a majority of those who had insurance, filed post-event claims.
2. Interviewed homeowners showed high general awareness of the existence of earthquake insurance but a low level of knowledge about specific, more recently made available insurance options, some of which might have benefited owners in the Napa quake. For example, most interviewees erroneously thought that deductible levels are fixed at ten percent and did not know that renter's or contents coverage was available. Owners who heard about the CEA Earthquake Brace and Bolt program were thrilled that it was about to become available in their community.
3. Homeowners relied mainly on word of mouth for information about insurance and to derive their impressions of its usefulness, affordability, and whether it is worthwhile. Only a few sought personalized information about it.
4. Interviewees were eager to help think of ways for CEA to get its information out more broadly and made a number of innovative suggestions.

HOMEOWNER IMPRESSIONS OF EARTHQUAKE INSURANCE BENEFITS AND NET VALUE

Internal CEA records and survey responses indicated that approximately three percent (sixteen out of 633) survey respondents were CEA policy holders at the time of the Napa event. Keep in mind this is not representative of overall earthquake insurance rates in the community because participants self-selected into taking the survey, and some homeowners in the area carry non-CEA earthquake policies, either long term “grandfathered in” policies continuously in place from before CEA was established or through non-CEA providers. There were about forty Phase 1 participants who had non-CEA earthquake insurance as of August 2014.

A mix of attitudes and beliefs about earthquake insurance surfaced during the interviews. Very few interviewees had earthquake insurance or had ever had it. Interviewees that had earthquake insurance were glad that they did and had had it for a long time. “I’ve always carried it, about 30 to 40 years now, currently with Amica.” (Case 555) “I am so glad I have earthquake insurance; I am ready for the next one.” This owner’s motivation to keep insured was notably affected by a family legacy of having earthquake insurance. (Case 874)

Most interviewees without earthquake insurance viewed it as a desirable thing. The key benefit mentioned was the ability to cover catastrophic loss (e.g., Cases 168, 23). One homeowner put it simply, “You can get a lot of money if you need it.” (Case 11) Another owner that had earthquake insurance but not enough in this particular event to receive a payout stated, “I was in a catch 22 situation but I still have earthquake insurance and I still believe in it.” (Case 168) One homeowner felt earthquake insurance is not that expensive if you have a lot of equity value in the home. (Case 874)

Other less favorable beliefs came up about earthquake insurance. First of all, interviewees across the board perceived that “not many people have earthquake insurance.” (e.g., Cases 607, Case 595) Interviewees discussed many perceived difficulties with earthquake insurance, most notably:

- Lack of affordability.
- Unattractive terms (i.e., deductibles too high, premiums too high).
- Beliefs that it wouldn’t cover the types and levels of losses they are likely to experience or would only pay off for the most extreme levels of damage.

As to premium or “price,” many interviewees said they felt earthquake insurance was unaffordable and that is a key reason why they don’t have it. Here is an example comment: “I’m interested but it’s all about the money.” (Case 11). Lack of affordability was sometimes tied to homeowner perceptions about all the other costs and trade-offs involved with homeownership and even being a small landlord. “I would have to raise my rent in order to cover it.” (Case 607)

As with retrofitting, owners viewed costs in relation to potential benefits, in this case mainly the likelihood of receiving a payout and how large that payout would be relative to the total loss and amount of premiums paid in over time. This is where many owners expressed the belief that earthquake insurance has unreasonable terms, particularly the deductible options in relation to the premiums. One owner said, “I’ve never owned earthquake insurance; the deductible is too high to be relevant.” (Case 486, also e.g., Cases 595, 607) Several owners said they looked into it and *can* afford it but a “high deductible” put them off (Case 497, 23). “Doable and worth it are two different things.” (Case 38) Another thought a ten percent deductible may be especially difficult for people in places where property values are so high.

Many interviewees mentioned that earthquake insurance would only be relevant for an extremely high degree of damage. “If the damage is not catastrophic, it would not cover a thing.” (Case 168) “You have to have severe damage to justify it.” (e.g., Cases 497, 23, 162) Insurance is “only useful for total loss.” (Case 861, 27) The low likelihood of payout makes it “not worth it.” (e.g., Cases 23, 162, 471, 607) At the extreme, this belief can even reinforce a sense of fatalism: “If the earth opens up and swallows your house, you are probably going to be gone anyway.” (Case 497)

The belief that earthquake insurance is only useful against catastrophic loss seemed closely tied to word of mouth accounts (and in some cases personal observations) related to the August 2014 event. Many owners perceived that earthquake insurance would not have led to a payout for the type and level of damage that they or neighbors just experienced. “Even with significant damage (estimated at \$60,000), earthquake insurance would not have helped me because my house has a replacement cost value of \$1.2 million.” (Case 23) Many interviewees said that they’d also “heard stories” of local cases where someone had insurance but the damage came up just below the deductible. This had a notable impact on people’s feeling about and openness to getting insurance themselves. (e.g., Case 861) “People who had it were not helped by it due to huge deductible.” (e.g., Cases 471, 162, 27).

Direct experience with a moderate earthquake can reinforce pre-existing beliefs that earthquake insurance is not attractive. “My house has been through the earthquake and went unscathed, so I would not consider earthquake insurance.” (Case 38) Occurrence of another moderate earthquake in 2000 in the Napa area may have exacerbated this effect. “I’ve considered earthquake insurance but my damage in both earthquake events I’ve been through here would have been under the deductible.” (Case 527) A few owners simply took these past experiences as proof that earthquakes are not a real threat. “I’m not interested in earthquake insurance unless a fault was found nearby and it was very serious.” (Case 480) “It’s hard to buy insurance for something you don’t think would happen.” (Case 486)

Homeowners that had significant damage in the past and invested in subsequent seismic improvements sometimes expressed less interest in insurance. “With the house having been damaged twice and now repaired, we don’t have an incentive to insure the house.” (Case 527) “Insurance does not seem worth it for this house because the house has had such good

upgrades.” (Case 7) Others, including non-retrofiters, noted some of the downsides of insurance compared to the upsides of retrofitting.” Insurance does not prevent loss and the repairs still take a long time.” (Case 497) “You’d still have to deal with the claims process, which could potentially be arduous.” (Case 861)

Among those who had insurance in the past and dropped it, financial reasons were the main cause cited. One owner that had about \$30,000 in the August 2014 event carried earthquake insurance in the past but went through a period of financial constraints. (Case 874) Another owner became discouraged about the value of insurance over time: “There was simply not enough paid out to pay in.” (Case 27)

Another issue is whether the *types* of earthquake impacts people in Napa had just experienced would have been covered. Given the high rate of contents and nonstructural damage in the August 2014 event, this was particularly salient. “None of my collectibles would have been covered anyhow.” (Case 38)

For a few, all these factors made earthquake insurance look like a “risky” (Case 607) thing to spend money on; some reasoned it would be better to save up and self-insure. One homeowner felt the premiums paid for the past 30 years would just about add up to the earthquake loss they just had, making it a “break even” proposition (Case 11) “We’ll take our chances,” said another. (Case 407) “Earthquake insurance leaves me in the same situation as I was before, so I would rather have a separate saving account.” (Case 861) “I’d rather save the money than throw it away (Case 497)

On the topic of having insurance on top of investing in retrofit work, several study participants had both, approximately one in ten of the owners of self-identified retrofitted houses. Others discussed the possibility of having both favorably. “I see all pros and no cons for having earthquake insurance and retrofits.” (Case 555) “I am open to both retrofitting and earthquake insurance, especially in order to secure and keep the house. It would be nice to do both.” (Case 11, 407)

LEVEL OF KNOWLEDGE AND SOURCES OF INFORMATION ABOUT EARTHQUAKE INSURANCE

From the standpoint of effective household management of earthquake risk, the perceptions discussed above would be less of an issue if homeowners were well-informed about their house’s earthquake vulnerabilities and about how earthquake insurance options could work for them. However, evidence in this study points to owners having generally low levels of knowledge about earthquake insurance and the many kinds of options now available. Interviewee knowledge about earthquake insurance was not tested systematically, but many interviewees seemed to be working with vague, second-hand impressions rather than up to

date facts. The majority had never obtained a personalized quote, even though CEA offers a simple quote generator online. (e.g., Case 162)

To start, twenty-one owners non-retrofitted houses (21% of 434) in the survey indicated they believe their homeowner's insurance will cover earthquake damage, which is not true unless they have a specific earthquake rider. As discussed in Chapter 3, this is a substantial number to observe in a community that has recently experienced a major event.

Misperceptions and information gaps in the interviews varied, but the amount of the deductible was a major point of discrepancy. Nearly every interviewee that mentioned a deductible thought it was rigidly ten percent, but in truth it used to be fifteen percent and policies are now available from five to twenty-five percent. Others cited oversized numbers not grounded in reality. "I looked into it. I got a quote for \$35,000 a year." Perhaps unsurprisingly, interviewees also didn't seem to know there is earthquake insurance offered for renters, even though this could have been relevant to the several landlords in the study and shows an overall lack of policy offering awareness.

The small number of interviewees that had earthquake insurance seemed comfortable explaining the terms of their policies. (Because the survey did not collect personal financial information, there is no way to verify whether the terms that owners recalled are in fact correct.) One said they paid \$475 premium a year, or about fifteen percent of their homeowner's insurance premium on a house appraised at \$1 million, with a ten percent deductible and loss of use included. (Case 555) Another owner with a similar deductible cited a much higher per year premium of about \$2,000. (Case 168) However, that same *insured* owner had a perception that having insurance disadvantaged them from getting other types of assistance, which is likely untrue. "I had the bad fortune of having earthquake insurance. It played a role in why FEMA denied my application for help." (Case 168)

In the interviews, not initiating information search for a personalized quote or consultation was the norm. A few recalled the CEA annual required mailings (e.g., Cases 527, 595) but regarded it as not influential or effective. Instead, people seemed to rely on word of mouth and impressions from acquaintances. Neighbors and friends were the predominant source of information about earthquake insurance. (e.g., Cases 471, 11, 497, 595)

Human beings naturally observe the behaviors of others and tend to assume that what is true or appropriate for those people will also be the same for them. Several people said something to the effect of: "My friend's reason for not getting earthquake insurance was the high deductible." (Case 555, 607) "I have not explored earthquake insurance, but I've heard from many people that it is unreasonably expensive." (Case 38) This can obviously be problematic if those other peoples' situations differ from one's own. In an extreme example of referencing the possibly irrelevant choices of others, one owner said: "Even the wineries do not have earthquake insurance and they have a lot to lose." (Case 497) A few people said they'd like to

look into insurance but haven't gotten around to it, while others seemed to feel comfortable with just relying on the impressions they already have.

Another reason many interviewees didn't have accurate, up to date and personalized information is they did not initiate information search for themselves. "My family has been talking about earthquake insurance but we don't know what it would cost." (Case 11) This is where reliance on acquaintances and the experiences of others can be a problem. When there's a low level of knowledge in the community, misperceptions become a self-reinforcing phenomena and everyone is more likely to remain under- or even ill- informed.

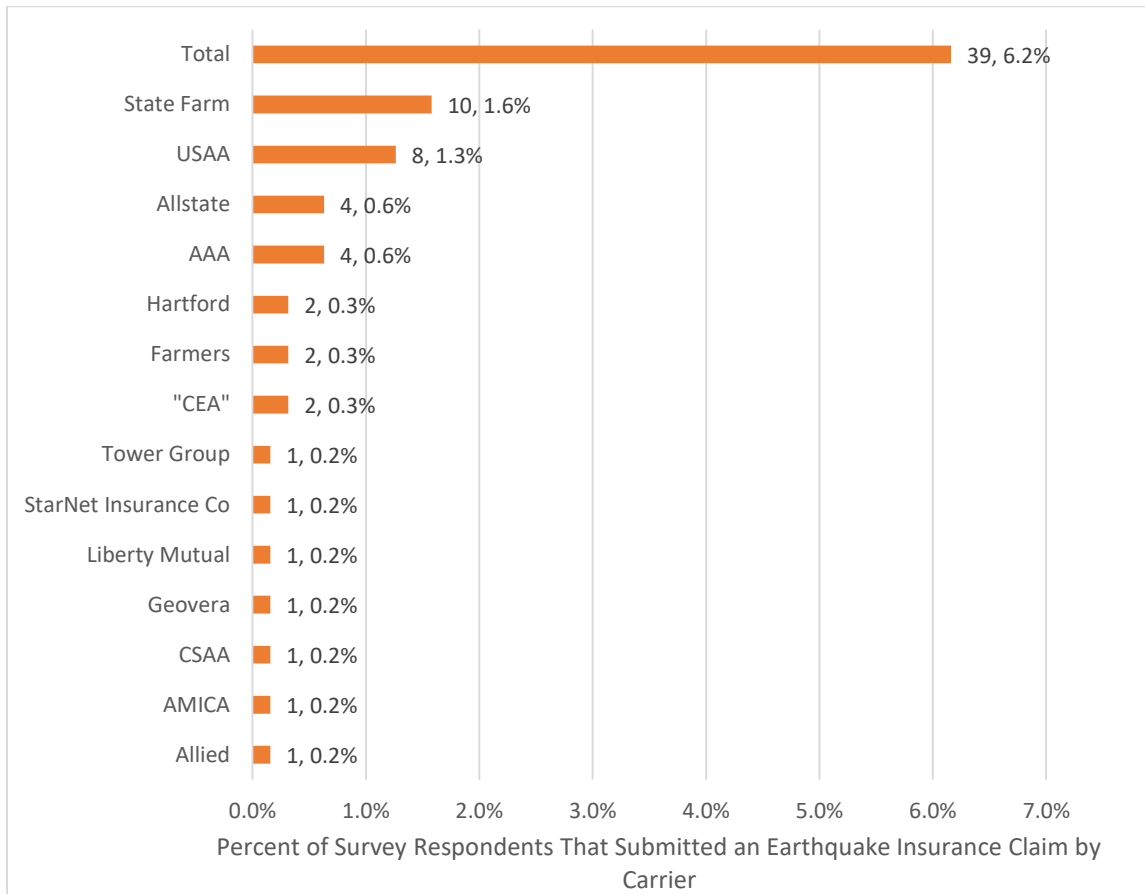
There was some evidence of people doing research and showing new interest in insurance as a result of the August 2014 event. Interviewees related that earthquake insurance did come up occasionally in the days, weeks and months following, for instance at neighborhood dinner parties when people shared their stories and thoughts. (e.g., Case 555) Unfortunately, the tone of those conversations was often unfavorable. According to several interviewees, a dominant theme was "what a shame it is that earthquake insurance is cost prohibitive." (Case 7) "We are like sitting ducks." (Case 407) This sentiment speaks to latent demand for insurance, and a willingness to invest in it if the terms were perceived as more reasonable.

Insurance agents seemed to play a surprisingly small role in informing homeowners about earthquake insurance. Many interviewees said their broker or agent never brought it up. Some said their agent recommended against it after they did make an inquiry, in some cases strongly advising against it. (Case 480) For some, having accurate, personalized information simply did not translate into a choice to go forward. Our insurance brokers told us about policy options but we decided not to follow up. (Case 527)

EFFECT OF EVENT ON HOMEOWNER OPINIONS ABOUT INSURANCE AND RETROFITTING

Earthquake insurance was involved in the post-event recovery of many study participants. Fifty-one respondents in the survey reported having submitted a claim, which is the majority of respondents that had earthquake insurance. These owners possessed insurance policies from a wide number of different carriers (**Figure 10**). All three earthquake-insured homeowners (non-CEA policies) later interviewed had submitting an insurance claim, to the carriers Amica or pre-CEA policies with Farmers and Liberty Mutual.

Figure 10. List of earthquake insurance carriers to which survey participants said they submitted claims related to the August 2014 Napa earthquake.



Ninety-seven homeowners in the survey (17.2% of the 563 who answered both these questions) said they sought out information about earthquake insurance since August 2014, including several owners that already had a policy (presumably to learn about options, explore claims possibilities, or update their coverage).

WILLINGNESS TO PAY FOR INSURANCE AND IDEALLY DESIRED TERMS

Researchers spent some time asking interviewees open ended questions about the kinds of insurance policies for earthquake losses that would be appealing. There was strong interest in contents coverage, in the tens of thousands of dollars range. *“Insurance should cover contents.”* (Case 435) *“I had \$40,000-\$50,000 of antique damage, would have liked to have coverage for that level of contents value.”* (Case 471)

Some homeowners wanted earthquake policy offerings that were more seamlessly connected or integrated to their homeowners' policy. "I'd be willing to pay more if earthquake insurance is built into my homeowner's policy." (Case 471) "It would be better as a rider to my home insurance." (Cases 349, 607) One thing that's interesting is that people reported paying such a wide range of annual premium amounts, from a low of \$870 per year (Case 607) to a high of \$7,500 a year (Case 349).

Some interviewees also wanted earthquake insurance to have *terms* more similar to their homeowner's policy. Interviewees mentioned a wide range of desirable per month premiums: about \$20 (Case 595); \$50-75 (Case 407); \$60 to \$70 (Case 527); \$75 to \$100 (Case 471); \$200 (Case 349); "a couple of hundreds of dollars per month sounds reasonable." (Case 435) One homeowner thought an earthquake policy should have a very low deductible like they have on their home owner insurance, on the order of \$5000 to \$15,000. (Case 527)

Interviewers also asked owners to put their willingness to pay for earthquake insurance in relative terms compared to their current homeowner's policy cost. "I would be willing to add on up to one third of what I pay for yearly home insurance." (Case 527)

Desired deductible levels also varied widely, from a low of \$5,000 to \$10,000 (e.g., Cases 11, 435, 471, 497, 595, 607) to more than \$50,000 (Case 349) "If it had a lower deductible, I would definitely think about insurance. I would write a check right now." (Case 435) One owner benchmarked a reasonable deductible as five percent of the house's value. (Case 39)

HOMEOWNER ADVICE ABOUT PROMOTING EARTHQUAKE INSURANCE AND MITIGATION

Beyond the specific terms that the interviewees thought might be attractive, homeowners also offered advice about how to get consumers like themselves more aware of and more interested in buying earthquake insurance and investing in retrofit work. Many interviewees were satisfied at the amount and quality of information about earthquake *risk* that's available, but said the fundamental challenge is "just getting people to pay attention to it." "You have to get people to read it." (Case 11)

Opinions about the availability of information about earthquake *insurance* were mixed. CEA was not a factor in recovery for most Napa residents. One interviewee said, "The CEA presence was not prominent; they are so little known compared to FEMA." (Case 555) "There needs to be more publicity about Earthquake Brace + Bolt grants." (Case 471) Earthquake Brace + Bolt (EBB) is a CEA program to help homeowners lessen the potential for damage to their houses during an earthquake. Owners of houses in program ZIP Codes with house characteristics suitable for a retrofit using California Existing Building Code Appendix Chapter A3 (Chapter A3) are eligible for an incentive payment of up to \$3,000 to help pay costs associated with the retrofit of their

houses. One interviewee specifically said they looked at CEA’s EBB website before hearing about this study to see if they might be eligible for a grant. (Case 607)

When asked where they might go for more information and advice about earthquake insurance, most answered “online or the internet” (e.g., Cases 23, 595, 349), social media (Case 349), or “Google.” (Cases 168, 7, 435, 480, 607) Some people were more specific about where they would go on the internet. Other mentioned sites are listed in **Figure 11**:

Figure 11. Websites mentioned by interviewees as possible sources of information about earthquake insurance and retrofitting.

Specialty Websites Mentioned by Interviewees
Duckduck.go (Case 607)
Earthquake early warning sites (Case 168)
Facebook (Case 162)
NextDoor (435, 607)
Nixle Alert (Case 168)
Pinterest (Case 349)
Quake Watch (Case 162)
YouTube (Case 7, 435)

Some owners mentioned the value of delivering information through existing, trusted community organizations or venues, such as the Napa Valley Vintner Association (Case 874); cities and counties (Case 555); neighborhood watch organizations or get “Block Chairmen” to be advocates (Case 497); community venues such as farmer’s markets, garden tours, home shows and movie theaters (Cases 162,497); and schools. (Case 861) Several owners mentioned that the local landmark association held a highly attended workshop in the past at which people could learn how to find out the history of one’s house and how to retrofit it. (e.g., Case 480) Many owners thought that instructional seminars and gatherings, linked to local organizations such as the Historic Society, would be particularly effective. (Cases 555, 7, 23, 349) Another said they would be willing to attend such workshops. (Case 349)

Several owners cautioned about paying attention to diverse audiences when choosing communication modes and messages. “Be sure to provide materials for people without computers (Case 497); Even though young people like social media, older people prefer mailings and newspapers (Case 27) One person also mentioned the potential to take advantage of interest groups for gaining access to harder to reach populations, for instance LGBT communities or non-English speakers. (Case 861)

In general, the sample of interviewees had high opinions of their local newspaper, *The Napa Valley Register*. “People actually read it.” (Case 38, 595, 162) One suggested that stickers they had seen on the front of newspapers were particularly effective, and recommended canvassing

the neighborhood with flyers, much like how door hangers were used in survey recruitment for this study. (Case 595)

When asked about what kinds of experts they might consult, people mentioned their [insurance agent \(Case 407\)](#); [government websites \(Case 480\)](#); [their city building department \(Case 555\)](#); and [looking for structural engineers in phone book. \(Case 480\)](#) One novel source of help for people after the 2014 event was local thrift stores and window shops, who provided replacement household items to people who had experienced damage. (Case 497) Such community partners could be a conduit for other types of preparedness and mitigation information.

Not surprisingly, many interviewees thought that offering more or different types of financing assistance would be a good way to improve programs to mitigate earthquake risk. [Financial help is the best way to get people to retrofit \(Case 480\)](#) [The level of financial help needs to match the need \(Case 349\)](#). [A future home inspection program should be a voluntary city effort or offered at low cost \(Case 527\)](#).

Interestingly, though, the idea of expanding financial help didn't always mean for *everyone*. Suggestions for targeted programs ranged from [subsidies for people who can't afford it \(Case 168\)](#); [special loan terms to help preserve older neighborhoods \(Case 471\)](#) or [historic properties \(Case 349\)](#); [programs for lower income people \(Case 595\)](#); and [grants or special loans for people in particularly dangerous locations \(Case 595\)](#).

Several comments focused on how the program should feel and function for participants. ["Financing processes should be streamlined and less intrusive than currently happened with FEMA. It was humiliating and took so much time." \(Case 349\)](#)

In some cases, homeowners suggested programs similar to ones that already exist. As said one owner, ["People should get a tax write off for disaster home repair cost." \(Case 23\)](#) In California, already homeowners can file paperwork with their jurisdiction to be exempted from assessment increases for value added to their home as a result of seismic improvements, though this benefit is not well known or easy to take advantage of. [Insurance should have tiered pricing factoring in age of house but also any retrofit work done \(Case 7\)](#), which some homeowners may now be eligible for through CEA.

Some interviewees expressed a desire for mandates or a stronger role of government in leading the way in community earthquake mitigation. [Higher standards should be built into the building code, especially for new construction. \(Case 607\)](#) [Cities should keep the pressure on; they could query property record based on year built and mail them a notice. \(Case 527\)](#). [Cities should have an ombudsman to guide people in making decisions and navigating paperwork of doing retrofit work. \(Case 38\)](#) [People need help with zoning issues and how to address their house's situation. \(Case 349\)](#) ["The onus of improving homes should not be left to the homeowner alone, builders should be included." \(Case 39\)](#)

Chapter 6 — Service Disruption, Post-Event Repairs and Recovery

This chapter reports on the range of service disruption experienced by survey respondents as well as key post-event recovery actions, and in a few cases important stories about these topics as conveyed in the interviews.

Key points from this chapter include:

1. Service disruption on a time scale of one to three days was a widespread and an important consequence of the August 2014 Napa event. Ninety-four percent of the survey sample experienced some loss of electricity, water, telephone, internet, or gas.
2. Recovery for most households was relatively quick, but a significant fraction took months to finish necessary repairs and many were still not finished.
3. There was no apparent association between retrofit status and service disruption, which makes sense because most service disruption results from damage caused outside the house or off the property.
4. The most widespread behavioral impact of the event was to increase general preparedness behaviors such as stockpiling supplies, securing furniture to walls or installing latching cabinets.
5. Homeowners had a wide mix of experiences in figuring out how to repair their houses and how to pay for such work. While some people completed repairs relatively quickly, not infrequently by themselves or with the unpaid help of family or friends, other repairs were delayed for many months or left unfinished. Several people that wanted to do post-event retrofit work could not afford to do so.

SELF-REPORTED SERVICE DISRUPTION AND RECOVERY ISSUES RELATED TO THE 2014 EVENT

Consistent with other research and media reports, survey respondents confirmed that service disruption was a major issue in the 2015 South Napa earthquake. Almost 80% of houses in this sample had no electricity for a period of time. For 28% of houses, the gas was shut-off for some period of time. More than half of houses had no television or internet connection for a period of time (which could be due to power outage). In the Napa event, some members of the community were affected by water delivery interruptions. One interviewee was without water for about three days. (Case 435) Only about six percent of surveyed homeowners reported no disruptions. **Figure 12** presents a summary of these self-reported impacts.

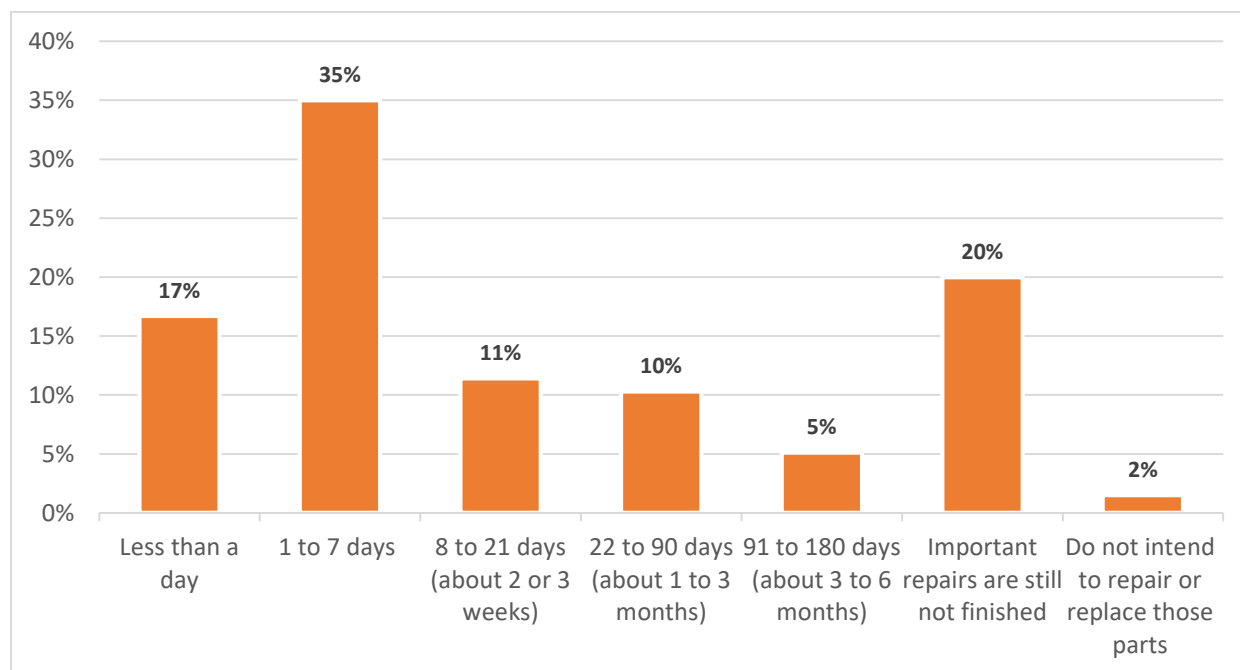
The lives of community residents were disrupted in non-trivial ways. More than six percent had to spend at least one night somewhere else, and more than twelve percent were not able to go to work for a time because of house damage.

Figure 12. Summary statistics on self-reported service disruption from the survey.

Characteristic		N	Percent
Service Disruptions That Happened at Your House (check all that apply)	Had no electricity for a period of time	633	75.3%
	Had no working TV or internet for a while		48.4%
	The gas was shut off for a period of time		27.0%
	Had no land line phone service for a while		26.9%
	Had no running water for a period of time		23.2%
	The water heater moved or slipped (still standing)		15.2%
	The sewer pipes broke or stopped working		2.6%
	The water heater completely fell over		0.8%
	On-site gas supply was damaged		0.6%
	Other		5.9%
	No disruption of utilities		5.7%
Kind of Service Disruption (check all that apply)	I turned off the gas	633	34.5%
	Had to buy bottled water		16.9%
	Because of house damage, couldn't go to work		11.8%
	Thought the water heater is braced but fell over		6.0%
	I had to live somewhere else for at least one night because of utility issues		6.0%
	I smelled gas		5.7%
	The house has an automatic gas shut-off valve		1.7%
	Other		13.7%
	None of the above / no services were disrupted		20.7%
If Disrupted, Number of Days Until All Services Were Working Again	1 to 3 days	376	88.3%
	4 to 7 days		6.4%
	8 to 14 days (1 to 2 weeks)		1.9%
	More than 15 days (more than 2 weeks)		3.4%

For most, service impacts were short lived. For more than half of the houses, services were running again after one to three days. Household function in terms of needed clean-up and repairs was back to normal quickly for some (**Figure 13**). For 14% of the houses, it took less than a day to clean-up and repair. For 29% of all study eligible participants, time to complete all major repairs after the event was between one to seven days. For others, damage impacts lingered—just under half of survey respondents (48%) said essential clean up and repairs took more than a week.

Figure 13. Estimate of total time until all essential clean-up and repairs were done following the August 2014 South Napa event.



Respondents played an active role in responding to the event. Only six percent smelled gas, but more than 36% of respondents said they turned off the gas themselves. (Only 1.7% of the houses have automatic shut-off valves.) More than one-third of study eligible participants (36%) eventually called or visited a FEMA center. About 15.6% applied for a Small Business Administration (SBA) loan. Less than half of respondents said they have not taken any of these types of action in the first six months (46%).

A non-trivial number of respondents seemed to be influenced in their life planning decisions as a result of the August 2014 event. Thirteen percent report considering selling or relocating, even some owners of houses that are already retrofitted. The event motivated some people to look for information about mitigation options, with 24.2% seeking out information about strengthening their house to avoid future damage (**Figure 14**). Around ten percent reported

having made plans to do retrofit work (again, including a substantial fraction that owned already retrofitted houses).

Figure 14. Summary of survey answers about recovery steps taken following the August 2014 South Napa event.

<i>Characteristic</i>		<i>N</i>	<i>Percent</i>
Recovery Actions Taken Since August 2014 Earthquake (check all that apply)	Called or visited a FEMA assistance center	633	36.2%
	Applied for a SBA loan		15.6%
	Applied for a home equity or new loan for repairs		5.1%
	Received help from a community organization		2.2%
	Submitted an insurance claim		8.1%
	Other		8.1%
	None of the above		46.4%
Since August 2014 Earthquake have you taken any of these actions?	Sought information about what can be done	633	24.2%
	Made plans for or begun new retrofit work		9.3%
	Sought out info about earthquake insurance		15.3%
	Considered selling or relocating		13.4%
	Other		11.5%
	None of the above		40.3%

In the interviews, homeowners were asked about whether and how they talk about earthquakes with their friends, family and peers, particularly since August 2014. Most said that earthquakes were a frequent, even incessant, topic of conversation for days, weeks, and months. Interestingly, many said the discussions revolved around what exactly happened to people during the event and how they felt about it afterwards, not on the future or what to do about future quakes. *“The conversation was seldom about what to do but rather about the experience of the earthquake.”* (Cases 595, 27) *“We exchanged very little information about retrofitting when communicating with friends and neighbors. Anxiety was a bigger issue and the focus.”* (Case 497) A few retrofitters mentioned that they took this opportunity to encourage others to strengthen their homes. (e.g., Case 39)

For most, the event did not seem to impact peoples’ willingness to live in Napa. *“We are still committed to the community, and invested in the home. We are not going to allow a little shaking or earthquake to kick us out of the house.”* (Case 497) Some said they are going to stay

in the house because their children love it there (Case 435) or because it's so well suited to their retirement. (Case 407) The earth is alive, but it's out of sight out of mind. (Case 11) Another common theme was the fact that there's nowhere "safer" to move anyhow. (Cases 168, 435)

Nearly all interviewees said they're staying put. The most prominent impact seemed to be major uptick in general preparedness behaviors and household safety, such as stockpiling of emergency supplies and implementing non-structural measures around the house. Countless survey respondents and interviewees related how after the 2014 quake they installed cabinet locks, furniture strapping, better-hung pictures, mirrors, and frames, put putty underneath collectibles, or stored more food and water (e.g., Cases 7,11, 27, 471, 497).

A few people did rethink their use of the property or when to sell, in at least one case declaring, "We are selling our house due to this earthquake." (Case 471) For one retiree, the earthquake sped up a decision to move into assisted living. It is a very expensive and difficult house to keep up and she does not want to be there when the bigger ones hit. (Case 23) Others were less conclusive but were put on edge. "I'm thinking of selling my rental before a bigger earthquake leads to greater damage." (Case 607) One owner of a damaged property already had it on the market at the time of the event and was the sales process was severely slowed down.

Overall, most interviewees perceived little effect on the local housing market or on their own home's value. (Cases (Case 607, 480) "I follow local real estate and am surprised how the earthquake hasn't affected prices. The earthquake impact on people's mind is very small." (Case 595) "Houses are selling just as they always have. The earthquake has had no impact on the property values in Napa." (Case 23)

REPAIR AND RECOVERY STEPS TAKEN

The interview data reveal some of the challenges for homeowners in making decisions about repairing their properties and what it felt like to carry out these projects (or not being able to, often for financial reasons). These were contributing factors to the sometimes long recovery timelines of Napa homeowners.

Owners of significantly impacted houses first had to determine how bad the damage was and figure out what should ideally be done. "The repair work needed was complicated. It took a long time to figure out what to do." (Case 11) People with damaged chimneys had to decide whether to remove it entirely, just down to the firebox, or replace it, and with what. For one house yellow-tagged because of the upper chimney, the homeowner decided to replace the chimney from the intact fire box up. However, this was a restoration project, and the homeowner felt they had to be deeply involved in and utilize their own skills in order to make it turn out right and stay affordable. (Case 555)

Many owners naturally sought input from contractors about what to do next. A few interviewees described efficient, positive experiences. One homeowner said they called someone quickly about their chimney, and it took just two days to take down the chimney and complete the project for the modest cost of \$2,200. (Case 607) The people that had the easiest time often called up a contractor that they already knew or asked a contractor that was coming in for some other purpose to offer some informal earthquake advice at the same time. (Case 480)

In some cases, the type or extent of damage required the homeowner to seek out a contractor or craftsman with special expertise. One owner with significant interior damage had to find a master plaster with unusual skills. (Case 23) The owner ended up pleased, because the craftsman they found carefully built the plastering even better than it was before.

Echoing the discussion of “Do It Yourself” work described in Chapter 2, many owners said they, or knowledgeable and handy family members or acquaintances, carried out repairs and even post-event retrofit work (Case 497, 27, 162, 435, 874) “I was deeply involved and used my own skills.” (Case 555) “We went under the house to inspect it ourselves and tightened back up some of the bolts. A family friend came by and thought of a way to fix the porch at a pretty low cost (\$1,000).” (Case 7)

For damaged houses with pre-event retrofit work, the event was an opportunity to improve on the work that had been done previously. (Case 518) Some owners of non-damaged properties also took the opportunity to look into (Case 874) or initiate and complete a retrofit. (e.g., Case 861) “A friend’s dad, an architect, came to look at the house and suggested brace and bolt be done. (Case 861)

Paying for repairs or new or improved retrofitting was another significant challenge, and in some cases a barrier. Homeowners paid for repairs with a mix of sources, but most commonly from savings. People paid out of their checking account (Case 607), savings (Cases 7, 23, 435, 40), borrowed from retirement saving fund (Case 23), and borrowed from their employer (Case 471). One owner was wrapping up a major renovation project at the time of the quake, and the additional repair costs caused shut down of the renovation entirely until new sources of funds could be found, ultimately through a private mechanism. This process added about nine months to the project timeline. (Case 349)

Others owners took on formal debt. “We took a home equity line of credit for \$250,000, but it was challenge getting more money from the line of credit because the house was damaged.” (Case 11) Insurance payouts, as mentioned previously, were not common, but there were a few cases discussed. Our AAA homeowner insurance agent gave us \$1,500 to fix chimney (Case 497) “Insurance paid half of the damage and we also got a SBA loan which we thought was terrific and covered the rest.” (Case 555)

Overall experiences with receipt of recovery funds or Small Business Administration (SBA) credit assistance were varied and with mixed outcomes. Some interviewees said they had good

experiences with FEMA, receiving help on the order of one to a few thousand dollars. (e.g., Cases 555,407, 23) “I got a \$6,000 check within two weeks.” (Case 23) “FEMA was helpful. We did not get a grant but the application process was quick.” (Case 40) Many were satisfied with the process even though they didn’t get a grant.

Others were not as pleased. One heard about the FEMA income threshold and did not attempt to apply. Others applied and were disappointed to be turned down by SBA, FEMA, or both or to receive less help than they hoped for. (e.g., Case 349, 595, 607) It was difficult to have to “grovel” for help during a time of trauma. (Case 497)

Owners reported many different kinds of challenges in carrying out their repair and upgrade projects. Several were frustrated by the incremental nature of repairs and needing to wait, either for workers to be available or to raise funds. “It was hard to afford repairs all at once. Money was the central issue.” (Case 595, 168) “We had a hard time tracking down contractors with so many busy at the same time. And, we did not want to hire someone unlicensed.” (Case 595) Police were handing out flyers to Napa homeowners at one point to be cautious of fraudulent contractors. (Case 874) “Just to manage all the contractors, I had to miss work, get competing bids I had to do it at the will of the contractor’s timeline.” (Case 861) “The City imposed extra code requirements for our upgrades, which delayed us considerably.” (Case 39)

Finally, some owners scaled back the work to make it more affordable or left needed repairs not done. (e.g., Case 168). “Even though we didn’t want to, we decided to do very low cost chimney removal instead of repair, about a \$500 fix.” (Case 407) “We left off redoing the outside stucco until we can save up.” (Case 595) “I’d like to replace the foundation (which is a little wet from water leaks anyhow) but do not have the money now.” (Case 480)

Some of that unfinished work is explicitly retrofit-related or would significantly improve the performance of the house in a future quake. These owners simply cannot afford the upgrade work they’d like to do. “I got a \$42,000 quote to fix our foundation. I want to do it but can’t afford it.” (Case 607) “I’d be willing to pay up to \$10,000 to retrofit if I had it. Would like to bolt the house and remove inside brick that is part of the inside chimney. Fix the garage door which sticks. Not going to happen.” (Case 595) “I bought bracing materials but haven’t had time to do the work yet.” (Case 480)

Chapter 7 — Insights on Use of the FEMA P-50 Form

Another aim of this study was to pilot use of the FEMA P-50 assessment methodology for single-family wood-framed dwellings to be used by professional home inspectors in a field setting. In 2015 and 2016, CEA trained approximately one hundred home inspectors in use of the P-50 evaluations. Four of those persons, all members of a professional association called the California Real Estate Inspection Association (CREIA), participated in inspecting homes during the Phase 2 site visits in this study.

Below is a brief summary of the P-50 data collected about the 39 houses inspected in Phase II. The most important findings, however, are insights for further development of programs to make P-50 home evaluations available to the public. Lessons learned from this trial effort are offered, including suggestions from participating inspectors who shared their thoughts during a two-hour focus group session after all the site visits were completed.

Key insights for this Chapter include the following:

1. CREIA-member Home Inspectors used the P-50 form in the field with a high degree of success. However, occasional errors were made in the calculations or application of look-up values, in particular when assigning the Seismic Hazard score. This suggests a need for careful training and practice on this aspect of the form's use.
2. Homeowner interview findings suggest a high level of interest in affordable, high quality, third-party assessment of their home's seismic vulnerabilities and potential performance.
3. CEA's efforts to create an automated application for the P-50 form have a high potential to reduce the cost of delivering home earthquake assessments and the improve the accuracy of those assessments.

PRELIMINARY FINDINGS FOR FEMA P-50 DATA ON INSPECTED HOUSES

The FEMA P-50 "Simplified Seismic Assessment" form is six pages long and divided into seven sections, A through G. Houses start with a structural score of 100 points, from which deductions are made based on observed characteristics of the foundation, superstructure framing and configuration, general condition, non-structural elements, age and size. This information is combined with a Seismic Hazard Score based on inherent regional hazards, and through the mapping shown in **Figure 15** below, an Anticipated Seismic Performance Score from A to D- is assigned. The range of observed structural scores by hazard score are shown in **Figure 16**.

Figure 15. Grade assignment table from FEMA P-50 form.

Seismic Hazard Score		0 - 1	2 - 3	4 - 5	6 - 7	8 - 10	11 - 12
Structural Score	1.0 - 45.9	B-	C+	C	D	D-	D-
	46.0 - 64.9	B+	B	C+	D+	D	D-
	65.0 - 74.9	A-	B+	B	C	C-	D+
	75.0 - 84.9	A-	A-	B+	B-	C	C
	85.0 - 100	A	A	A-	B+	B	B-

Figure 16. Counts of inspected sites reflecting assigned P-50 structural and seismic hazard scores as recorded by home inspectors.

		Seismic Hazard Score (from Section F)						Totals
		3	4	7	8	10	12	
Structural Score Bin	1.0 - 45.9	0	0	0	0	1	0	1
	46.0 - 64.9	0	1	0	1	3	0	5
	65.0 - 74.9	0	3	0	1	5	0	9
	75.0 - 84.9	1	1	0	1	8	1	12
	85.0 - 100	0	1	1	1	8	1	12
Totals		1	6	1	4	25	2	39

The resulting recorded grades are shown in **Figure 17**, broken down by era of construction. Older houses seemed to have slightly lower grades, but there was no strong association between era and assigned grade. This very small sample includes many already retrofitted houses, however, there was similarly no apparent trend between assigned P-50 grade and pre-August 2014 self-reported retrofit status (**Figure 18**). Keep in mind though that the inspections occurred almost 18 months after the 2014 quake and several houses have been retrofitted since.

Figure 17. Anticipated Seismic Performance Grades assigned for houses inspected in Phase 2 by era of construction.

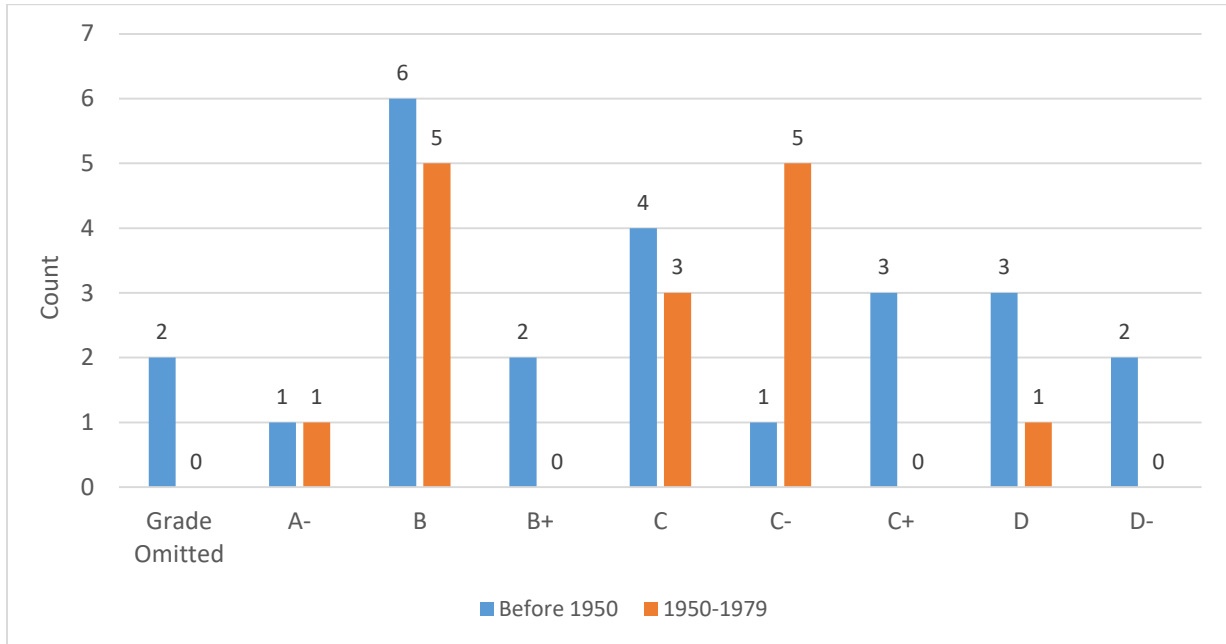
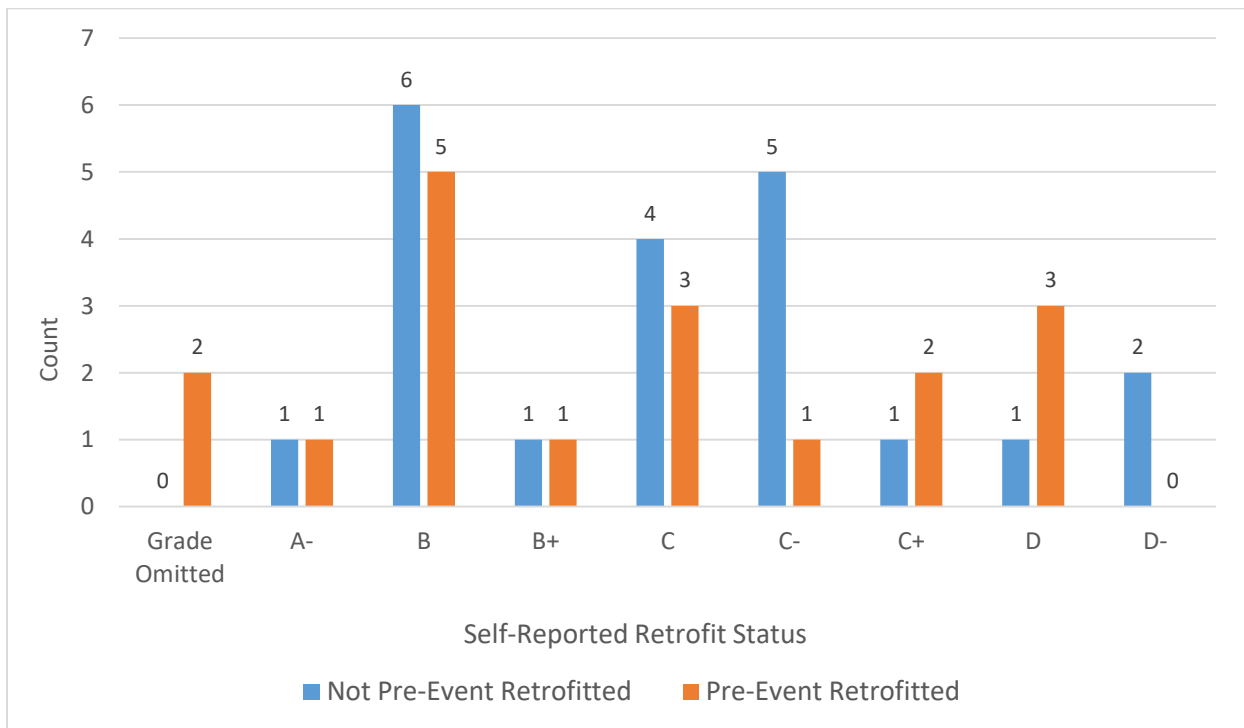
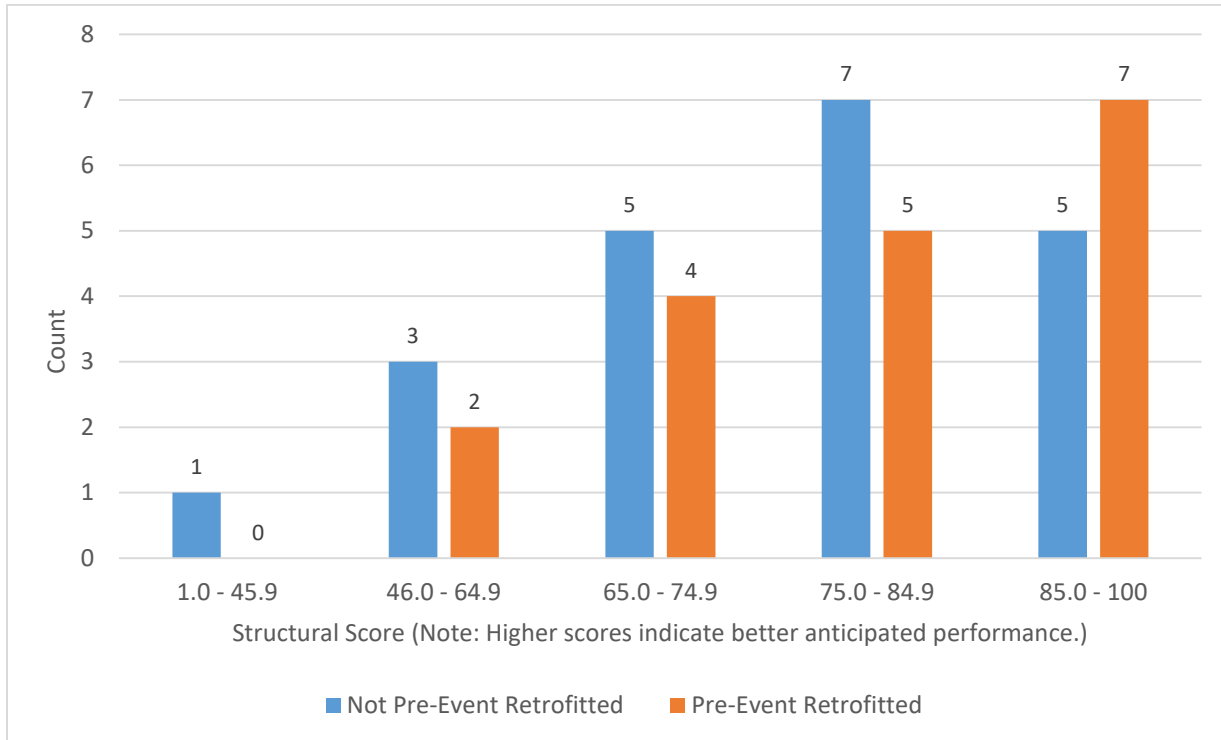


Figure 18. Anticipated Seismic Performance Grades assigned for houses inspected in Phase 2 by self-reported pre-August 2014 retrofit status.



Pre-event retrofit status did appear to associate with the reported structural scores (**Figure 19**). This suggested that the lack of association between overall grades and retrofit status might be a result of errors in assigning the Hazard Scores. Upon systematic analysis, this turned out to be true for approximately one in five houses. The issues posed by this and other apparent errors in the use of the form are taken up in the next section.

Figure 19. Structural Scores assigned for houses inspected in Phase 2 by self-reported pre-August 2014 retrofit status.



Much of the forms were filled out successfully. However, two problematic aspects arose in this pilot test:

- **Use of ambiguous “NC” term in the retrofit recommendations section.** Twenty times out of 39, inspectors used the initials “NC” on the sixth page of the P50 form to indicate the grade a house would receive if completion of all recommended work were completed. Presumably, this means “no change,” but in light of the difficulty of explaining to homeowners what that means, it should be clarified for inspectors how to handle that space on the form.
- **Errors in calculations or assignment of the Structural Hazard Score (SHS).** Several houses were assigned Hazard Scores that are inappropriately low given the proximity to known faults. Upon systematic review, the Hazard Score was calculated incorrectly for twenty percent of the 39 of the FEMA P-50 reports. All of the errors shifted the score down, namely houses were assigned lower than appropriate hazard scores, which

is non-conservative because it could lead to a higher than appropriate performance grade.

All of the Phase 2 houses are within a five-mile square area so there shouldn't be as much seismic hazard score variation as reported. Difficulties accessing the necessary information on landslide and liquefaction risks arose due to the upgrading of the source website, at times causing it to not operate as anticipated. This could have contributed to these errors. Incorrect calculations were entered by three of the four inspectors, so the errors were not isolated to any particular individual. This suggests a need for additional emphasis and practice time during P-50 method trainings regarding how to calculate the hazard score.

These issues affirm the high value of automating data entry and calculations for the P-50 form. CEA is currently creating an online application (App) that inspectors will be trained on and able to use in the future, which should improve information accuracy.

The presence of calculation and grade assignment errors prevents further analysis in this study of Phase 2 home features and the assigned grades with and without mitigation. A potential next step in future research is for a qualified person to review each inspected house's P50 form and correct them as needed. Once that is done, it will be possible to use the P-50 data to address questions about the types of retrofit work observed and how those inspector-documented features might associate with damage.

Figure 20. Table showing example Phase 2 cases where some kind of anomaly or element of interest was present in the P-50 form as filled out.

Case Reference Number	Types of Anomalies Noted
Case 7	Seismic improvement table not filled out. No idea of what is to be recommended. Why is this house a medium/low performance house?
Case 11	Home grade omitted and improvement grade omitted.
Case 27	Ambiguous recording of improved structural grade as "NC." Not clear whether strapping for a metal chimney would enhance performance.
Case 39	Homeowner felt there was "not much value in retrofitting" but P-50 shows that the score is improvable.
Case 162	Got an A- on P-50 evaluation but was marked down for a lot of points and had a lot of retrofit work recommended. Any discrepancy?
Case 168	A qualified engineer should look into the nature of any remodeling done. The house was given a C+ on its P-50 as its best possible grade, making the nature and value of any retrofit work unclear.
Case 486	Did not fill out section H. Inspector simply wrote, "major repairs."
Case 497	Ambiguous recording of improved structural grade as "NC."
Case 527	Priority retrofit items not identified on page 6.
Case 607	Grade omitted on Page 2. Page 6 not filled out at all. Issue of access to tenant occupied unit.

HOME INSPECTOR IMPRESSIONS OF USING FEMA'S P-50 FORM

In the focus group, participating inspectors felt the form had a quick learning curve and was easy to use. Time to complete the field inspection work ranged from about 45 to 90 minutes, and additional preparation, information look-up, and calculation times were also not a burden.

Inspectors made a few recommendations for amending the form. One suggestion was to re-organize the form according to how a typical inspector might move through the house in a field visit. In particular, some of the structural questions at the beginning cannot be answered until the inspector goes under the house, which is usually messy and done at the end of a visit. Not having the form in an intuitive order made for a less efficient, skipping around kind of data entry.

Participating inspectors also discussed the possibilities and barriers to creating a market for P50 assessments. Inspectors cautioned that marketing of a new seismic assessment “product” or “service” offering needs to fit within existing frameworks through which home inspections are commissioned, without radically affecting the price or timing. Different scenarios might affect who wants the assessment and why, or why not. For instance, for a pre-listing inspection commissioned by a realtor (the inspectors regard these as the dominant single family home sale scenario), a home owner may never be present. The group thought a price on the order of \$100 as an add-on service would be attractive, but at that price might not be attractive to very many inspectors.

Inspectors did not get a chance to practice how they would explain the form's results or content to a homeowner, but thought that it wouldn't be difficult to talk with homeowners about what the information meant. Participating inspectors agreed that the format and technical appearance of the form make it unsuitable as a deliverable to a homeowner. Instead, they would package the results into a report with a cover letter and summary, in order to make it more familiar and understandable to a homeowner client.

HOMEOWNER DEMAND FOR AFFORDABLE, OBJECTIVE EARTHQUAKE VULNERABILITY INSPECTIONS

Overall, this study provides multiple points of evidence of unmet demand for objective, easily obtainable, property-specific earthquake vulnerability information. As one interviewee stated: “I like the idea of inspections. They are great because homeowner may not be aware of terms or details about their foundation.” (Case 407) Another surveyed homeowner said: “I would like

to hire a building inspector to check the building completely, to see if anything needs to be done to protect the house.” (Case 910)

Getting information about the qualities of their house was, in fact, one a significant reason many owners wanted to participate in the interviews. Because of the experimental nature of the form’s use in the field, it was not possible to provide participating homeowners the P-50 information collected about their houses. This disappointed several owners, (e.g., Cases 39, 486) but nonetheless it shows a strong interest in having their homes evaluated.

People want this kind of information because they hope to learn things they can act upon, and that they can have high confidence will be beneficial. Particularly in Napa where salience of earthquake threats is high, there is a growing familiarity and interest in mitigation at the community level. Relatively low rates of retrofitted properties in a community, in this study under ten percent, can be seen as an opportunity to make substantial improvements to earthquake resilience for homeowners.

The most important features of an evaluation, from a homeowner point of view, are for it be affordable, high quality, third-party assessment of their home’s earthquake resilience. People are skeptical of seismic information conveyed to them by contractors or engineers who have a stake in doing the work that gets done, as well as some doubt about how well a contractor might carry out the project.

These are also, not coincidentally, critical features of an evaluation method from the point of view of home inspectors. That is because inspectors need a willing market in order to be able to offer this service. Participating inspectors reasoned that homeowners will not be interested in getting an assessment unless the advantages of having that information are clear and substantial. Their impression is that many homeowners do not value, much less take action about, earthquake risk information currently. Other government programs they have experience with, such as free energy audits, had low uptake. Why should we expect this to be different?

Inspectors felt pricing was key to developing adequate demand. Homeowners are accustomed to paying for general home inspections around the time of sale at a certain approximate price range. Additional services rendered means additional cost. We do not know whether homeowners will interpret a typical home inspection as something now lacking or incomplete.

One final, critical barrier to making a P-50 assessment a viable commercial product is the ability of inspectors to obtain professional insurance to be able to do that kind of inspection. Insurers are not familiar with the product and may hesitate to underwrite a less understood service. An effective insurance market for offering P50 services would be enhanced by efforts of home inspection credentialing and standards-setting organizations. In other words, once practices are sufficiently standardized and inspectors can be uniformly trained and evaluated on their abilities to deliver the special service, it will be easier for insurers to estimate and underwrite inspectors to carry out this new service.

Chapter 8 — Insights for Retrofit Performance and Homeowner Earthquake Impact Research

This study charts new territory in study of earthquake mitigation and insurance beliefs and behavior. A voluntary post-event survey can be used to elicit important information about vulnerabilities in the local housing stock and how households were impacted by a major local event. Site visits with both a home inspection and qualitative interview provided an unprecedented level of detail about both damaged and undamaged houses and how an event influenced homeowner thinking.

Qualitative investigations enrich our understanding about complex phenomena and systems. In this case, interviews revealed how little information most homeowners have about earthquake retrofitting and insurance and the importance of social influences on retrofit and insurance perceptions and behavior. The case studies conducted in Phase 2 also shed light on challenges for households in protecting themselves from earthquake risks, and the many and sometime lengthy ripple effects earthquakes can create in peoples' lives.

This Chapter presents summary conclusions from the project, including insights about how to pursue this kind of research even more effectively in the future. The Phase 1 survey and home inspection visits lay a foundation for future study of retrofit performance using a community-based, multi-disciplinary approach. The interviews provide a precedent for tracking and comparing beliefs and behavior over time across earthquakes in many locations and different magnitudes. Put together, this study lays a path for how data can be collected over time to advance our understanding of how retrofits affect homeowners and yields ideas for improving programs to help more California homeowners realize the benefits of greater earthquake resilience.

CHALLENGES AND OPPORTUNITIES IN RETROFIT PERFORMANCE RESEARCH

A great deal was learned in this study about the state of retrofitting in the City of Napa and what happened to local houses and owners since August 2014. However, even this wealth of new data did not prove adequate for determining if pre-event retrofitting was associated with better outcomes for single family wood frame houses in the South Napa earthquake case. That doesn't mean retrofits had no positive effects, or that they wouldn't for future events of other magnitudes or in other places. Rather, this study affirms that retrofit prevalence and performance are very nuanced and difficult phenomena to study.

The inherent challenges of studying retrofit performance share similarities with evaluating the effectiveness of medical interventions. Both types of research seek to understand outcomes at

the population scale by studying and trying to summarize and draw inferences about individual members of that population that may be very different from each other. True, real world evidence is either rare or impossible to collect.

Furthermore, both fields face the fundamental dilemma of all “cause and effect” research, in that it is impossible to observe the outcomes of interest *if no intervention had been done*. Therefore, the best researchers can do is try to estimate what the hypothetical outcomes might be. This can be done using theory, laboratory experimentation, and when possible, in natural settings, for instance using so called quasi-experimentation where matching or statistical methods simulate the effect of an experiment. Empirical field studies are rare but critical and informative, and perhaps also the most credible in the eyes of the public.

Methods for cause and effect research tend to be data intensive and rely on statistical modeling. Unfortunately, it can be difficult to obtain enough examples of houses and circumstances in order to be able to account for the large number of factors involved. Houses vary in configuration, materials, and maintenance, degradation, and renovations can change things over time. Retrofitting is also relatively rare. Furthermore, the infrequency and variability of earthquake events impedes not only our ability to make point observations but also to record the range of potential benefits in events with different intensity of shaking it might experience over the lifetime of a house. Performance may be enormously variable, across different micro-settings, and different or cumulative events.

Given such challenges, the following recommendations:

- **Develop consensus on a typology of house characteristics that are the major factors to control for in evaluating appropriate retrofit approaches and potential effectiveness.** Doing so will enable accurate planning for the size of data set that is needed to achieve sufficient statistical power to detect significant effects. It would also enable more strategic and standardized selection of case studies, the need for which are discussed in the next section.
- **Standardize a typology of retrofit features that is usable across multiple disciplines.** Cause and effect studies require a clear description and ways to document the “cause” being studied. This study showed many of the limitations and difficulties of using a simple “yes—retrofitted” or “no—not retrofitted” definition. A nuanced typology that defines different types of retrofits and classifies their features, cost ranges, and expected benefits is needed. Ideally, such a typology would also provide some way to rate or measure installation quality. Alternatively, studies could focus on a much more narrowly described kind of retrofit, for instance permitted applications of Plan Set A done within the past five years. That approach gives a better chance of answering a smaller research question.

- **Standardize a typology of outcomes for homeowners and houses that covers a wider range of earthquake impacts and is yet still useful for multiple disciplines.** A typology or guidance is also needed for the “effects,” to distinguish and accurately and reliably measure the many kinds of damage and loss outcomes that retrofits are meant to prevent. Clarifying the types and severities of impacts that retrofit features are trying to prevent, and measuring those outcomes carefully, is critical. Once the list of outcomes of importance is more complete, measures for those outcomes should be standardized and aligned with existing engineering post-event assessment methods. Regardless of the approaches chosen, we must specify what it is we are trying to measure and how we are measuring it in order to be able to assess causal linkages.
- **Continue to seek ways to involve more of the public in earthquake recovery and retrofit performance research.** Given already significant measurement difficulties, some may question the value of including homeowners with limited knowledge directly in the research. These concerns are not without merit. In community-based studies, there may be information quality issues due to question wording, recollection issues, or lack of awareness of key concepts and terminology among lay people. The fact that so many homeowners in this study did not know or did not report the retrofit status of their house is clearly an issue in involving homeowners in data collection. However, homeowners play too important of a role to ignore, and there is so little data available we cannot afford to dismiss any information source. The complexities of understanding retrofit performance warrant use of a wide range of research techniques and data sources. It is methodologically sound to study earthquake impacts from a variety of perspectives. Instead of dismissing homeowner involvement, researchers should focus on improving study design, recruitment procedures, and questions to maximize the usefulness of information collected from homeowners.

There is also great healing value in personally involving more of the public in post-event research. In this study of Napa, the public’s eagerness to participate is a testament to the level of interest in the topic and in being a part of learning from the event. Nearly one thousand Napa area homeowners entered the CEA survey website to share their experiences, including over 500 people in the first three days. Three hundred volunteered for further research and many participants said they deeply appreciated the opportunity to voice their stories and concerns.

HOMEOWNER EARTHQUAKE IMPACT STUDIES 2.0

In addition to the above research needs, this study yields insight into research priorities and design options that can better address the complicated questions of retrofit uptake,

performance during real world events, and cost-effectiveness. Complementary and refined research design alternatives include the following:

- **Increasing the sample size of houses under study.** For instance, data could be collected about more houses affected by the same event, or about a wider set of houses affected by different events in different regions.
- **Randomly selecting the set of houses to study.** This approach makes it more reasonable to generalize from a sample of houses to the whole community, comparable across different communities, and accurately portray proportions and incidence.
- **Collecting longitudinal (time series) data about the same houses.** This would involve, for instance, recording the conditions of the same house at different times, such as before retrofitting, after retrofitting, and after an event. A particularly powerful approach would be to identify retrofits *before* an event and then do post-event follow up visits. To do that, inventories of retrofitted properties in many different communities are needed. An important virtue of CEA's EBB program is the creation of exactly this kind of pre-event retrofit information in communities throughout the state.
- **Continue to study outcomes in both retrofitted and non-retrofitted houses.** This is important in studies with a large number of houses, and in case study research with carefully match pairs of retrofitted and un-retrofitted houses. A matched comparison study, possibly using index building types or genetic matching (a statistical technique for finding as similar as possible pairs in a large data set) would take advantage of the small number of retrofitted houses and make it more affordable to do very detailed engineering analysis.

Not all of the above design features can be used simultaneously, but some of them can be combined in the same study, or in multiple studies of different types, to powerful effect. If study of retrofit performance is approached in different but compatible ways, from different disciplinary perspectives and using diverse types of data and methods, we are more likely to grasp the full range of issues at play and more reliably advance our state of understanding.

Another innovation in this study is the use of home visits by inspectors to yield a wealth of descriptive and earthquake vulnerability information about single-family homes. With the P-50 data already collected about 39 houses, more analysis could be done to identify key earthquake risk features and the types of retrofit work done. With a little more effort, it would be possible to assess grades without and with further retrofit work, and explore which traits seem to indicate houses where retrofits would be most beneficial. To make this information more useful, it would be better if a structural engineer participated throughout. Adding involvement

of a cost estimator would help price out recommended upgrades relative to the increase in performance that could result.

The FEMA P-50 piloting aspect of this study validates and shows opportunities for facilitating cost-effective earthquake vulnerability assessment by home inspectors. CEA is using lessons learned from this pilot as it is developing a web application that will allow inspectors to perform high quality, rapid FEMA P-50 assessments in the field. For instance, the app seeks to automate data entry by home inspectors in field, and pre-populate fields.

Other lessons from this study relate to streamlining data collection and how to ease and speed up analysis and interpretation of findings. To achieve the necessary size of data set, data collection need to be scaled up to different communities impacted by different events.

Recommendations to facilitate cost-effective future studies of this type include:

- **Develop a strategy for when it's most important to deploy field teams for site-visits and interviews.** Such a plan would specify priorities for determining when the high costs of labor and data processing of site-visit information would be worth it.
- **Automate data entry as much as possible.** This could be done, for instance, by creating a way to fully-integrate, cloud or internet-style data collection (avoid cut and paste or manual data entry).
- **Where future qualitative work is deemed important, include sufficient budget to transcribe interview texts and use computer-aided qualitative data analysis (CAQDA) software.** This is another process measure that can increase consistency and streamline analysis, as well as institutionalizing the data analysis process to be less dependent on any one particular researcher.
- **Prepare a comprehensive analysis plan including data cleaning steps, recoding formulas, and lists of statistical comparisons to be made.** This will facilitate analysis by multiple researchers and standardize findings across events, organizations, and communities. Algorithms could be established for post-observation analysis for each house, cross-comparisons between house types, regions, and events, and long term program effects at the community scale.
- **Develop data collection and analysis collaborations with other researchers and institutions involved in disaster resilience.** Potential partners could include local jurisdictions, non-profit groups such as the Earthquake Country Alliance or Red Cross, or federal and state emergency response entities such as FEMA or the California Office of Emergency Services. Collaboration with cities, and especially building officials, is paramount because of the prominent role they already play in property-specific data

collection and the high stakes they have in how their communities will fare. Partnership with the California Association of Building Officials (CALBO) could be particularly important to ensuring cross-community cooperation and data standardization.

On a detailed level, this study highlights issues with specific survey topics and questions that can be addressed in future iterations or similar research.

- **Delete the service disruption section.** This makes sense for a study focused on retrofitting and insurance, because a retrofit is not likely to affect outcomes that are controlled outside the property, and would also make room in the survey for richer detail about other topics.
- **Include more precise questions for questions such as year built, square footage, and costs incurred.** Using wide ranges is easier for people to answer but makes the data more difficult to analyze. As much as possible, point estimates should be used instead of ranges (e.g., ‘Enter the approximate number of square feet for your house: _____’ is a more useful question than “Which of the following best describes your house’s approximate square footage? – 0-1500 sq. ft., 1501-2000 sq. ft., ...) This will allow these variables to be more easily used in statistical inference and models.
- **Ask directly about historic status and probe more fully about the remodeling history.**
- **Experiment with question formats to illicit information about when a retrofit was done, with what materials, and how long the work took to do.**
- **Experiment with ways to illicit information about retrofit costs.** Understanding retrofit performance is critical to understanding the conditions under which mitigation might “pay off” for the homeowner, and by extension, what types of discounts are appropriate for insurers to offer for qualifying retrofit work. However, financial questions are uncomfortable to ask and difficult for owners to answer, particularly if many years have elapsed since the work was done or if the work was done as part of a larger project. In a small case studies, it might be possible to ask homeowners to look up past documentation or financial records. For purposes of accurate recollections, it will be easier for homeowners to answer cost questions closer to the time when the money was spent. It might also help to look up and supplement homeowner recommendations with building permit data and reported valuations.

IDEAS AND A CONCEPTUAL FRAMEWORK FOR PROMOTING EARTHQUAKE RESILIENCE ACTION-TAKING

Through the survey and interviews, knowledge and action gaps among Napa area homeowners were revealed. These are likely common issues in other communities. The good news is, these can serve as a guide for CEA program design, refinement, and implementation in the future.

One fundamental need is to continue to motivate interest and action about household earthquake resilience. Most homeowners in this study were generally aware of earthquake risks, but lacked specific information about their own risk. Some effective messages to motivate attention to earthquakes and the search for personalized risk information suggested by this study include the following.

- **Point out how common and significant non-structural and contents damage can be.** This is likely to be a surprising fact to many people. They may also be unaware of how retrofitting can reduce that kind of damage or of insurance policy options for covering that type of loss.
- **Show data about the length of time that critical repairs can take.** Again, typical time spans of recovery may be much longer than people expect. Surprise makes people curious, and curiosity motivate information search.
- **Gently share stories about the psychological trauma that earthquake survivors go through.** Strong emotions are very common and can be debilitating, but may be lessened for those with financial resources to bounce back more quickly.
- **Urge people to make *their own* informed decisions.** So many homeowners unwisely hitchhike on (sometimes inaccurate) information provided by others. Just because insurance isn't right for someone else doesn't mean it's not right for you. People can ask a financial counselor who has less of a stake than an insurance agent or real estate broker for giving sound advice.
- **Point out helpful actions homeowners might be able to do for themselves or get “in-kind” help to do from a friend, neighbor or family member.** Many retrofit steps can be taken by the homeowner themselves with just a little more support.
- **Tap into the emotional connection people have with their houses and neighborhoods.** Many retrofit projects can be taken by the homeowner themselves with just a little more support. Love your home? Love it before *and after* the next big earthquake.
- **Convey more nuance as to what constitutes a retrofit and what different retrofit work is supposed to do.** For instance, homeowners on the cusp of considering a retrofit need to know about the existence of different kinds of retrofit work that can be done (e.g., chimney, foundation)

- **Carefully choose vocabulary.** For instance, alternative ways to talk about a ‘retrofit’ include earthquake ‘upgrades’ or ‘improvements.’ Most homeowners do not know what a cripple wall is, so it is sufficient to talk about the “foundation.”

None of these message will sink in if there are rarely seen. Increasing the frequency of encounters people have with the topic and the number of sources from which they receive information increases not just the chances that any particular person will see it but also the odds that it will be remembered and regarded as relevant. Educational content about the seriousness of the issue for the community should be complemented by information about cues or circumstances (e.g., age of home or proximity to major fault) for homeowners to self-diagnose that they might have an atypically higher level of risk. Positive tone is also constructive. The idea is to evoke curiosity together with a sense that following up on that curiosity will either relieve worry or provide actionable information about how to take care of any issues that are found.

For owners further along in the process, the challenges are less about motivating attention and more about informed decisionmaking. Because earthquake resilience decisions are so heavily influence by social networks and information exchange, CEA has the opportunity to strategically use these processes in delivering more accurate information.

- **Capitalize on information flow in existing social networks where trust is high and related issues are discussed.** Participants offered many ideas about trusted sources of information could CEA potentially partner with in trying to communicate with homeowners. Community institutions on which people already rely included schools, historic preservation groups, economic independence / independent living service providers, home and garden enthusiast, green living, and neighborhood watch.
- **Maintain a balance of communication efforts with both traditional and digital media.** Interviewees showed that different people respond to different media. New social media options, especially extreme local-focus such as NextDoor, can be utilized to cultivate even more familiarity and information sharing. Other preparedness and alarm innovations such as NixleAlert may be willing to become CEA partners in information delivery.
- **Seed the community with well-informed leaders.** While the reliance on word of mouth may superficially seem like a hindrance, it also means the entire community can benefit quickly if new, accurate information is inserted in the social network, particularly if high quality information is given to people who have particularly strong and varied social relationships in the community. Identifying and developing communication with individuals like this is a way to inform more people through natural communication habits rather than requiring people to seek out information themselves.

For persons who already perceive personal value to retrofitting and want to do it, the issues shift towards means and follow-through. This is where programs such as EBB that offer financial

help or incentives, education on specific, practical topics such as finding a contractor, or technical assistance with permitting and other aspects of project completion can help owners stay on track.

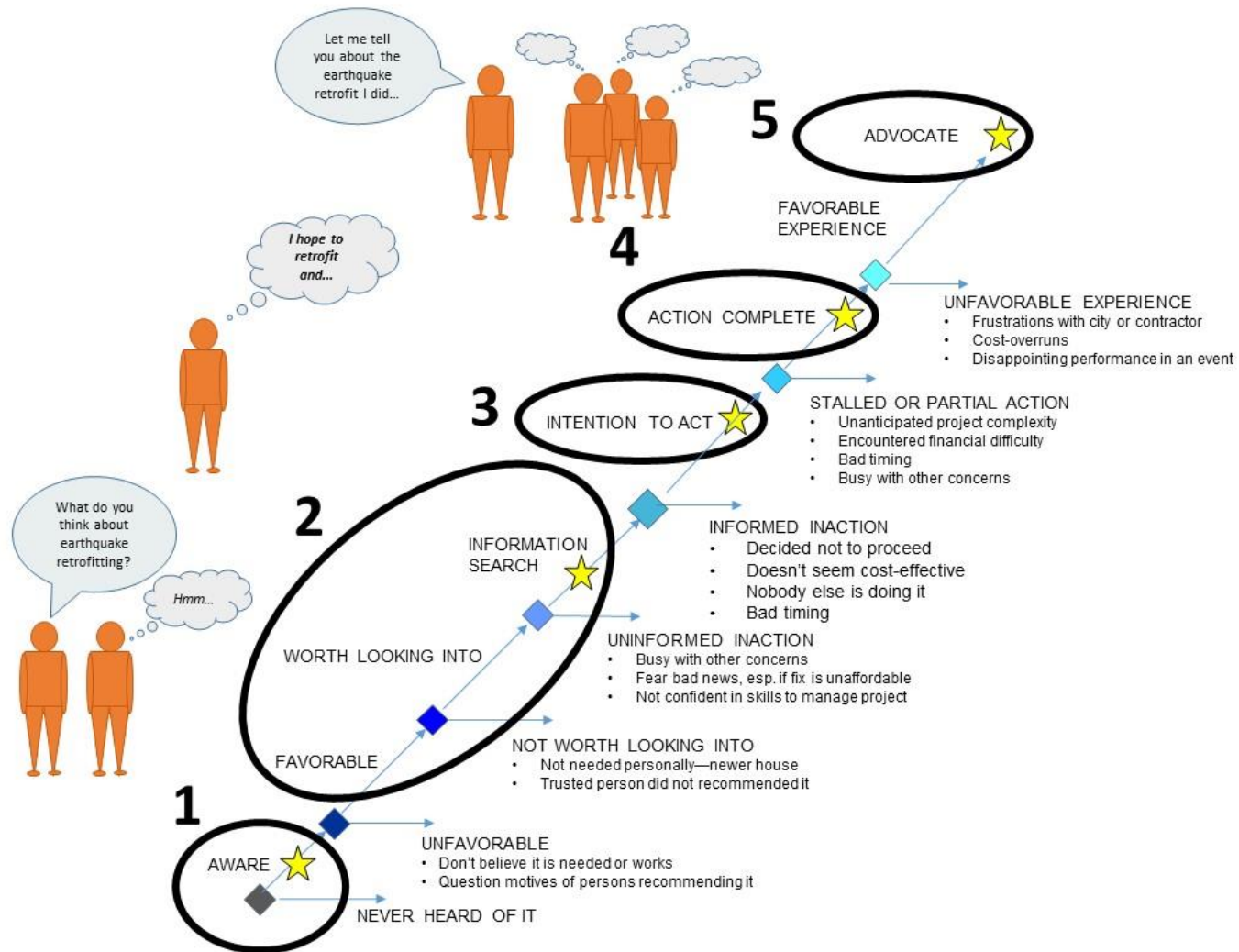
After an owner completes a project, it may be effective to acknowledge their successful action. This doesn't have to be a financial reward. Visible public recognition might be a good way to reinforce positive feelings and encourage others to follow in their footsteps. For instance, CEA could provide people who have retrofitted with ways to talk about their experiences with other owners, which would both make retrofitters feel good and spread authentic information to other owners.

This study demonstrates that while homeowners face many barriers in increasing their earthquake resilience, there are also numerous opportunities to help them progress through different steps or stages of behavior change towards the resilience end-goal. **Figure 21** shows one way to conceptualize this process as a series of steps or stages. An effective portfolio of programs would spread efforts where leverage is highest to move beliefs and behavior forward and avoid trying to get across all messages simultaneously.

In sum, this study points to five high-value approaches for reaching individuals stuck at different stages in the behavior change process, each indicated by their number in **Figure 21**. CEA already has many programs that address these needs, and each opportunity can be explored further in future CEA research and program development efforts.

- 1. Increase *salience* of earthquake risk in general (by evoking curiosity and frequent, normalized encounters with the topic).**
- 2. Create and publicize opportunities for *cost-effective diagnosis and remedy* of personal risk.**
- 3. Motivate and ease *information search* (reduce anxiety involved).**
- 4. Assist people in *carrying out projects* to completion.**
- 5. Reward and help people *advocate* among their peers.**

Figure 21. Diagram showing stages of behavior change for earthquake retrofit action-taking, including sticking points with possible associated beliefs.



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Appendices

APPENDIX A – METHODS AND PROCEDURES FOR PHASE 1 SURVEY.

Research Design, Target Population, and Eligibility Criteria

Phase 1 of the study collected data via a 52 question on-line survey of local homeowners who voluntarily participated between February 22 and March 15, 2015 (3 weeks total). The target population of interest was the approximately 38,200 single-family dwellings in the 94558 and 94559 zip codes, specifically in the boundaries of the city of Napa. CEA had a special interest in the subset of those properties constructed prior to 1960 that number about 12,500, but owners of any aged house could participate.

Specific study eligibility criteria were as follows:

1. The potential respondent must be able to provide information about a house in the 94558 or 94559 zip code.
2. The potential respondent must own or be a co-owner of the house in question. The dwelling need not be their primary residence.
3. The house must not be a manufactured (e.g., mobile home or trailer) residence.
4. The house must have four or fewer units (as this is one operational definition of a single-family residence that would be eligible for coverage under CEA's policies).
5. Potential respondent must be willing to provide the full street address of the property about which they will answer questions.
6. Only one entry allowed per household.

For three main reasons, CEA decided early on not to pursue a random probability sample of homeowners for the study. First, the study was primarily aimed at identifying and evaluating the performance of houses that were retrofit prior to the South Napa earthquake, not on estimating the incidence of various housing characteristics and damage impacts overall. Second, conducting a Computer-Assisted Telephone Interviewing (CATI) survey would have been much costlier. Finally, there are significant ancillary benefits to CEA in leading a broad-reaching, public effort in which the entire community could be involved.

Survey Mode and Instrument

The survey was created and delivered via Qualtrics Research Suite⁴, a leading online survey platform. Homeowners initially accessed the survey by clicking on a custom URL link (www.egsurvey.org; also re-directing from www.egsurvey.net and www.egsurvey.com) from CEA or the City of Napa's websites or by directly typing the URL into their browser after viewing a survey announcement. Following a welcome letter, two initial screens asked questions to quickly ascertain eligibility.

In the main part of the survey, eligible homeowners voluntarily provided information about their houses, any retrofit efforts made prior to the event, and any damage or service disruptions experienced as a result of the August 24, 2015 South Napa event. The question content, format, and sequencing followed best practices of the Total Design Method for survey research (Dillman, Smyth et al. 2014) as well as successful precedents of post-disaster data collection (Bourque and Shoaf 1999). The research consultant conducted 10 formal pilot tests of the survey that led to minor modifications, mostly concerning how eligibility and technical choice options were described.

Depending on their retrofit status and answers, respondents answered from 30 to 52 questions, which took on average about 15 minutes. A copy of the full survey instrument text is in Appendix A. The survey was professionally translated to Spanish and piloted with multiple native speakers.⁵

Nearly all the questions were multiple choice categorical in format, either forced or mixed (choose all that apply). Many also had an open-ended text box allowing for further explanation or provision of alternative answers. To maximize participation and completion, respondents were allowed to skip questions, but only in a handful of instances (that are noted below) did the fraction that skipped a question exceed 5%.

Marketing and Recruitment

Marketing, recruitment, and community partnership efforts were carried out by the CEA Mitigation and Communications departments. The survey was advertised to residents within the city of Napa through multiple avenues including door hangers, newspaper print and on-line advertising, radio spots, flyers, and links to both City and County websites and social networking sites.

⁴ Further information available at: <http://www.qualtrics.com> (Accessed April 13, 2015).

⁵ Full Spanish text version available by request.

Print and on-line media advertising were conducted through the Napa Valley Register. A public service announcement was recorded by Mayor Jill Techtel and rebroadcast on local radio stations KVON/KVYN. A press release was issued with quotes from both Mayor Techtel and Glenn Pomeroy, and several local news articles featured the study.

The primary avenue for direct recruitment was door hangers placed on the front entrance handle of all identifiable, safely reachable single family Napa properties in ZIP Codes 94558 and 94559, within the boundaries of the city of Napa. The timing was on the second through fourth days of the first week of the survey. An estimated 29,000 door hangers were distributed.

Several pre-survey meetings were held with the City of Napa's Community Outreach Coordinator Barry Martin, and the City of Napa agreed to co-brand the effort. An email announcement of the survey sent to each City of Napa council member, each member of the Board of Supervisors for the County of Napa, and through *Puertas Abiertas Napa* (a local community center).

Incentives, Remuneration, and Thank You Letters

In order to increase participation, CEA offered and subsequently gave a \$25 Target gift card to the first 500 eligible respondents who completed at least 80% of the survey and were willing to provide a valid name and mailing address to which information about how to retrieve the gift could be sent. Every eligible survey respondent that gave a mailing address received a letter of appreciation signed by CEA's Chief Executive Officer, Glenn Pomeroy.

Consent, Confidentiality, and Handling of Personally-Identifiable Information

At the arrival URL for the survey, potential respondents were provided a letter that summarized terms of use, proposed uses of the data to be collected, and who will have access to that data (refer to Appendix A). Respondents were advised of their rights as a voluntary research participant, who to contact with questions, and where to obtain more information about CEA's privacy policies.

Participation in the survey could not be anonymous by necessity, because of the need to associate each response with a complete house address and the name of a person to whom the gift card could be sent. Also, recording the IP address of the computer used to complete the survey fulfilled the need to assure only one entry per household. All analyses were conducted on password-protected, non-networked laptop computers or by CEA staff.

Respondents were advised they could not receive compensation for participation unless they gave a valid street address for the property about which they were answering questions.

Respondents could if they so choose provide the house address but not a personal contact address to receive a gift card.

Response and Completion Rates

A total of 914 persons visited the survey website during the study period. Seventy-three percent of these “hits” occurred within the first five days. A small fraction (about 3%) did not for whatever reason enter a valid house address and therefore dropped out. Among all visitors to the site, 633 (69%) met all study eligibility criteria.

Among eligible respondents that started the survey, over 93% (591) answered more than 80% of the questions (the benchmark for gift card eligibility). This is a very high rate of completion for an online survey of this length and level of detail, likely attributable to the highly personalized and potentially emotional importance of the survey topic in the target population.

The overall response rate was 2% (633/32,000), well within the acceptable range for a cold call voluntary online survey. Very low response rates (under 5%) are the norm in general population direct marketing where there is little to no prior connection between the research entity and individual target population members. Participation depends entirely on the voluntary initiative of contacted persons. If response rates are unequal in different segments of the target population in ways that systematically relate to key identifying or outcome traits, sampling bias can occur. In other words, the proportions observed in the study population may not reflect the true rates in the overall target population. Consequently, the results of this study should not be regarded as representative of the entire set of City of Napa homes or homeowners.

Potential systematic ways that response patterns may affect this study include over-representation of persons that experienced more severe impacts or are particularly eager to share their own stories of survival or having shown above average knowledge or initiative (e.g., having retrofitted previously). Also, in general, survey participation tends to be higher among women, older persons, persons with high trust in science, technology and government, and those who have greater economic security (which might associate with easier access to the internet, comfort with and prior participation in research, and above average leisure time available to complete the survey). On the side of potential under-representation, there may have been a lack of participation among homeowners that experienced less damage, who rent out their properties, use it as a vacation property, or otherwise travel often or do not live in the area, who left the area or sold their home between the event and the time of the study, or who purchased the property after the August 24, 2015 event. As a consequence, self-reported damage rates in this study might be higher than those reported elsewhere.

Relationship between the Phase 1 and Phase 2 Research Designs

One of the key objectives of Phase 1 was to identify a list of specific houses and their owners who were willing to be contacted about participating in a Phase 2 follow-up site visit during which the property will be further assessed by trained personnel.

At the end of the Phase 1 survey, respondents were given the option to provide further personal information in the form of an email and phone number. Doing so affirmatively indicated their willingness to be contacted about Phase 2. As incentive, they were informed that this would create a second opportunity to receive a \$50 gift card if they were eligible and actually completed the site visit. More than half of respondents (319, or 51%) expressed a willingness to be contacted about the Phase 2 site assessment, which will involve about 50 houses. Note that it might be possible for some respondents to receive both the Phase 1 and 2 monetary incentives. Phase 2 participants who did not receive the first gift card are still potentially eligible for the second. The data collection and analysis plan for how each house will be assessed is currently in development. Insights for that process that result from Phase 1 findings are discussed in Section 6.

Data Analysis Procedures

All responses in the dataset were visually checked and received basic cleaning (e.g., correction of misspellings or removal of errant characters). Responses that were missing key information such as a valid house address were classified as ineligible for the study.

Responses with unusual data entries were flagged for individual assessment. If duplicate response entries were received for the same house, only the most complete response entry was kept. Also kept were multiple entries from the same IP address if the records referenced a different house address, based on the assumption that these surveys may have been completed on a public computer. Responses received by homeowners outside the City of Napa were included for analysis purposes but were not eligible for a Phase 1 gift card. Finally, an anonymous response ID was created so that as much as possible of the analysis of the dataset could be done without reference to particular IP addresses, individuals, or house addresses.

Summary statistics were calculated using Microsoft Excel and IBM SPSS counts and cross tabulations.

APPENDIX B – METHODS AND PROCEDURES FOR PHASE 2 SITE VISITS.

Study Objective:

Collect *case-by-case* data about the performance of about 50 selected retrofitted and non-retrofitted single-family dwellings in the August 24, 2014 earthquake in the American Canyon area and the perceptions and experiences of these homeowners regarding mitigation.

Overview

This second phase of CEA's South Napa research project seeks to collect information about a specifically chosen set of about 50 single family dwellings affected by the August 24, 2014 South Napa M6.0 earthquake. This study builds on Phase 1, which identified a pool of 319 seismically retrofitted and non-retrofitted single-family dwellings within the City of Napa whose owners agreed to be contacted about participating in additional research during a site-visit. Researchers and trained home inspectors will be paired together and conduct approximately 50 site visits, during which they will record more detailed information about each property and conduct interviews to document the perceptions and decisions processes of the owners related to earthquake mitigation.

Through detailed assessment of a purposively selected set of houses, CEA can analyze factors associated with higher or lower performance, document the state of recent retrofit practices in the field and how well these approaches functioned (in *this* event), and investigate of the role of year built, site characteristics, construction materials, and other factors. Finally, the study will also offer a rare in-depth view into the social contexts in which individual purchase, retrofit and recovery decisions are made.

Types, Use of, and Access to Data

CEA will be the sole agency in collecting this data and a work shall be conducted in close coordination with designated CEA project leaders.

Technical observations about the house will be collected by trained inspectors during voluntary site visits that take mostly outside the house and with the homeowner or their designee present. A social science researcher will conduct an interview that includes both closed form (multiple choice) and open-ended questions. This will occur in-person at the same if at all possible and using a digital recording device if the homeowner agrees. If necessary, the interview can be offered as a follow-up via a phone call or online survey platform. As an incentive to participate and to acknowledge their contribution of time and information, each eligible homeowner that completes the process will receive a \$50 gift card.

Data collected in the inspections and interviews will be the sole property of CEA. Because the data collected will contain personally identifiable information, the raw data will be retained by CEA internally. However, data stripped of personally identifiable information, may be used in reports made available for wider use, for instance on the California Virtual Earthquake Clearinghouse website. Homeowners will be alerted to this possibility as part of securing affirmative consent prior to participating. The homeowner will be notified that the information may be shared with a third party for additional research purposes.

Target and Study Population

The initial selection pool for recruitment is the set of homeowners that participated in the Phase 1 survey and voluntarily “opted in” as willing to receive more information about participating in a second part of the study that would involve a site visit. The potential for additional compensation was mentioned at that time. These homeowners provided full names and a phone number and/or email address in addition to the address of the property they answered questions about. As of April, all eligible Phase 1 participants received a thank-you note and a \$25 gift card if they were within the first 500 respondents.

From that pool, exclusion criteria were applied to remove from the Phase 2 eligible pool any persons with an incomplete or unusable name or addresses that currently hold a CEA earthquake insurance policy. The latter exclusion was necessary to ensure no conflicts of interest involving potentially active claims.

Specific Aims and Research Questions

The overall study aim is to advance knowledge about how to help California homeowners better protect themselves from the threat of earthquakes. This particular phase has multiple goals, some more technical in nature and oriented to retrofit practices while others address social, cognitive, and behavioral phenomena related to mitigation decision-making and potential ways to improve CEA programs.

This interdisciplinary approach was chosen because some of the phenomena CEA is interested in can only be understood by integrating technical and social science information. For instance, how does a decision to do a certain kind or level of retrofit work come about? Did the homeowner correctly understand the work that was done? Furthermore, the paradox of low homeowner uptake of seemingly cost-beneficial mitigation is still poorly understood and thus best investigated in a qualitative manner.

The specific technical research aims are to:

- Assess the *nature* and *performance* of any identifiable pre-event retrofit or strengthening work, including:
 - *Characteristics* of pre-event voluntary retrofits, i.e., What retrofit work, if any, was done?
 - *Develop a classification scheme for types of retrofit work*
 - *If possible, assess how appropriate the work was and how well it was carried* (i.e., Was the retrofit done to a standard?)
- What kinds of *damage* occurred to these houses?
 - What kind of repair work was necessary and/or done after the event?
 - What lessons for housing construction and engineering practice can be drawn from how these retrofits performed?
- Develop and evaluate the capacity of local California Real Estate Inspection Association (CREIA) home inspectors to conduct FEMA P-50 evaluations
 - Pilot the use of the HDR verification form
- Collect dollar estimates where possible to:
 - Total cost of any previous retrofit work
 - Total repair costs for damage resulting from the Napa event
 - Total costs to perform additional needed / recommended retrofit work

On the social science side, the specific aims are to:

- Document the *understandings* among participating homeowners of:
 - What makes a house vulnerable to earthquakes
 - What a retrofit is and does
- Get feedback on different kinds of language may help people better understand the retrofitting concepts, processes, and implications
- The process of doing retrofit work
- The perceived costs and barriers
- Perceived motivations and benefits
- Document the *experiences* among participating homeowners of the August 2014 event and how these may have influenced the above beliefs, intentions, and behaviors
- Document in brief the demographic *characteristics of persons* in this community that have voluntarily retrofitted or not

The nature of this study requires the owner or a well-informed owner representative of each house to be present to meet the assessment team for (and to stay on site during) a site visit scheduled in advance. This inconvenience is mitigated by the owner's level of interest in making a contribution to the research cause and the value they receive from both the chance to interact with experts in the context of their own house and the resulting information.

The physical inspection is estimated to take from one to three hours depending, for instance, on the structural materials and complexity or access issues. The social science data collection could take up to one hour.

With a limited amount of time to engage a homeowner and a motivation to obtain genuine participant-volunteered information, the number of topics and questions asked must be carefully chosen and kept to a minimum. The concepts covered should be tightly focused on specific topics for which answers are likely to help CEA make strategic policy decisions. For instance, the information should help improve the attractiveness of products or program offerings, or advance the broader cause of understanding, motivating, and performing effective preventive actions to reduce earthquake risks.

CEA can use the results of this study to inform in pursuit of its mission to educate, mitigate, and insure in the following ways:

- 1. Provide feedback on how to effectively train inspectors to perform FEMA P-50 assessments in the field.**
 - What kind of training and support do inspectors need to have in order to perform consistent and accurate and timely assessments?
 - How are homeowners likely respond to this type of information?

- 2. Prioritize and plan for future public education campaign efforts.**
 - What are the key educational needs among this homeowner population?
 - How can CEA effectively time and structure programs to educate California homeowners?
 - For instance, how do the type, timing, and amount of the incentive affect homeowner interest in a program?
 - What is the relative effectiveness of offering educational efforts before, during or after the time of home purchase?
 - Which trusted sources of information could CEA potentially partner with in trying to communicate with homeowners?

- 3. Fine-tune CEA mitigation research, incentive programs, and partnership efforts.**
 - How can this type of study be expanded as a model of post-event learning after future California disaster events?
 - Which criteria are best used to prioritize incentives offerings, for instance to better reach older properties, higher risk properties, or homeowners that may face unique or particularly severe implementation barriers or would particularly benefit?

- Are current mitigation incentive amounts or formats well matched to the upgrade needs and costs of these properties?
- Under what conditions does mitigation appear to “pay off” for the homeowner and how can that information best be communicated and used to develop programs?

Phase 2 Recruitment Priorities

From all houses in the pool, ranked lists were created to prioritize visits to homes that will best address the research aims. The criteria at this stage relate exclusively to the physical circumstances of the property. The intention was to select properties for further analysis that represent a mix of the following features:

RETROFIT STATUS, defined as self-reported non-retrofitted or retrofitted (*Don't Knows automatically receive lowest priority unless selected for another reason*)

ERA, defined as the self-reported decade built (this is relevant to the codes, methods, and materials used at time of construction as well as the likely degree of degradation and maintenance):

- 1949 and earlier
- 1950-1979
- 1980 or later

CRIPPLE WALL HEIGHT, defined as self-reported from the following four categories:

- < 2 feet
- 2 -4 feet
- 4 feet
- “Slab on Grade” / concrete foundation / no apparent cripple wall

SPECIAL CASES, defined as instances that represent unexpected combinations of house characteristics and damage outcomes

Figure 22. Breakdown of eligible Phase 2 recruitment pool by self-reported retrofit status and self-reported decade built.

	Counts by Retrofit Status			
ERA	Don't Know	No	Yes	Grand Total
Missing Data	1	1		2
After 1980	20	49	3	72
1950-1979	30	104	11	145
Before 1950	15	48	37	100
Grand Total	66	202	51	319

The first two criteria together define six categories, four of which were chosen as targets for data collection. The final four categories are shown as shaded red. Modern era construction (post-1980 houses) were excluded in order to focus on the homes likely most in need of retrofit work. Sample size goals for each target category were then chosen (**Figure 23**) to maintain an approximately three to one ratio between retrofit properties and similar non-retrofit properties.

The third criterion was used to select five additional houses to visit that may or may not have been retrofit but evoked curiosity in the research team’s review, based on a strategy of expert-driven, creative exploration of the field sites that would keep the study open to new discoveries.

The final criterion was used in a different way. The ideal of systematically representing variation across all relevant housing traits in this small of a sample is not possible. In preparing the priority order for recruitment within each category, efforts were made to include a range of cripple wall heights, and to eliminate slab on grade / concrete foundations. In effect, this allows us to alternatively classify the targeted sample of properties by the “Housing Type Index.”

Post-event “outcome” traits were explicitly not used in the selection process. While it is tempting to focus visits on the most damaged properties, it is better for the intent of this research to investigate properties without selecting based on the outcomes of interest. Failing to do so would impede the goal of trying to understand the true distribution of effects that

occur among houses with similar pre-event observable traits. For instance, it is important to analyze retrofits that *succeeded* in avoiding damage, and to analyze non-retrofitted houses that would have been predicted to have high damage but ultimately sustained little to none.

Breakdowns of the Phase 1 survey results are the better way to look at the potential mix of types and range of severities of damage and impact outcomes in the resulting sample to see if it mirrors the outcomes in the overall sample.

Procedures and Requirements

The project involves a complex sequence of steps involving many parties, and will thus require careful coordination of trainings, timelines, data collection monitoring, and quality control. All participants should anticipate unexpected turns of events and potential delays. The project will conclude with a period of data integration, in-depth analyses of both technical and social science findings, distillation into recommendations, and preparation of written and other communications about the results.

Recruitment & Participant Interaction Steps

We anticipate high interest in participating because the topic is highly personal, timely, and salient. Owners may also look forward to being able to tell their story or perceive value in the technical information they can receive at the end of the site visit. The main cost to the homeowner is in the form of time spent and the difficulty of scheduling the visit at a feasible time and within the offered timeframe.

Targeted number of homeowners / home visits:	50
Assumed contact to completion ratio:	3:1
Estimated # homeowners that will be contacted:	150
Total percent of recruitment pool that will be contacted:	60%

Figure 23. Breakdown of eligible Phase 2 recruitment pool and targeted sit visit numbers to over-sample retrofit properties and key eras of construction.

		Counts by Retrofit Status		
		No	Yes	Grand Total
ERA	After 1980			
	Count	49	3	52
	Targeted # Site Visits	5	3	8
	Percent of Category reached by Site Visits	10%	100%	15%
	1950-1979			
	Count	104	11	115
	Targeted # Site Visits	5	10	15
	Percent of Category reached by Site Visits	5%	91%	13%
	Before 1950			
	Count	48	37	85
	Targeted # Site Visits	5	25	30
	Percent of Category reached by Site Visits	10%	68%	35%
Special Cases (note: these will overlap with the counts for above categories)				
Cases Remaining in Each Retrofit Status Category	186	13	199	
Targeted # Site Visits (any era)	2	3	5	
Percent of Category reached by Site Visits	1%	23%	3%	
Grand Totals	201	51	252	
Cases Remaining in Each Retrofit Status Category	184	10	194	
Total #Targeted Site Visits	12	38	50	
Percent of Phase 2 Sample Devoted to Each Retrofit Status	24%	76%		
Percent of Category reached by Site Visits	6%	75%	20%	

Some of the key steps in the sequencing of the research are to:

- Use the established selection criteria to create prioritized recruitment contact lists
- Pre-contact letter or email to potential participants

- Training of potential inspectors in use of P-50 form
- Pre-contact letter or email to potential home inspectors
- Prepare a survey or semi-structured interview guide to reflect key social science research priorities
- Train participating social science researcher(s) to collect that data (e.g., brief piloting, practice interviewing)
- Data analysis plan for how to use the collected data both separately and in conjunction with the inspection assessment findings
- Create contact protocols & scripts
 - Appointment time offerings (e.g., evenings, weekend, daytime)
 - Standardized messages, reminders, re-scheduling policies
 - Consent materials as needed (with CEA legal approval)
- Establish researcher roles, quotas, and timeline
 - Arrange pairings of inspectors with qualitative research partners
 - Arrange for Janiele Maffei (and/or other CEA staff) to participate in initial set of site visits)
- Train inspectors on expectations for how the site visits should go
- Conduct Round 1 interviews, supervised by senior research personnel for quality control purposes
 - Each interview is followed by transmittal of the gift and submission of the collected data to a central repository
 - Modify contact and on-site protocols as needed
- Inspector progress reporting, centralized maintenance of contact records and tracking progress related to selection goals
 - Inspectors are obligated to report their progress regularly
 - Post-visit compensation
- Data cleaning and analysis (described in the Data Analysis Plan in development)
- Following-up with participants as needed, including the gift car, additional thank you note, or research findings briefs
- Descriptive summary report(s)
- Final report summarizing findings and recommendations

Procuring this data is important because it will allow CEA to make recommendations to advance retrofit practices in the field and develop new ways to improve or expand CEA's incentive programs.

Some key issues in coordinating the work are to: [1] train inspection personnel to carry out a standardized high quality data collection effort, [2] collect adequate data to document and assess the performance of pre-event seismic upgrades (especially in older properties) in a

comparable way, and [3] create conditions that help homeowner express their true beliefs about mitigation and other preparedness and recovery planning measures.

CEA staff will perform the recruitment and interview scheduling in conjunction with the inspectors. Dr. Rabinovici will conduct and/or supervise trained personnel to do the first approximately 10 interviews, as well as carrying out data management functions and qualitative data analysis.

Because only a handful of interviewee-inspector teams will be used for this project and the interviews must take place on site and in person, there is a natural limit to the rate of interviews that can be conducted week to week. Each inspector-interviewer team might be expected to complete about three to four interviews per week with the goal of completing all the interviews over the course of about six weeks.

The process of producing specific recommendations, such as potential policy or program improvements to enhance mitigation uptake as well as for future research, should be highly collaborative between CEA and other parties involved in the research.

Gift Cards / Remuneration

Providing an incentive to homeowners should increase the likelihood of participation in a site visit and their overall satisfaction with the experience. The recommended format is a \$50 gift card, to be sent to the homeowner following a successful site visit.

Conduct and Content of the Site Visits

During the site visit, topics and activities on the technical side will include:

- A physical inspection pursuant to a P-50 evaluation (abbreviated)
- Documentation of any repair work done since the August 2014 earthquake
- Interview with the homeowner building from answers given in the Phase 1 survey
- Procurement and/or taking of photographs (if signed for on consent form)

While the inspector(s) are making their observations, a trained social science researcher will ask homeowners additional questions designed to deepen our understanding of the context in which retrofit decisions are being made and how policy offerings or earthquake events are perceived.

The interview will ask questions about the homeowner's experiences with such things as:

- Homeowners' experiences related to the August 2014 event
 - What happened to them / what they thought or did immediately

- What happened to the house / severity of impact on property in the August 2014 quake
 - Any repair needs and decisions, if any—what, why, how
 - Challenges encountered
 - Costs / how paid for
 - Overall financial impacts of event—types and amounts
- What homeowners *think about* and *have done regarding their house and earthquakes (if anything)*:
 - Overall financial position in the house
 - EQ insurance actions / attitudes / willingness to spend
 - Role of EQs in property search / purchasing / remodeling decisions
 - Any retrofit decisions and steps taken, if any—what, why, how, who
 - Challenges encountered
 - Feelings about having done it
 - Money and time costs / how paid for
 - Words for communicating about earthquakes and retrofits
 - Public policy preferences
 - Future plans for the property
- The *demographic characteristics of the person* participating in the study

A final interview guide with questions will be reviewed by CEA prior to use. Homeowners who participate will be provided terms of use, outlining the proposed use of the data collected, and who will have access to that data.

The social science data collection will be in an interview form, but for tractability and to save costs, will be recorded on a handheld or laptop device by the interviewer, and also by digital audio if the homeowner consents. Imagine a setting in which the interviewer and interviewee are seated side by side, looking together at the screen, while the interviewer navigates and given a chance for the participant to see the answers being recorded, ask clarifying questions, or amend what they said at first. This interactive, more casual format will provide homeowners the opportunity to voluntarily elaborate and for the interviewer to probe deeper on topics of interest that unexpectedly come up that relate to the study aims. Depending on each subject's answers, the interview should take less than an hour.

At this time, no experimental aspects to the study are planned. However, the researcher may ask how the homeowner would react to various hypothetical policy options or disaster scenarios.

APPENDIX C – PHASE 1 SURVEY INSTRUMENT TEXT (ENGLISH VERSION)

Q1.1 Dear Napa homeowner,

The mission of the California Earthquake Authority, founded by the state legislature in 1996, is to educate and help California homeowners reduce and recover from earthquake damage. That is why we are doing detailed research about what happened to houses in the Magnitude 6 South Napa earthquake on August 24, 2014.

This survey asks questions about the structure of your house and any types of damage or loss of services caused by the August 2014 quake. The survey is available in English or Spanish. Don't wait! Data collection ends March 15, 2015.

Because we are targeting information about houses within the city limits of Napa, we will ask for the street address of a house about which you can answer questions. The first 500 homeowners to complete the survey can receive a \$25 Gift Card. In order to receive the Gift Card, we will also need your name and mailing address. If you prefer, you may answer anonymously but we will not be able to send you a Gift Card. Either way, your participation in this survey is critical to our efforts to improve programs for owners to protect their houses in future earthquakes. Any information you share in this study will be kept confidential according to CEA's privacy policies and used only for research purposes.

Please take a few moments now to complete this survey.

Thank you,

Glenn Pomeroy

CEO

California Earthquake Authority (CEA)

Q1.2 Let's quickly figure out if this study is for you. Please answer all of the following:

I can answer questions about a house located in either the 94558 or 94559 zip code.	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> Don't Know
The house I can answer questions about is owned by me or a family member (I am not a renter).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> Don't Know
The house was originally built on the property (it is not a trailer, mobile or manufactured home).	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> Don't Know
The house has no more than 4 separate apartments.	<input type="radio"/> Yes	<input type="radio"/> No	<input type="radio"/> Don't Know

Q2.1 Terrific -- we want to hear from you! Please type in the street address of the Napa area house that you will answer questions about. We need this to understand how much the ground shook at your house. Remember, CEA will not share your information for use by any third parties for their marketing purposes.

Address
 City
 State
 Postal Code

Q2.2 If you finish the survey and are otherwise eligible, in order to receive the \$25 gift card, you must provide us with your name and other potential personally identifiable information. We will use this information only for our internal verification and business purposes and in accordance with CEA policies. We'll also tell you more about a follow-up study in which qualifying participants can earn an additional \$50 gift card. Only one survey submission allowed per house address. Participation is voluntary and you are free to skip questions or withdraw from the study at any time. Depending on your answers, the survey should take about 15 minutes. You have up to 3 days after starting to complete it but you must use the same electronic device to access the survey each time. Please try to do it all at once and answer all the questions.

- I am NOT willing to give an address (if you check this, you will exit the survey).

Q3.1 Thank you! Let's get started. The first few questions ask some general things about your house. We understand that most people are not experts about houses or construction. If you are unsure of any

answer in this survey, just make your best guess and move on! Please tell us approximately when your house was FIRST BUILT. (For example, if the house was built in 1962 you would choose: 1960-1969)

- 2000 or later
- 1990-1999
- 1980-1989
- 1970-1979
- 1960-1969
- 1950-1959
- 1940-1949
- 1930-1939
- 1920-1929
- 1910-1919
- 1900-1909
- Before 1900

Q3.2 What is the approximate SQUARE FOOTAGE (total floor area) of the house? (For example, a typical 2 bedroom house is about 1501 to 2000 square feet)

- 500 to 1000 square feet
- 1001 to 1500 square feet
- 1501 to 2000 square feet
- 2001 to 2500 square feet
- 2501 to 3000 square feet
- 3001 to 3500 square feet
- 3501 square feet or more

Q3.3 How many separate LIVING UNITS are in the house? (For instance, if you live in a duplex, choose '2')

- 1
- 2
- 3
- 4
- 5 or more

Q3.4 Does the house have a GARAGE or carport (covered parking structure)?

- Yes
- No

Q3.5 Does the garage or carport have any LIVING SPACE above it? (For example, a bedroom or workshop)

- Yes
- No

Q3.6 How many CARS in total could fit in the garage or carport?

- 1 car
- 2 cars
- 3 cars
- More than 3 cars

Q3.7 Please tell us what the ROOF on your house is made of. (Note: Do not choose 'Clay or concrete tiles' or 'Slate' if those materials are only used in small areas as accents.)

- Composite or asphalt shingles
- Wood shingles or shakes
- Clay or concrete tiles
- Slate
- Tar and gravel
- Metal sheeting
- Other -- please describe: _____

Q3.8 Next we want to ask about the structure that supports your first floor (also called framing). Framing is how things are held up, not what covers the floor (such as carpet or hardwood).

To the best of your knowledge, what is the FIRST FLOOR FRAME of the house made of? (Do not consider the garage floor, just the part under your living space. Most Napa area houses have a wood frame. If you're not sure, the picture below might help. Look outside to see if you have a gap between the ground and the bottom of the first floor -- also called a crawl space. There may be vents near the ground on the outside. Also, choose 'Wood' if your first floor creaks or bounces if you jump up and down on it.)

- Wood (also called a raised wood frame floor)
- Concrete (also called slab on grade)
- Some areas are wood and others are concrete.
- Other--please describe: _____

Q3.9 If you stood outside next to the house, HOW HIGH above the ground is the first floor surface? (If the house is on a hill, please tell us the distance from the ground to the first floor surface where it is highest. Remember, if you're not sure, just make your best guess and move on.)

- More than 4 feet (above a person's chest)
- 2 to 4 feet (between a person's knees and their chest)
- Less than 2 feet (below a person's knees)
- At or below ground level (sunken, step down)

Q3.10 If the house has a BASEMENT OR CRAWL SPACE, are any parts of its inside walls finished? (A crawl space is a short wall between the foundation and the bottom of the first floor. Finished could mean being painted or covered with drywall or panels of wood.)

- Yes
- No
- Don't Know
- There is no basement or crawl space

Q3.11 Please tell us what the FOUNDATION under your house is made of. If you're not sure, look through each of the pictures below and then choose the best match.

- Raised perimeter concrete
- Raised perimeter masonry or brick
- Raised perimeter stone
- Wood posts (set on individual foundations such as concrete blocks or masonry piers)
- Concrete (slab on grade)
- Other -- please describe _____

Q3.12 Does the land directly under your house have a SLOPE (for instance, is it on a hill)?

- Yes
- No

Q3.13 Please tell us more about the DIRECTION OF THE SLOPE relative to the way the house faces:

- The ground is highest in the front of the house.
- The ground is highest in the back of the house.
- The ground is highest on one side or the other, or slants at an odd angle crosswise.

Q3.14 Now we want to ask about some things that might have happened at your house as a result of the August 24, 2014 earthquake. Were you or other PEOPLE inside the house at the time of the earthquake?

- Yes
- No

Q3.15 Was anyone INJURED or hurt?

- Yes
- No

Q3.16 As for damage, which of the following may have happened to THINGS THAT WERE INSIDE your house at the time of the earthquake? Please check all that apply.

- Little to no damage
- Things like books or dishes fell off shelves
- Paintings, mirrors, or artwork fell off the wall
- Computer, TV, or other electronics were damaged
- Furniture, appliances, or other large items tipped over, damaged, or broke
- Other -- please describe: _____

Q3.17 Did you experience any damage to the INSIDE STRUCTURE of your house? Please check all that apply.

- No damage to the inside ceiling, walls, or finishes (finishes are things that are permanently attached, such as wood paneling, light fixtures, faucets, or built-in cabinetry)
- Small cracks or breaks in the inside ceiling, walls, or finishes
- Bigger cracks (wider than a match stick) in the ceiling or walls
- Damage to floor coverings (for instance cracked floor tiles or ripped wood flooring)
- Damage from a water leak
- Damage from a fire
- Other -- please describe: _____

Q3.18 Did anything happen to the WINDOWS or DOORS? If so, please tell us more about the damage (check all that apply).

- 1 or more windows or doors could not be opened
- 1 or more windows broke
- Glass in a sliding door broke
- Glass in a regular door broke
- I did not notice any damage to the windows or doors

Q3.19 Does the house have one or more CHIMNEYS?

- Yes
- No

Q3.20 What type of MATERIAL is the house's main chimney made of?

- Masonry (stacked bricks, rectangular blocks, or stones and mortar)
- Other (anything else, for instance concrete or metal piping)

Q3.21 Was there any chimney DAMAGE from the August 24, 2014 earthquake?

- Yes
- No

Q3.22 Please consider the following TYPES OF CHIMNEY DAMAGE and choose all that apply to what happened to yours:

- Small cracks but only in the part of the chimney above the roof
- Small cracks all over the chimney
- Chimney still standing but the part above the roof was badly damaged
- Chimney still standing but all the whole chimney was badly damaged
- The whole chimney peeled away from house
- The part of the chimney above roof fell off or toppled over
- Other -- please describe: _____

Q3.23 What material covers most of the OUTSIDE WALLS of your house?

- Stucco
- Wood shingles
- Plywood sheathing
- Horizontal wood boards (also called wood siding)
- Horizontal aluminum or metal sheathing (also called metal siding)
- Other type of exterior finish - please describe: _____

Q3.24 Did you experience damage to the OUTSIDE WALL SURFACES of your house in the August 2014 earthquake? (For instance, to the wood siding or stucco.)

- Yes
- No

Q3.25 Please consider each type of OUTSIDE WALL DAMAGE below and check all that apply.

- Small cracks in the stucco finish
- Big cracks (wider than match stick) in the stucco finish
- Large pieces of stucco finish fell off
- Shingles or sheathing came loose but stayed attached to the building
- Large pieces of shingles or sheathing fell off
- Other - please describe: _____
- No outside wall damage

Q3.26 Please tell us about any OTHER KINDS of outside damage that might have happened (check all that apply). Remember, if you're not sure, just make your best guess and move on.

- A porch roof moved sideways (also called racking)
- A porch roof collapsed
- House slid or toppled off of the foundation
- Garage door frame moved sideways or racked
- 1 or more of the doors to the outside could not be opened
- Other -- Please describe: _____
- No outside damage of these types

Q3.27 If your house was TAGGED by the city, please tell us what color tag it was given at first.

- Green
- Yellow
- Red
- The building was not tagged.

Q3.28 The next few questions are about things that may have happened to the SERVICES at your house (utilities). Please read the list carefully and check all that apply.

- The house had no running water for a period of time
- The house had no electricity for a period of time
- The sewer pipes broke or stopped working
- The gas was shut off for a period of time
- On-site gas supply was damaged (for instance, a propane or heating oil tank)
- The water heater moved or slipped (but was still standing up)
- The water heater completely fell over (not usable)
- The house had no land line phone service for a period of time
- The house had no working TV or internet connection for a period of time
- Other -- please describe: _____
- No disruption of utilities

Q3.29 If you had any DISRUPTIONS to services, please take a moment to tell us more about what happened. Check all that apply.

- I smelled gas
- I turned off the gas
- The house has an automatic gas shut-off valve
- I thought the water heater was braced (strapped to the wall) but it still was damaged or fell over
- I had to buy bottled water or visit a distribution truck or center
- Because of damage to the house, I couldn't go to work for a period of time
- I had to live somewhere else for at least one night because of utility issues
- No services were disrupted at my house
- Other -- please describe: _____

Q3.30 If any services such as water, sewer, electricity or gas were not available at your house for a period of time, please tell us the NUMBER OF DAYS it took until ALL SERVICES were working again. If there were no disruptions, choose zero (0).

- 0
- 1 to 3 days
- 4 to 7 days
- 8 to 14 days (1 to 2 weeks)
- More than 15 days (more than 2 weeks)
-

Q3.31 If your house had damage, how much TIME did it take to complete all the important clean-up and repairs?

- Less than a day
- 1 to 7 days
- 8 to 21 days (about 2 or 3 weeks)
- 22 to 90 days (about 1 to 3 months)
- 91 to 180 days (about 3 to 6 months)
- Important repairs are still not finished
- I do not intend to repair or replace those parts of the house

Q3.32 For your house, what is the approximate total value or COST to repair all damage caused by the August quake (in US dollars)?

- \$0 to \$500
- \$501 to \$1,000
- \$1,001 to \$5,000
- \$5,001 to \$15,000
- \$15,001 to \$25,000
- More than \$25,000

Q3.33 Please share anything else you think we should know about how the August 24, 2014 earthquake affected your Napa area house:

Q3.34 You're almost done! This last part of the survey asks about any strengthening or earthquake retrofit work that might have been done to the house before the August 24, 2014 earthquake. Before August 2014, had there been any MAJOR REMODELING done to the house? (By major we mean projects that changed the building itself, such as new walls, windows, or adding another room, not just carpeting, lighting, or paint).

- No
- Yes
- IF YES, please enter the most recent year that significant work was done: _____
- Don't Know

Q3.35 As far as you know, has the house ever been specifically RETROFITTED for earthquakes?

- Yes
- No
- Don't Know

Q4.1 As far as you know, has any of the following specific kinds of REMODEL WORK been done to the structure of the house in the past twenty years? Please do your best to check all that apply.

- Improving or finishing an original basement
- Creation of new basement space (digging out)
- Replacing some or all of the foundation
- New connections from the foundation to the wood framing, such as bolts or steel brackets (see picture)
- Remodeling of basement or crawl space walls (including new plywood, inside walls, or drywall)
- Adding a new frame around the garage door, a new garage, or an attached carport
- Adding a new porch or replacing an existing porch
- Other - please describe: _____
- None of the above

Q4.2 We recognize there could be many REASONS why houses may not have been retrofitted for earthquakes and not all houses need retrofitting. Please tell us more by choosing whether each statement is important or not to your situation.

	Important	Not Important	Not Applicable
I'm not sure I've got the skills to manage that kind of project	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I want to but it's too expensive or I can't figure out how to pay for it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I don't trust what contractors or engineers recommend	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I'd like to but haven't been able to convince my co-owners	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I've tried to learn more but information is hard to find or confusing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Not sure what is involved	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My homeowners insurance will cover any costs to repair or rebuild	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I already have earthquake insurance on the house	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Not worth it -- it costs more than it would help	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The house is new enough that it doesn't need it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Not necessary -- the risk isn't that big	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Haven't really thought about it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other - please describe:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q4.3 Following this survey, visit Earthquake Brace + Bolt to learn more about what can be done to strengthen your house. Property owners in your area may qualify for an incentive worth up to \$3,000 to do retrofit work.

Q5.1 Please tell us more about what KIND(S) of strengthening work may have been done to different parts of the structure BEFORE the August 2014 quake. Read each item below carefully and check all that apply.

- Plywood or Oriented Strand Board (OSB) sheets was added to the basement walls
- Plywood or OSB was added to the garage walls
- Plywood or OSB was added to the crawl space walls
- Anchor bolts, bracing, or foundation plates were installed in the crawl space
- The garage structure or frame was made stronger
- The chimney was strengthened, braced, or removed
- FEMA flood retrofit
- Other - please describe: _____
- None of the above

Q5.2 Was the work you just described, if any, done while YOU or a family member were the owners?

- Yes
- No
- I don't know who owned the house when the work was done

Q5.3 Please indicate WHO DID THE WORK on the retrofit. (This is the person or people that physically did the work, not who paid for it.)

- Owner, family member, or friend (Do it Yourself, "DIY")
- Paid contractor
- Don't Know
- Other - please describe: _____

Q5.4 Was a BUILDING PERMIT involved in doing the work? (Note: Permits are generally not required for retrofit work.)

- Yes
- No
- Don't Know

Q5.4 Was any of the work DESIGNED by an engineer?

- Yes
- No
- Don't Know

Q6.1 Since the August 2014 earthquake, have you done any of the following kinds of things as part of your recovery? (Check all that apply)

- Called or visited a FEMA assistance center
- Applied for a Small Business Administration (SBA) loan
- Applied for a home equity or new loan in order to do repairs
- Received direct help from a community or charity organization (for example, the American Red Cross)
- Submitted an insurance claim -- if so, please enter the insurance provider: _____
- Other -- please describe: _____
- None of the above

Q6.2 Since the August 2014 earthquake, have you taken any of the following ACTIONS to protect your house or assets from future earthquakes?

- Sought information about what can be done to strengthen my house or avoid future damage
- Made plans for or begun new retrofit work
- Sought out information about earthquake insurance
- Considered selling or relocating
- Other -- please describe: _____
- None of the above

Q6.3 Congratulations -- You've finished the survey questionnaire! The information you've contributed is so valuable, CEA is offering a \$25 Gift Card to the first 500 eligible participants. If you are eligible to receive a gift card for your participation, you must provide your name and a valid mailing address below. If you do not provide this information, your survey will be submitted anonymously and you will not receive a gift card even if you are otherwise eligible. All information you submit will be kept confidential and used only for research purposes and for sending any gifts for which you qualify. Gift card winners will be notified by mail.

First Name
Last Name
Address
City
State
Postal Code

Q6.5 Finally, are you INTERESTED in learning more about retrofits and having the structure of your house inspected by an engineering professional? If so, consider participating in follow up research that is aimed at improving retrofit techniques and assistance programs. We are particularly interested in houses that were retrofit before the August quake and older houses (built before 1960). The inspection

visit would take place mostly outside or underneath the house, and be scheduled at a time when you or someone you trust is at the house.

If you are selected for and agree to a site visit, you can receive an additional \$50 Gift Card!

By entering the personal information below, I agree to be contacted by a representative of CEA based on the information collected. Giving false information on purpose would make me ineligible for a site visit or second gift card. There is no obligation to participate. Remember, CEA will not share this information or use it to contact you for any other reason except this research.

Best Phone Number for Contacting You:

Email address:

END OF SURVEY MESSAGES (Intro paragraph versions differ by exit type):

Thank you for taking the time to find out more about this research. This study is aimed at persons who own or are related to someone who owns a house located in a specific area.

Thank you for your time. We cannot collect information for this study without a valid Napa area address. If you arrived at this screen in error, please try to start again.

Thank you for taking time to participate -- Your input is very important!

Here are four other things you can do right now:

1. Refer neighbors and friends to try the survey before March 15th, 2015 at: eqsurvey.org.
2. Visit [Earthquake Brace + Bolt](#) to learn more about what can be done to strengthen your house. You (or the property owner) may qualify for an incentive worth up to \$3,000 to do retrofit work.
3. Did you know that your homeowners insurance won't cover earthquake damage? The [CEA website](#) shows policy options to cover the costs to rebuild your house, protect your belongings, or pay for emergency shelter. Affordable and effective earthquake insurance is also available for renters!
4. Visit the [CEA website](#) to learn how earthquake insurance works and can help you.

APPENDIX D – PHASE 2 INTERVIEW GUIDE.

CEA South Napa Home Impact Study

Phase 2 Site Visit Interview Guide

I would like to get started on the interview now, is that ok?

A. AUGUST 24th PERSONAL EXPERIENCES

Let's start with what happened in the August 2014 earthquake. I've read through some of the things you answered in the survey, so we don't have to start from scratch, but we can go over things in more detail.

1. Who, if anyone, was in the house at the time?
2. What, if anything, did you or the others **do during** the shaking?
3. What did the house **look like** once the shaking stopped?
4. What did you **do next**?

B. DAMAGE OUTCOMES & HANDLING OF ANY NEEDED REPAIRS

5. You said that ___(paraphrase survey responses)___ happened to the house. Would you say that the earthquake's **overall effect on the house** was Serious, Minor, or Not much at all?
 - IF MINOR to NO DAMAGE, *skip to Q9*
 - IF MEDIUM to SERIOUS DAMAGE, continue here:

So, one thing we're trying to understand is what homeowners like you go through in terms of doing repairs and making decisions about what to do after an earthquake.

6. Tell me about the **kinds of repair work** that was needed or done since the quake.
7. Did any **challenges** come up in deciding what to do, or was it a relatively straightforward process?
 - Getting information, sources
 - Trust / feelings about whoever did the work
 - Making choices / any work you **decided not to do**, or that's still not done?
8. What did the repairs **cost**?
 - Time spent
9. How did you figure out **how to pay** for it?
 - e.g., Savings, private loans, SBA loan, FEMA grant, borrow from family, combination

C. FINANCIAL ISSUES

9. You said in the survey that the overall cost of the event for your household was in the ___(answer)___ range. What would you put the **actual number** at? Can you tell me more about **any other kinds of costs** you faced, beyond doing any physical repairs? (e.g., a hotel stay, an ER visit, lost work time, extra childcare)
10. I'd like to ask just one or two more questions about finances. First, about how much would you say this house would be **worth**, if you sold it now?
 - **When did you buy** it?
 - Do you own it 100%, or if not, about how much is **left on the mortgage**?
11. Does the value of the house and how much of it you own **play any role** in your deciding what to do about earthquakes, or not so much?

- Alternative / Follow-up: **What else plays a role?** For instance, who's living there, what you can afford, how hard it is to do, whether it's really needed, how old you are, how close to retirement

12. I'm pretty sure from the survey that you *_don't_* have **earthquake insurance**, is that right?

- IF HAVE INSURANCE, is it **through CEA**? IF YES, *skip to END*
- IF NO, continue here:

13. Have you ever **heard anything** about earthquake insurance or looked into it, or has it never come up?

- IF NO, why do you think that is / why not interested
- IF SOUGHT INFO, why and from where / why didn't get it in the end

Now I'm going to ask a couple "what-if" type of questions.

14. About how much, if anything, would you be **willing or able to spend for insurance** coverage? What kind of **terms** would make it seem worth it?

15. About how much, if anything, would you be **willing or able to spend on strengthening** the house?

- What would you spend money on **first**?
- What do you think about doing **both** retrofit work and insurance?

D. HOME SELECTION and PAST RETROFIT DECISIONS

16. Thinking back in time now, did earthquakes ever come up when you were **first looking for** and bought this house?

- IF YES, **why / who** mentioned it: e.g., inspector, real estate agent, broker, seller

17. So far as you know, was any retrofit **work done before you bought it**?

18. Before the August quake, **did you ever consider** strengthening the house for earthquakes, or any other risk like flooding?
- IF NO, skip to Q23
 - IF YES, continue here:
19. Tell me more about the **kinds of earthquake work** you thought about or did.
- What did you end up doing and **why**?
 - IF DECIDED AGAINST WORK, skip to Q23
 - IF YES WORK, continue here:
20. What kind of **steps** were involved?
21. **Who was involved** in thinking through what to do? What was that like?
22. Tell me more about any **challenges** that came up, or was it a relatively straightforward process? **How long** did it take?
23. About **how much** did it end up costing? How did you **pay** for it?
24. This is kind of a funny question, but do you ever **talk about earthquakes with other people**, or about any earthquake upgrading you've done? If so, what do you say? What kind of **words** would you use to describe it?
25. I'm curious about what you think might be the **value of strengthening a house**, both the good and bad / pros and cons?
- e.g., impact on home value, peace of mind, might be damaged anyhow
26. What do you think about the **possibility of other quakes**, esp. much bigger ones, nearby?
27. What do you **wish would happen** in terms of helping homeowners in California better prepare for earthquakes? What's something **realistic** that government can do?

F. NEXT STEPS

Coming back to the present:

28. If you wanted **more information about earthquakes** and your house, who would you ask or where would you look for it?
 - If internet, what **search terms**?
 - If a person, **why them**?
29. What would be some good ways to reach you or get your attention?
30. What are your plans for this house **going forward**?
 - Intentions re: any unfinished repairs
 - Any other steps you're interested in taking re: earthquakes, or not so much?
 - Longer term goals, e.g., leave to children, sell, rent out

DEMOGRAPHICS

Congratulations, we're just about done! The last few questions ask a little more about you. You can come sit here at the computer and answer them yourself, or I can type them in if you want.

31. How old are you (year born)?
32. How long have you been living in CA (year moved year)?
33. What's your highest level of education completed? < HS, HS/GED, associate's degree, college, graduate or prof. degree
34. Level of income (ranges):
35. Are you interested in receiving info on CEA policy offerings or programs?
36. Are you interested in receiving info about the results of this study?

That's it! Thank you for sharing this information.

37. Is there anything else about this topic that you haven't had a chance to say yet?

Before leaving, remember to provide details about gift card process.