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Standard Guide for Property Resilience Assessments¹

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INTRODUCTION

An ASTM standard guide is a compendium of information or series of options intended to increase the awareness of information and approaches in a given subject area. This standard guide, herein referred to as “the guide,” provides an overview of a generalized, systematic approach for conducting a Property Resilience Assessment (PRA) consisting of three stages: Stage 1, identifying the natural hazards likely to affect a property; Stage 2, evaluating the risks posed by those hazards along with the capacity of the property to prepare for, adapt to, withstand and recover from those hazards; and Stage 3, identifying conceptual resilience measures to enhance property-level performance and recovery. Stage 2 of the PRA includes, at minimum, a baseline assessment of safety, damage, and functional recovery time, and a limited consideration of community resilience or other material dependencies, such as the ability of utilities to deliver service to a property following a hazard event.

This guide is not intended to provide a certification of a property as resilient or to characterize a property as compliant with the guide, but rather to outline a flexible approach to facilitate informed decisions at the property level. This guide is not prescriptive and does not advocate a specific analytical methodology for ascertaining the performance of the built environment. In addition, while resilience is understood to be related to sustainability broadly, the scope of this guide is limited as noted herein.

The PRA process includes identifying hazards, evaluating risk, and if necessary, identifying measures to enhance resilience at the property level. According to the National Institute of Standards and Technology (NIST), building performance during a natural hazard event depends on multiple factors, including the original design and current condition and the capacity of the building to resist the effects of the hazards. Risk, as defined by the Federal Emergency Management Agency (FEMA), is the potential for harm or loss resulting from a hazard or threat, and risk is determined by integrating hazard, exposure, and vulnerability. Resilience, as defined by Guide E3341, is the ability to prepare for anticipated hazards, adapt to changing conditions, to withstand and limit negative impacts due to events, and to return to intended functions/services within a specified time after a disruptive event.

Resilience is described by the National Infrastructure Advisory Council (NIAC) in terms of four components: robustness, resourcefulness, recovery, and redundancy. The National Institute of Building Sciences (NIBS) Whole Building Design Guide (1)² describes building-specific considerations within the context of these four components. For example, structural components may relate to both robustness and redundancy. Resilience is also described in Guide E3341 by four general principles: planning and preparation, adaptation, withstanding and limiting impacts, and recovery of operations and function. Elements of this PRA guide are aligned with these concepts in the context of resilience at the property level.

Property-level resilience is affected by broader community resilience and dependencies associated with supporting infrastructure such as availability of water, fuel, power, transportation, communication, and other services. The PRA process includes a limited review of community resilience considerations and material dependencies and highlights the importance of community and infrastructure considerations as potential additional areas of inquiry beyond the scope of this guide. The PRA is a property-level assessment process to inform decision-makers such as real estate investors, owners, operators, lenders, and insurers, with a goal of enhanced property-level resilience leading to improved occupant safety, preservation of property value, reduced disruption, or other user goals. Appendix X11 of this guide provides additional guidance, as well as Guide E3350 and Guide E3130 regarding community-level resilience.

1. Scope

1.1 This guide covers a generalized, systematic approach for conducting a Property Resilience Assessment (PRA) consisting of three stages: Stage 1, identifying the natural hazards likely to affect a property; Stage 2, evaluating the risks posed by those hazards along with the capacity of the target property to prepare for, adapt to, withstand, and recover from those hazards; and Stage 3, identifying potential conceptual resilience measures to enhance property-level performance. The PRA includes, at minimum, a baseline assessment of occupant safety, damage, functional recovery time, and a limited consideration of community resilience or other material dependencies.

1.2 *Background*—The intent of the guide is to increase the awareness of methods to assess property-level multi-hazard risks and property-specific resilience measures that can enhance performance and recovery of the target property, as well as to enhance awareness of the importance of community and infrastructure considerations as potential additional areas of inquiry (beyond the scope of this guide). This guide may be used for a broad variety of structures and infrastructure, though some specialized facilities may require additional expertise. Since the concept of resilience applies broadly beyond climate change considerations and since hazards interact at the property level, the PRA process includes evaluation of a broad range of hazards, including those related to, exacerbated by, and unrelated to climate change.

1.3 *Natural Hazards*—Hazards addressed in this guide include the following:

1.3.1 *Extreme Temperature, Snow, and Hail:*

1.3.1.1 *Extreme Temperature:*

- (1) Cold;
- (2) Heat.

1.3.1.2 *Extreme Snow and Hail:*

- (1) Heavy snow;
- (2) Hail.

1.3.2 *Geologic Phenomenon:*

- (1) Seismic;
- (2) Landslide;
- (3) Land Subsidence;
- (4) Coastal erosion.

1.3.3 *Water:*

1.3.3.1 *Precipitation:*

- (1) Heavy rainfall;
- (2) Drought;
- (3) Wind-driven rain;
- (4) Freezing rain;
- (5) Rain on snow;
- (6) Freeze-thaw.

1.3.3.2 *Flood:*

- (1) Storm surge;
- (2) Coastal flood;
- (3) Riverine flood (fluvial);
- (4) Surface flood (pluvial).

1.3.4 *Wildfire:*

- (1) Flame exposure;
- (2) Blown embers;
- (3) Smoke.

1.3.5 *Wind:*

- (1) Tropical cyclone (hurricane);
- (2) Winter storm;
- (3) Severe thunderstorm and tornado;
- (4) Local or regional wind.

1.4 *Objectives*—The objectives of this guide are to: (1) develop practical and reasonable steps for conducting and preparing PRAs; (2) assist in developing an industry baseline standard for appropriate research and observations; (3) facilitate high-quality standardized PRAs; and (4) establish guidelines by which a provider can communicate observations, opinions, and conclusions to a user in a manner that is meaningful and transparent.

1.5 *Application*—This guide may be used for the purposes outlined herein and by the users defined in 3.2.11 who may obtain a PRA during real estate investment due diligence, development, portfolio risk analysis, climate risk analysis and reporting, natural hazard identification and preparedness, facilities management, capital planning, operations and maintenance, underwriting or financing activities. The purpose, goals, and processes of evaluation outlined within this guide are not limited to any one area, region, or country. The applications for use may vary, including:

1.5.1 *Climate-Related Risk Reporting*—Many organizations and jurisdictions are developing recommendations, guidance, and standards to address climate change-related property physical risks and resilience. As these risks vary by region, it is critical to maintain consistent assessment methodology, terminology, and disclosure-related outputs. Organizations such as, but not limited to, the International Organization for Standardization (ISO), Task Force on Climate-Related Financial Disclosures (TCFD), and International Financial Reporting Standards (IFRS) Foundation have developed recommendations, guidance, and standards to assess, quantify, and mitigate climate-related risks.

1.5.2 *Natural Hazard Risk, Disaster Recovery, and Resilience Assessments*—Many organizations have developed or are developing natural hazard risk, disaster recovery, and resilience assessment guidance. Organizations such as, but not limited to, the Alliance for National and Community Resilience (ANCR), American Society of Civil Engineers (ASCE), Department of Homeland Security (DHS), International Code Council (ICC), Federal Emergency Management Agency (FEMA), National Institute of Building Sciences (NIBS), National Institute for Standards and Technology (NIST), United Nations Office for Disaster Risk Reduction (UNDRR), World Bank Building Regulation for Resilience (BRR), and others, have developed guidance on identifying hazards, evaluating risk, and enhancing resilience.

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² The boldface numbers in parentheses refer to the list of references at the end of this standard.

1.5.3 Complementary Application—This guide, to the extent feasible, is intended to complement existing and future climate and natural hazard-related risk and resilience assessment guidelines, frameworks, and standards to facilitate a consistent approach to evaluating property resilience, regardless of location. This guide is not intended to replace existing guidance or programs. The information generated in a PRA is intended to be supportive of and aligned with those programs, to the extent possible. There is nothing in this guide that would prevent users from requiring more than a baseline PRA to meet their needs as part of the scope of work. Although most of the context of this guide is focused on the United States, the use of this guide is not limited to any one area or country. It should be noted, however, that geographical variances are possible in other regions. This guide is also intended to complement existing property decision-making processes involving existing ASTM standards, including Practice [E1527](#), Guide [E2018](#), and Guide [E2026](#). Refer to [8.3.2.4\(1\)](#) for additional information regarding seismic risk assessment and the PRA.

1.6 Flexibility and Transparency—Depending on the intended application of the PRA by the user, as well as the level of confidence required, the depth of assessment may vary. For example, site selection screening or risk awareness within a portfolio of properties may require less rigor than financial disclosures, risk quantification, and development of site-specific retrofit and resilience strategies. The guide provides flexibility to align with the user's goals and objectives and emphasizes transparency in the depth of assessment engaged and completed by the PRA professional.

1.7 Considerations Beyond Scope—The use of this guide is strictly limited to the scope set forth herein. This guide does not address the following:

- 1.7.1 Hazards and the effects of hazards not listed in [1.3](#).
- 1.7.2 Federal or state, local, tribal, or territorial (SLTT) laws and regulations of building construction or maintenance. Users are cautioned that current federal or SLTT laws and regulations may differ from those in effect at the time of the original construction of the building(s).
- 1.7.3 Advanced (or performance-based) design for resilience and climate adaptation.
- 1.7.4 Socio-economic factors.
- 1.7.5 Transportation and utility infrastructure, except as noted in [6.17](#).
- 1.7.6 Direct human-caused impacts such as terrorism and vandalism.
- 1.7.7 The causes of natural hazards or climate change.
- 1.7.8 Secondary hazards such as pollution and pests which may be present on a local, regional, or national basis.
- 1.7.9 Transitional risks, cultural impacts, environmental justice, or impacts to society in general.
- 1.7.10 Broad sustainability considerations or climate change mitigation-related reporting requirements such as greenhouse gas emission reporting, except as noted in [9.11.8](#) (refer to Guide [E2725](#)) and financial disclosures (refer to Guide [E2718](#)).
- 1.7.11 The PRA is only intended to provide concept-level resilience measures and rough order of magnitude costs. In some cases, additional study or analysis by a qualified profes-

sional may be required following the completion of the PRA to determine the appropriate resilience measures to implement at the target property. Detailed engineering and design drawings and detailed cost estimates are not included within the PRA scope.

1.7.12 This list is not comprehensive, and additional considerations beyond scope are noted in [8.7](#).

1.8 Organization of This Guide—This guide consists of several sections and appendices. The appendices are included for informational purposes only to assist with implementing this guide.

- 1.8.1 Section [1](#) describes the scope.
- 1.8.2 Section [2](#) identifies referenced standards.
- 1.8.3 Section [3](#) provides terminology both unique and not unique to this guide.
- 1.8.4 Section [4](#) sets out significance and use of this guide.
- 1.8.5 Section [5](#) describes qualifications of those conducting a PRA.
- 1.8.6 Section [6](#) contains a summary of the PRA Assessment Methodology and Approach.
- 1.8.7 Sections [7](#) through [9](#) provide in-depth discussion of the three stages of the PRA.
- 1.8.8 [Appendix X1](#) provides a list of hazard-specific and other resilience-related resources.
- 1.8.9 [Appendix X2](#) provides building considerations related to each of the hazards.
- 1.8.10 [Appendix X3](#) provides qualifications of the hazard specialist, if utilized, as noted in [5.2](#).
- 1.8.11 [Appendix X4](#) provides greater detail on user engagement.
- 1.8.12 [Appendix X5](#) provides recommended content of a detailed PRA report.
- 1.8.13 [Appendix X6](#) provides hazard-specific mapping and modeling discussion.
- 1.8.14 [Appendix X7](#) provides further detail on climate and natural hazard maps and models.
- 1.8.15 [Appendix X8](#) provides a discussion of cascading and compounding hazards.
- 1.8.16 [Appendix X9](#) provides example risk and benefit-cost analysis methodologies.
- 1.8.17 [Appendix X10](#) outlines example resilience and adaptation measures for each of the hazards.
- 1.8.18 [Appendix X11](#) provides more information regarding consideration of community resilience.
- 1.8.19 References and citations are provided at the end of the document.

1.9 Units—The values stated in SI units are to be regarded as standard. The values given in parentheses after SI units are provided for information only and are not considered standard.

1.10 This guide is a compendium of information. *ASTM guides are intended to increase the awareness of information, approaches, and existing standards in a given subject area. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the*

professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title means only that the document has been approved through the ASTM consensus process.

1.11 This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.

1.12 This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.

2. Referenced Documents

2.1 ASTM Standards:³

- [E631 Terminology of Building Constructions](#)
- [E1527 Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process](#)
- [E2018 Guide for Property Condition Assessments: Baseline Property Condition Assessment Process](#)
- [E2026 Guide for Seismic Risk Assessment of Buildings](#)
- [E2114 Terminology for Sustainability](#)
- [E2432 Guide for General Principles of Sustainability Relative to the Built Environment](#)
- [E2557 Practice for Probable Maximum Loss \(PML\) Evaluations for Earthquake Due-Diligence Assessments](#)
- [E2718 Guide for Financial Disclosures Attributed to Climate Change](#)
- [E2725 Guide for Basic Assessment and Management of Greenhouse Gases](#)
- [E3032 Guide for Climate Resiliency Planning and Strategy](#)
- [E3130 Guide for Developing Cost-Effective Community Resilience Strategies](#)
- [E3341 Guide for General Principles of Resilience](#)
- [E3350 Guide for Community Resilience Planning for Buildings and Infrastructure](#)

2.2 Other References:

- [ASCE 7 Minimum Design Loads for Buildings and Other Structures](#)
- [FEMA P-58 Seismic Performance Assessment of Buildings, Methodology and Implementation](#)
- [FEMA P-2090/NIST SP-1254 Recommended Options for Improving the Built Environment for Post-Earthquake Re-occupancy and Functional Recovery Time](#)

2.2.1 Refer to [Appendix X1](#), [Appendix X7](#), [Appendix X8](#), [Appendix X9](#) and References for additional guides, resources, and references.

3. Terminology

3.1 *Definitions*—For terms related to building construction, refer to Terminology [E631](#). For terms related to sustainability relative to the performance of buildings, refer to Terminology [E2114](#).

3.1.1 *acute risk, n*—those risks arising from event-driven hazards, including increased severity of extreme weather events, such as cyclones, hurricanes, or floods.

modified from TCFD (2)

3.1.1.1 *Discussion*—For example, acute risks may result from extreme weather events, earthquakes, wildfire, etc.

3.1.2 *adaptation, n*—the risk treatment and mitigation actions undertaken to reduce the adverse consequences of natural hazards, as well as to harness any beneficial opportunities; adjustment or preparation of natural or human systems to a new or changing environment which moderates harm or exploits beneficial opportunities.

modified from E3032

3.1.3 *adaptive capacity, n*—the ability of a system to adjust to natural hazards (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with consequences.

modified from E3032

3.1.4 *building code, n*—a code applicable to buildings, adopted and administered with the primary intent of protecting public health, safety, and welfare.

E631

3.1.5 *building envelope, n*—the outer elements of a building, both above and below ground, that divide the external from the internal environments.

E631

3.1.6 *building performance, n*—the behavior in service of construction as a whole, or of the building components.

E631

3.1.7 *building systems, n*—interacting or independent components or assemblies, which form single integrated units that comprise a building and its site work, such as, pavement and flatwork, structural frame, roofing, exterior walls, plumbing, HVAC, electrical, etc.

E2018

3.1.8 *built environment, n*—structures, infrastructure, and landscapes constructed or modified for human purposes.

E2432

3.1.9 *chronic risk, n*—physical risks that refer to impacts from longer-term hazard conditions.

modified from TCFD (2)

3.1.9.1 *Discussion*—For example, chronic risks may result from changing weather patterns, sea level rise, and similar physical risks that do not result from a distinct event.

3.1.10 *commercial real estate, n*—any real property except a dwelling or property with no more than four dwelling units exclusively for residential use (except that a dwelling or property with no more than four dwelling units exclusively for residential use is included in this term when it has a commercial function, as in the construction of such dwellings for profit).

³ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.1.10.1 *Discussion*—This term includes, but is not limited to, undeveloped real property and real property used for industrial, retail, office, agricultural, other commercial, medical, or educational purposes; property used for residential purposes that has more than four residential dwelling units; and property with no more than four dwelling units for residential use when it has a commercial function, as in the building of such dwellings for profit.

E1527

3.1.11 *community resilience*, *n*—the ability of a community to anticipate, prepare for, and adapt to changing conditions, and withstand, respond to, and recover rapidly from disruptions.

modified from E3130

3.1.12 *dependency*, *n*—reliance of physical or social systems on other physical or social systems to function or provide services.

E3350

3.1.12.1 *Discussion*—A dependency is considered a unidirectional relationship between two systems where the operation of one affects the other. An interdependency is a bidirectional relationship between two systems where the operations of each affect the other.

3.1.13 *due diligence*, *n*—the process of inquiring into the characteristics of commercial real estate or other conditions, usually in connection with a commercial real estate transaction.

modified from E1527

3.1.14 *emission pathways*, *n*—modelled trajectories of global anthropogenic emissions over the 21st century.

IPCC (3)

3.1.15 *exposure*, *n*—the presence of people, infrastructure, housing, production capacities, or other tangible assets in hazard-prone areas.

modified from UNDRR (4)

3.1.16 *functionality*, *n*—a measure of how well a building or lifeline infrastructure system operates, delivers its required services, or meets its intended purpose.

FEMA P-2090/NIST SP-1254

3.1.17 *functional recovery*, *n*—a state in which a building or infrastructure system can be maintained or restored, to safely and adequately support the basic intended functions associated with the use or occupancy of the building, or the service level of the infrastructure system.

modified from FEMA P-2090/NIST SP-1254

3.1.17.1 *Discussion*—As defined in FEMA P-2090/NIST SP-1254, functional recovery is achieved when “basic intended functions” are achieved, which could be less than full pre-hazard functionality, but more than what would be considered the minimum sufficient for re-occupancy of buildings. According to Guide **E3350**, time to recovery of function can be measured at various functional levels, such as minimal, functional, and operational.

3.1.18 *hazard*, *n*—an event or condition that may cause injury, illness, or death to people or damage to assets.

U.S. Climate Resilience Toolkit (5)

3.1.19 *impacts*, *n*—effects on natural and human systems that result from hazards.

U.S. Climate Resilience Toolkit (5)

3.1.20 *infrastructure systems*, *n*—physical networks, systems, and structures that make up transportation, energy, communications, water and wastewater, and other systems that support the functionality of community social institutions.

modified from E3350

3.1.21 *maladaptation*, *n*—actions that may lead to increased risk of adverse climate-related outcomes, including via increased greenhouse gas (GHG) emissions, increased vulnerability to climate change, or diminished welfare, now or in the future.

modified from IPCC (3)

3.1.22 *material*, *adj*—that which is pertinent to the objectives of the assessment and which a reasonable observer would expect to influence the judgments and actions of any party to the assessment.

E2018

3.1.23 *mitigation*, *n*—attempts to lower or compensate for risks from natural hazards, weather/climate related events including flood, fire, landslides, drought, extreme temperature, sea level rise and storms, etc.

modified from E3032

3.1.23.1 *Discussion*—In the climate change context, mitigation (often referred to as climate mitigation) can also mean processes that reduce the amount and speed of future climate change by reducing emissions of heat-trapping gases or removing them from the atmosphere **(5)**.

3.1.24 *observation*, *n*—the visual survey of items, systems, conditions, or components with ready access and easy visibility during a walk-through survey of the property.

modified from E2018

3.1.25 *observe*, *v*—to conduct an observation pursuant to this guide within the context of easy visibility and ready access.

modified from E2018

3.1.26 *ready access*, *n*—describes areas of the property that are promptly made available for observation by the field observer at the time of the walk-through survey and do not require the removal or relocation of materials or personal property, such as furniture, floor, wall, or ceiling coverings, and that are safely reached in the opinion of the field observer.

modified from E2018

3.1.27 *Representative Concentration Pathways (RCPs)*, *n*—scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases and aerosols and chemically active gases, as well as land use/land cover, with the word “representative” signifying that each RCP provides only one of many possible scenarios.

modified from IPCC (3)

3.1.28 *resilience*, *n*—the ability to prepare for anticipated hazards, adapt to changing conditions, to withstand and limit negative impacts due to events, and to return to intended functions/services within a specified time after a disruptive event.

E3341

3.1.29 *Shared Socioeconomic Pathways (SSPs)*, *n*—scenario pathways developed to complement the Representative Concentration Pathways (RCPs).

3.1.29.1 *Discussion*—By design, the RCP emission and concentration pathways were stripped of their association with a certain socio-economic development. Different levels of emissions and climate change along the dimension of the RCPs can hence be explored against the backdrop of different socio-economic development pathways (SSPs).

modified from IPCC (3)

3.1.30 *stressor, n*—a changing condition that negatively affects system performance over time.

E3341

3.1.31 *vulnerability, n*—the propensity or predisposition to be adversely affected, encompassing a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.

modified from IPCC (3)

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *damage assessment, n*—an evaluation of expected or anticipated damage to the property relative to each identified hazard, expressed qualitatively or quantitatively, which is part of the Stage 2 consideration.

3.2.2 *field observer, n*—the professional who conducts the site visit and gathers property-specific information.

3.2.3 *hazard screening reviewer, n*—the professional who reviews the output of the mapping and modeling producer to evaluate the findings, and who may reference federal, state, local, tribal, or territorial (SLTT) maps and models, in addition to the original output of a mapping and modeling producer, to confirm or elaborate upon initial screening findings.

3.2.4 *hazard specialist, n*—a professional with relevant expertise and experience related to the relevant physical hazard in the built environment, as specified in **Appendix X3**.

3.2.5 *mapping and modeling producer, n*—the entity providing the natural hazard and climate risk maps, models and other hazard information for the property location utilizing proprietary data sources as well as public sources including academic, governmental, or government-related sources.

3.2.6 *PRA professional, n*—the individual that both exercises responsible control over the field observer, discussed in **5.2.4**, and who reviews the PRA prior to delivery to the user.

3.2.7 *provider, n*—entity or organization that provides the PRA report and is responsible for the findings.

3.2.8 *recurrence interval, n*—a measurement that uses historical data to predict the probability of a hazard with a certain intensity occurring within a specified period of time.

3.2.8.1 *Discussion*—Assessment methodologies for different hazards may use different terms for the concept of recurrence interval, including return period and repeat interval.

3.2.9 *safety, n*—the extent of human exposure to conditions that would reasonably be expected to directly result in imminent loss of life or severe debilitating injury due to failure of building systems as a consequence of projected natural hazard events.

3.2.9.1 *Discussion*—Safety as used in the PRA should consider the following:

(1) For example, consequences such as the collapse of structural or nonstructural building components; inability to maintain appropriate temperatures during extreme heat or cold events; absence or failure of backup generators; and impacts to ingress or egress to the target property that might be reasonably expected to result in loss of life or severe debilitating injury.

(2) Injuries that would be expected to require skilled medical attention within 24 h of the injury for the person to survive would typically be considered to represent an imminent loss of life, while severe debilitating injuries would include injuries that result in life-changing infirmity or disability.

(3) Safety, damage and loss of functionality are related but should be considered independently. A building with slight damage or loss of functionality may pose material safety risks, while a building with significant impacts may not result in unsafe conditions.

3.2.10 *time horizon, n*—the time period or periods in years considered by users to establish short-, medium-, and long-term targets for planning processes and goals.

3.2.11 *user, n*—the user is the party for whom the PRA is performed and who fulfills the user responsibilities outlined herein.

3.2.11.1 *Discussion*—A user may include, without limitation, a potential purchaser of a property, a potential tenant of a property, an owner of a property, an investor, insurer, lender, or property manager.

4. Significance and Use

4.1 This guide is intended for use on a voluntary basis by parties such as real estate investors, owners, operators, lenders, and insurers (users) who wish to better understand the natural hazards, including those made more extreme by climate change, that may be affecting a property. A user may include a purchaser, tenant, owner, investor, lender, developer, designer, building professional, or property manager of the target property. This guide outlines procedures for conducting a PRA for specific users, considering the user's requirements.

4.2 *Uses*—This guide may be used for the purposes outlined above and by the users defined in **3.2.4** who may obtain a PRA during real estate investment, development, risk management and reporting, facilities management, capital planning, operations and maintenance, underwriting or financing activities. There is nothing in this guide that would prevent a user from requiring more than a baseline PRA to meet its needs as part of its scope of work or approval process.

4.3 *Types of Investigations*—This guide provides suggested approaches for the performance of the PRA. A user may contract for Stage 1 only in a Stage 1 PRA, or the entire process from Stage 1 through 3. A user may also contract for a PRA for a single building, multiple buildings, or a portfolio of properties (see **6.3**). Although much of the PRA guide is directed to the PRA process for existing buildings, the PRA process can also be applied to planned development, new construction, and substantial renovation projects assuming sufficient design detail is provided. In addition, this guide may be used for a broad variety of structures and infrastructure, though some specialized facilities may require additional expertise.

4.4 Application and Temporal Relevance of Report—The user should only rely on the PRA for the specific purpose that it was intended and upon confirmation that the target property is in the condition it was at the time of assessment and that the considerations evaluated within the PRA have not materially changed. In addition, due to the evolving nature of climate conditions and ongoing operations and maintenance considerations, a PRA has a limited time of effectiveness. A PRA over 12 months old, or a PRA for a target property impacted by a significant hazard event or subject to significant updates to natural hazard resources (such as flood maps) since the PRA was issued, should no longer be considered reliable unless a PRA professional has determined that the above resulted in no material changes and the PRA remains valid. The intent of this guidance is not that users would need to maintain a current PRA on file annually, but rather that if decisions are being made, a PRA older than 12 months may not be reliable.

4.5 Availability of Information—This guide recognizes that a provider's opinions and observations may be affected by or contingent on information that is readily available for the provider during the PRA process. For instance, a provider's observations may be affected by the number of people using the building or the availability of property management to provide information, such as detailed building construction information, elevation certificates, or construction documents.

4.6 Property-Specific—PRAs are property-specific in that they relate to a single property, multiple improvements at a single site, or a portfolio of properties. While the evaluation practices in this guide are generally property-specific, there is nothing in this guide that would prevent a PRA professional from conducting a hazard screening of a portfolio of properties in Stage 1. Properties selected for Stages 2 and 3 should then receive individual PRA reports, as further discussed in 4.7.3 and 6.3.

4.7 Principles—The following principles are an integral part of this guide and should be referred to in resolving any ambiguity or exercising such discretion as is accorded to the user or the provider. The principles should also be used in judging whether a user or provider has conducted an appropriate PRA.

4.7.1 Uncertainty Not Eliminated—No assessment can fully quantify or wholly eliminate uncertainty regarding the hazards and potential risks to a property, especially with respect to estimates of future climate conditions. The successive stages of investigation described in this guide are intended to reduce, but not eliminate, uncertainty. This guide acknowledges the reasonable limits of time and cost related to a selected stage of assessment.

4.7.2 Not Exhaustive—There is a point at which the cost of gathering information outweighs the usefulness of the information and, in fact, may be detrimental to the orderly completion of transactions within the resources available to support the investigation. This guide acknowledges this and suggests that a balance be sought between the competing goals of limiting the costs and time demands versus limiting the resulting uncertainty by acquiring as much information as possible.

4.7.3 Assessment Scope—Not every property warrants the same extent of assessment. Consistent with good commercial or customary practice, choosing the appropriate scope of assessment is guided by the type and age of the target property subject to assessment, the resources and time available, the anticipated hazards and risks, the expertise and risk tolerance of the user, and the information developed during the PRA. Users may choose to work with a PRA professional to conduct Stage 1 PRA screenings of a portfolio of properties, and then over time, complete Stage 2 and 3 of the PRA process only for those sites that are identified as a concern based on the user's purposes and risk thresholds. This guide provides flexibility to align with the user's goals and objectives and emphasizes transparency in the depth of assessment engaged and completed by the PRA professional. Additional information is provided in [Appendix X4](#).

4.7.4 Subsequent Use of the PRA—This guide recognizes that assessments of buildings based on the approaches discussed herein may include information that subsequent users will want to use to avoid undertaking duplicative investigations. Consequently, usage of prior reports is based on the following principles that should be adhered to in addition to the specific procedures set forth in this guide.

4.7.4.1 Use of Prior Information—Information contained in prior reports may be helpful to assist in understanding the target property and planning the current PRA but should serve only as an aid to the provider and should be verified during completion of a current assessment. Prior PRAs should not be used without current investigation of conditions likely to affect the findings, as discussed in 4.4.

4.7.4.2 Use of Prior Assessments—Objectives, information, and evaluation methods may change over time. A prior PRA prepared for specific stages of assessment may be used in its entirety, without regard to specific procedures set forth in this guide, if, in the judgment of the PRA professional, the prior report was prepared meeting or exceeding the requirements of the current version of this guide and the PRA considerations are not likely to have changed materially since the prior report was prepared. In making this judgment, the PRA professional should consider the scope and limitations of the prior report, and any new information related to the hazards, building or target property, as well as current site conditions.

4.7.4.3 Actual Knowledge Exception—If the user or the PRA professional has actual knowledge that the information being used from a prior PRA is not accurate or suspected of being inaccurate, then such information from a prior report should not be used.

5. Roles and Qualifications

5.1 Individuals Involved and Their Roles—This section outlines the individuals involved and their roles.

5.1.1 The user is the party for whom the PRA is performed and who fulfills the user responsibilities outlined herein.

5.1.2 The provider is the entity or individual preparing the PRA and is responsible for the findings.

5.1.3 The mapping and modeling producer is the entity providing the natural hazard and climate risk maps, models and other hazard information for the target property location.

utilizing proprietary data sources as well as public sources including academic, governmental, or government-related sources as described in Section 7.

5.1.4 The hazard screening reviewer reviews the output of the mapping and modeling producer to evaluate the findings. The hazard screening reviewer may reference federal, state, local, tribal, or territorial (SLTT) maps and models, in addition to the original output of a mapping and modeling producer, to confirm or elaborate upon initial screening findings.

5.1.5 The field observer conducts the site visit and gathers property-specific information.

5.1.6 The PRA professional oversees the PRA process and the selection of the hazard screening reviewer, field observer, and hazard specialists, as needed. The PRA professional determines whether each subsequent step in the PRA process (as outlined in Section 6 Assessment Methodology and Approach) is needed.

5.1.7 The hazard specialist provides specific expertise on the hazards of concern or resilience measures at a property or both. Qualifications of the hazard specialist are outlined in [Appendix X3](#).

5.1.8 The hazard screening reviewer, the field observer, and the PRA professional may be the same professional.

5.2 The competency of the professionals involved is highly dependent on many factors that may include education, training, experience, certification, or professional licensing/registration, or a combination thereof. It is the intent of this guide to identify factors that should be considered by the user when retaining a provider to conduct a PRA and by the provider in selecting the appropriate hazard screening reviewer, field observer, PRA professional, and hazard specialist, as needed. No standard can be designed to eliminate the role of professional judgment, competence, and experience during assessment of the hazard. Consequently, the qualifications of the team involved are critical to the performance of the PRA and the resulting PRA report. Therefore, the PRA report should include a statement of qualifications of the key team members involved.

5.2.1 Appropriate qualification levels may vary for different assessments depending on such factors as asset type and scope (for example, size, age, and complexity) and hazard type. The purpose of the PRA is to serve the specific needs of the user.

5.2.2 The level of certainty of the findings may be commensurate with the level of expertise involved in conducting the PRA.

5.2.3 *Hazard Screening Reviewer Qualifications*—The hazard screening reviewer assigned by the PRA professional to review the mapping and modeling producer outputs will most likely be a single individual having a general, well-rounded knowledge of geographic information systems (GIS), natural hazard and climate change risk maps and models, the interpretation of outputs from such maps and models, and the general concepts of building vulnerability and resilience. The hazard screening reviewer should have a working knowledge of hazard models and be able to interpret the applicability of hazard data at the property level to account for data age, spatial and temporal resolution, and inaccuracies or uncertainties in spatial data or site configuration with respect to the hazard. The

hazard screening reviewer should be able to guide other members of the project team on the interpretation, limitations, and application of the hazard data.

5.2.4 *Field Observer Qualifications*—The field observer assigned by the PRA professional to conduct the site inspection, if required as discussed in 6.6, will most likely be a single individual having a general, well-rounded knowledge of pertinent building systems and components and the concepts of building performance or building resilience, or both. However, a single individual may not have knowledge, expertise, or experience with all building types, building systems, hazard types, and resilience considerations, which are applicable in all locales. The field observer should also be capable of observing the surrounding environment with regards to existing resilience measures (for example, levees, seawalls, or retention ponds), if readily observable. For certain hazards of concern or building types, a field observer with additional experience or qualifications should be selected by the PRA professional, or a hazard specialist, such as an expert in floodproofing or evaluating roofing systems for wind resistance, etc., should accompany or direct the activities of the field observer during the site visit.

5.2.5 The decision to supplement the field observer with hazard specialist(s) should be made by the PRA professional in accordance with the hazard of concern and level of risk posed by that hazard, the potential or expected vulnerability of the target property, the age of improvements and availability of building plans, expertise of the field observer and PRA professional, and related considerations. If hazard specialists are not utilized in the completion of the PRA, this should be stated. Specific qualifications of the hazard specialist are outlined in [Appendix X3](#).

5.2.6 *PRA Professional Qualifications*—The PRA professional qualifications should be aligned with the hazards of concern or the PRA professional should engage a hazard specialist as necessary. PRA professional responsibilities include instructing and supervising the hazard screening professional and field observer in observations, and performing necessary calculations and assessments based on information gathered during the screening activities and onsite. The PRA professional also may act as the hazard screening professional, field observer, or hazard specialist and may conduct the site inspection. In such an event, the PRA professional should identify these multiple roles in the PRA.

5.3 It is recommended that the PRA professional possess a professional designation in architecture, engineering, or science, along with a minimum of 3 to 5 years of appropriate experience in the building performance, natural hazard mitigation, or building resilience fields. The PRA professional should have experience commensurate with the target property type and scope (size, complexity, etc.), and experience in the evaluation of natural hazards and building resilience.

5.4 *Independence of the Provider*—In the event the hazard screening reviewer, field observer, the PRA professional, or members of the provider's staff are employees of or subsidiary of the user, such affiliation or relationship should be disclosed in the PRA. While the PRA professional is the qualified individual designated to exercise responsibility for the

field observer on behalf of the provider and to review the PRA, the provider is ultimately responsible for the PRA process.

5.5 The user may contract the same provider for a Property Condition Assessment (PCA) and a PRA. It is considered reasonable that the field observer assigned to a PRA may also be the Field Assessor for the PCA, and it is recommended that qualifications for the PRA field observer meet those outlined in Guide E2018, as well as those outlined above. These qualifications also apply in instances where a PCA is not being concurrently performed, and therefore, it is necessary to obtain a current copy of Guide E2018 in order to remain informed about the qualifications outlined therein.

6. Assessment Methodology and Approach

6.1 This guide is organized into three stages: Stage 1, identifying the natural hazards likely to affect a target property; Stage 2, evaluating the risks posed by those hazards along with the capacity of the target property to prepare for, adapt to, withstand and recover from those hazards; and then Stage 3, identifying potential conceptual resilience measures to enhance property-level performance and recovery. Depending on the purpose of the assessment and the results in Stage 1 and 2, a PRA may only include Stage 1, Stage 1 and 2, or the entire process from Stage 1 through 3.

6.2 *Iterative Process*—The decision to move from Stage 1 to Stage 2 to Stage 3 of the PRA is an iterative process made in accordance with the user’s risk appetite discussed in 6.9, and as further described in 6.5, 6.6 and 6.7. The process is iterative in that if in Stage 2 or 3, the PRA professional identifies that additional information is needed from the prior stage, the process will return to that prior stage to gather the needed information. In addition, the decision to move from Stage 1 to Stage 2 depends in part on the nature of the hazards, the user’s risk appetite, and the availability of property information. Depending on the intended application of the PRA by the user, as well as the level of confidence required, the depth of assessment may vary. For example, site selection screening or risk awareness within a portfolio of properties may require less rigor than financial disclosures, risk quantification, and development of property-specific resilience strategies. The guide provides flexibility to align with the user’s goals and objectives and emphasizes transparency in the depth of assessment engaged and completed by the PRA professional.

6.3 *Portfolio Considerations*—In the case of a portfolio, the PRA professional may work with the user to establish a Stage 2 implementation protocol that reflects the user’s risk appetite, risk thresholds, and resilience-based objectives. This may involve Stage 2 site assessments at only the largest properties, only those properties exposed to the most significant Stage 1 hazards, or properties with particular socio-economic issues for tenants, for example. Alternatively, the Stage 2 protocol may involve a risk hierarchy that dictates when the Stage 2 assessment occurs, planning Stage 2 assessments over time with more urgent assessments performed sooner. A target property may be within or be part of a portfolio-wide assessment, or both, and that, depending on their purposes, the user may engage a PRA professional to complete Stage 1 in

alignment with this guidance and pursue the remainder of the PRA assessment at a later date. In this circumstance, reporting should include recommendations to proceed to Stage 2 but indicate that, in accordance with user direction, Stage 2 and 3 were not included in the engagement. If the PRA only includes Stage 1 even though hazards of concern are identified as potentially exceeding the user’s risk appetite, risk tolerance and resilience-based objectives, the assessment should be clearly named a Stage 1 PRA. In contrast, a PRA where Stage 1 identifies no hazards of concern, and therefore, Stage 2 and 3 are not necessary, the assessment will be considered a full PRA.

6.4 The PRA may be conducted for a variety of purposes, as discussed in Section 4. The PRA may be conducted concurrent with the other due diligence assessments that are typically performed, such as Practice E1527, Guide E2018, or Guide E2026; however, users may seek a PRA for purposes other than due diligence, such as capital planning, portfolio risk analysis, climate risk analysis and reporting, and development planning. A PRA is advisory only, to be utilized by the user for the purposes outlined in the unique scope of work and does not constitute a design document.

6.5 *Stage 1*—The first step in conducting the PRA is to identify the natural hazards that may constitute a concern to the portfolio or target property by utilizing publicly or commercially-available natural hazard and climate data or models. Stage 1 also includes verification of initial screening information with other resources, including local or regional hazard maps, models, and data sources, if necessary and where readily available, as further discussed in 7.8.

6.6 *Stage 2*—If the hazards identified in Stage 1 indicate a potentially material adverse impact to the target property, the PRA proceeds to Stage 2 in order to evaluate the risks posed by those hazards along with the capacity of the target property to prepare for, adapt to, withstand and recover from those hazards. The PRA includes within Stage 2, at minimum, a baseline assessment of safety, damage, functional recovery time, and a limited consideration of community resilience or other material dependencies, as further detailed in Section 8. For instances of new development, re-development, or substantial renovations, project documents or construction documents may be reviewed in lieu of an onsite assessment of an existing structure.

6.7 *Stage 3*—If needed based on the findings of Stage 2, Stage 3 identifies conceptual property-specific resilience measures, if such measures are feasible, rough order of magnitude cost estimates, and a list of priority actions and next steps for enhancing the resilience of the target property. Prioritization of resilience measures depends on several key factors, including the criticality of the target property, operational expectations for the target property during a disruption, cost of strategy, feasibility of implementation, implementation timing relative to when the hazard is projected to impact the target property, and a review of the maintenance, capital planning, and future investment needs for the target property. Cost estimates, ongoing operation and maintenance

requirements, and expected performance and recovery upon implementation of the Stage 3 measures are provided in Stage 3.

6.8 Uncertainties—Uncertainties are inherent in many aspects of the PRA. Examples include, but are not limited to, the magnitude and duration of actual hazard events may vary from projections, there may be data gaps, the sophistication of the risk assessment model used may mischaracterize potential impacts, access to community resilience information may be limited, and physical site characteristics may need more detailed studies. Uncertainties associated with each of the Stages are further detailed within the appropriate sections of the guide.

6.9 User Engagement—When initiating a PRA, the user and provider should discuss the physical characteristics and intended function of the target property and agree on resilience-based objectives and risk thresholds related to the target property. Resilience-based objectives and risk thresholds differ depending on property type, occupancy and intended function, geographic location, community resilience considerations, and the user’s needs and priorities. Occupancy considerations may include tenancy, such as low and moderate income (LMI), disabled or elderly residents. Setting resilience thresholds is critical because without such a threshold, resilience improvement projects could be either unnecessarily costly or result in reduced performance (1). User engagement is therefore critical to the PRA process. User risk threshold levels that define further study may also be warranted as these may be lower than the acceptable risk appetite for the target property overall.

6.10 User and PRA Provider Communication—During Stage 1, the PRA professional and user should discuss the available modeling tools and resources that could be incorporated into the PRA, as well as the limitations of the data and modeling. During Stage 2, the PRA professional and user should discuss the results of the Stage 2 assessment and, if applicable, compare the results to the target property’s resilience-based objectives to determine whether a Stage 3 assessment should be completed. During Stage 3, the PRA professional and user should discuss potentially applicable resilience measures and may conduct a benefit-cost analysis to help the user select resilience measures that are consistent with the user’s resilience-based objectives, future hazard planning and capital requirements. To aid in determining the user’s needs, the provider should ask questions as detailed in [Appendix X4](#). Additional information regarding user responsibilities is included in [Appendix X4](#).

6.11 Hazard Selection—The decision of which hazards to assess within Stage 1 should be agreed upon between the user and provider, and it is the responsibility of the PRA professional to confirm the adequacy of the selected hazards. For instance, some users may evaluate seismic hazards independently from the hazards assessed in the PRA. If the PRA professional determines at any time during the PRA process that an additional hazard(s), not originally included in the Stage 1 scope, should be assessed based on site observations or

other knowledge, the PRA professional should inform the user and recommend expanding the PRA to include this additional hazard(s).

6.12 Recurrence Interval, Risk Target and Time Horizon Selection—The decision of which recurrence intervals, risk targets, and time horizons to use for the selected hazards should be agreed upon between the user and provider, and it is the responsibility of the PRA professional to confirm the adequacy of the selected parameters. If the PRA professional determines at any time during the PRA process that the selected parameters are inadequate based on the site observations or other knowledge, the PRA professional should inform the user and recommend changing the recurrence intervals, risk targets, or time horizon. The selection of recurrence intervals for different hazards can impact the likelihood of occurrence of compounding events (for example, precipitation and wind, or heat and drought). Thus, the selection of recurrence intervals for different hazards can impact the resulting risk for different assets due to differences in vulnerability and location. The rationale for such selection should be disclosed as discussed in Section 7.

6.12.1 Selection of Future Emissions Scenarios—The decision of which Representative Concentration Pathway (RCP) or Shared Socio-economic Pathway (SSP) scenarios, if applicable, to be evaluated should be agreed upon by the user and provider (IPCC AR6, 2023 and IPCC, 2022) (3). The rationale for such selection should be disclosed. Note that the recurrence interval of climate events is influenced by the selection of RCPs and SSPs. For example, the change in the return interval for wet and windy events under the low (SSP1-2.6), moderate (SSP2-4.5) and high (SSP5-8.5) emissions scenarios show large variability between CMIP6 models. Under the low and moderate emission scenarios, future changes in recurrence interval are relatively small, but considerably intensified under a high emissions scenario (6). Also, some building codes prescribe certain design level intensities (recurrence intervals) for some hazards like wind and earthquake, which may have building compliance implications.

6.13 User Responsibilities—As discussed above and further detailed in Section 8 and [Appendix X4](#), user responsibilities include communicating with the provider about the purpose of the PRA, the level of detail needed in the report, discussing the resilience objectives of the property, providing relevant documentation, site access, and information from knowledgeable parties. Relevant documentation and interviews with knowledgeable parties are further outlined in Section 8. This PRA guide has been designed for use by many types of potential users allowing for flexibility in approaches with an emphasis on transparency. If a particular community of users, for example, those in commercial real estate finance, would like consistency and comparability of reporting outcomes, certain study parameters including but not limited to the RCPs and time horizons, hazards, return intervals, scoring system, quantitative risk metrics, etc., should be standardized across that community, and requested of the PRA professional within the scope of work.

6.14 Consideration of Property Characteristics—Certain characteristics of a property can provide valuable information when conducting a PRA.



6.14.1 *Occupancy*—A building’s occupancy type has been designated by model building codes to guide provisions for egress, safety, construction type, and fire protection. The International Building Code assigns a Risk Category I through IV to each use and occupancy type to articulate the importance of the building and the risk to the public in the event of significant damage to or failure of the building (7). Design loads generally increase as the Risk Category increases, with Risk Category IV targeted for better performance than Risk Category III, and so on. Depending on the nature of use, the target property may have been designed with increased loads and performance objectives due to the role the property serves in the community.

6.14.2 *Building Code*—The building code in place at the time of construction (and any alterations or changes to governing code or in target property occupancy) along with any material building or fire code violations, should be considered. Whether any alterations or changes in occupancy were permitted and inspected by the jurisdiction may also influence target property resilience. The extent to which particular hazards are addressed in codes varies based on the code edition and the extent to which jurisdictions amend the model codes. Currently, the most widely recognized and adopted set of model building codes that address natural hazard resistance are published by the ICC and are referred to as the I-Codes. These model building codes are updated on a three-year cycle and incorporate current information such as updated wind speed maps, snow load maps and seismic ground motion maps.

6.14.3 *Age*—The age of the structure may be used to interpret common construction practices associated with different occupancy types. In addition, degradation over time can reduce the building’s structural capacity and ability to meet its intended safety and functionality performance objectives, although building maintenance may help counteract the effects of aging. Furthermore, construction methodologies have evolved due to economic changes (relative costs of labor versus construction materials and practices) and to remedy known deficiencies to building durability or structural performance. It is also important to note that degradation or deterioration may be present regardless of building age.

6.15 *Ancillary Structures*—Structures evaluated as part of the assessment that are ancillary to the target property or not intended for human occupation should be identified and discussed in the context of their intended uses, importance to the functionality of the target property, permits and government approvals.

6.16 *Application of PRA in New Construction and Development Planning*—Although the above discussion focuses on conducting a PRA for existing improvements, Stage 1 information can be used to consider planned building attributes relative to the identified hazards in the development planning and design phase. Review of Stage 1 information along with building plans and documents allows for relevant resilience measures to be integrated during design and construction when changes are least costly.

6.17 *Community Resilience Considerations:*

6.17.1 *Property-Level Focus*—Property-level resilience is affected by broader community resilience and dependencies

associated with supporting infrastructure such as availability of water, fuel, power, transportation, communication, and other services. Supporting infrastructure may be external to the target property or within a larger collection of proximate assets with which the target property is associated, such as a campus. Recognizing the differences between property-level, multi-asset-level and community-level resilience, this guide provides a property-level assessment process to inform decision-makers such as real estate investors, owners, operators, lenders, and insurers, with a goal of enhanced property-level resilience leading to improved occupant safety, preservation of property value, reduced disruption, or other user-specific goals. This guide is focused on the property level with a goal of producing informed decisions and enhanced resilience for buildings and associated structures.

6.17.2 *Understanding Interdependencies in Multi-Asset PRAs*—The target property may be part of a larger collection of proximate assets that provide required services by working together under the same jurisdiction. These interdependencies are critical to the resilience of the target property as associated sites; thus, interdependencies should be well defined. This information can be extracted during the user engagement stage, as discussed in [Appendix X4](#). If available, business continuity plans or emergency response procedures should be reviewed to understand the role of the target property in the recovery of the multi-asset site under the relevant business context. At a minimum, physical and operational interdependencies for the target property should be identified. Physical interdependencies include various building services within a site, such as power distribution, telecommunication, and HVAC services. Operational interdependencies are determined by the functional role of the target property and can be client specific. Examples of assets with operational interdependencies include distribution centers in a logistics network, regional fire stations, and buildings in a manufacturing plant.

6.17.3 *Review of SLTT Resources*—Although a full evaluation of community or regional resilience is beyond the scope of the PRA, it is expected, as discussed further in [8.3.2.6](#), that any readily observable or generally known dependencies which would be likely to have a material impact on the target property, such as utilities and other infrastructure, should be disclosed in the PRA. Many SLTT governments have hazard mitigation plans and community resilience plans in place or have conducted community resilience benchmarking to help their communities prepare for and adapt to current and future natural hazard impacts. The PRA professional should perform a limited review of SLTT plans and resilience actions with ready access, where applicable to the target property. Review of these community-wide plans will further the PRA professional’s understanding of the risks to the larger community, including potential disruptions to water, power, fuel, transportation, and telecommunications infrastructure. Additional discussion of community resilience considerations within the PRA process is included in [7.8](#), [8.3.2.6](#), [9.10](#), and [Appendix X11](#).

6.17.4 *Community Resilience Resources*—Guide [E3350](#) presents a process for communities to develop customized resilience plans including establishing recovery and mitigation

for the performance of buildings and infrastructure systems. Users and PRA professionals seeking to develop or understand community resilience planning should refer to that standard. Furthermore, Objective Resilience Policies and Strategies – Manuals and Reports on Engineering Practice 146 (8) presents an overview of recent advances in the objective resilience of critical infrastructure that provides vital services delivering energy, communications, water and wastewater, transportation services, and for supporting financial transactions and supply chains.

7. Stage 1—Hazard Screening and Identification

7.1 Identify Relevant Hazards—The first step in conducting Stage 1 of the PRA is to identify which hazards would be expected to affect a building or portfolio of buildings. Hazard identification should include, but not be limited to, a review of the hazards identified in 1.3 and discussed in 7.6. In Stage 1, hazard models integrating climate model outputs may be used to identify current hazards and project near- and long-term climate futures using different RCP or SSP scenarios. Outputs from hazard models are often used to determine potential near- and long-term property-level, economic or societal risk. The PRA may also use catastrophe (CAT) models, which are probabilistic models that quantify specific hazards in a given region. See Appendix X7 and Appendix X8 for more detail about climate and catastrophe models.

7.1.1 The PRA should use available SLTT and national resources, as appropriate, to identify potentially applicable hazards and their respective frequency and severity. Resources vary widely and may include, but are not limited to maps, studies, data, aerial photography, images, models, tools, web pages, and scientific articles. Ongoing hazard mitigation or climate adaptation programs to improve the resilience of the surrounding community or region may also be referenced in the PRA. Applicable resources are discussed in more detail in Appendix X6 and Appendix X7.

7.1.2 Hazard models may use modeled climate futures derived from projected increases in GHG emissions to assess the exposure of a building or portfolio of buildings to specific hazards. Climate models evaluate changes in hazards such as temperature, precipitation, wind, or extreme events using decades of observed weather to set a historical baseline. Climate models often use scenario analysis for the determination of physical climate hazards based on projected changes in climate over time under different pathways of emissions increases.

7.1.3 While climate models inherently have a degree of uncertainty, scenario analysis and GHG emission pathways (RCPs and SSPs) can inform estimates of future climate conditions or indicate the potential frequency and severity of certain hazards under different emissions-level scenarios (9). Using multiple scenarios affords the user the benefit of a range of outcomes (for example, where the number represents the level of radiative forcing at watts per meter squared); with an upper and lower bound, which is instructive as to the potential hazard intensity and frequency that may be expected. RCP 4.5 and RCP 6.0 are most similar to current emissions trajectories based on global climate policy, but RCP 6.0 data are generally

less available and accessible. RCP 8.5 may most accurately reflect near-term risk because it closely follows historical emissions but represents an upper-bound/high-consequence future for the end of the century.

7.1.4 SSPs are a set of scenarios to describe the different GHG emissions pathways that were developed by the climate change research community to facilitate an integrated analysis of future climate impacts (10). The illustrative pathways were developed as a joint community effort and describe plausible major global developments that could result in increased or decreased emissions trajectories. The SSPs are based on five narratives describing alternative socio-economic developments, including sustainable development, regional rivalry, inequality, fossil-fuel development, and development, and are used in conjunction with RCPs to provide climate scenarios used for analysis.

7.1.5 When comparing multiple hazard models for the same property, it is possible that different ratings may be reported for the same hazard. These differences may result from the models using different RCPs, time horizons, resolution, or supporting SLTT information. When comparing results from different hazard models, the PRA professional, with assistance from the mapping and modeling producers, hazard screening reviewer, and hazard specialists as needed, should compare the type of model used (for example, deterministic or stochastic), resolution, RCP, time horizon, and the quality of the supporting information. Lastly, differences in the ratings systems used by hazard models can result in different ratings for the same hazard (for example, medium versus high risk) and a careful comparison of the rating factors and thresholds used by the models should be conducted. When more than one hazard model is considered and different ratings are reported for the same hazard, the PRA professional should disclose in the PRA report the rationale for selecting the risk rating used. If necessary, the comparison may also be supported by a site inspection to confirm onsite conditions and exposures.

7.2 Associated Risk Levels—Depending on the source of Stage 1 information, Stage 1 may include hazard identification only, or if the models include consideration of vulnerability information related to historic loss information, building type, construction attributes and occupancy, may provide risk ratings or rankings. The PRA professional should select the appropriate Stage 1 tool to meet the goals and needs of the user and disclose the type of reporting utilized (whether hazard-identification only or more complex risk evaluation). In Stage 1, each hazard should be assessed using current and future climate-adjusted hazard risk projections (if included) to the extent reasonably available, so that the PRA professional can identify which hazards potentially exceed the risk appetite, risk thresholds, and resilience-based objectives of the user. The PRA should also indicate if an identified hazard is attributable to an acute shock or chronic stressor. Acute hazards, such as wildfires, hurricanes, tornadoes, floods, and heat or cold waves are sudden, short-term weather events. Chronic hazards, such as long-term temperature increases or decreases, drought, and sea level rise are long-term conditions that can have gradually increasing impacts. To the extent that there are reasonably available data that have been scientifically peer reviewed

made available by a government agency, the PRA should consider compounding and cascading effects as discussed below in 7.7. Additionally, chronic hazards impact acute hazards, and changes in risk may occur over time. The PRA should include documentation that supports a greater understanding of the tools and resources used, and the associated risk rating outputs (see 7.3).

7.3 Disclosures—All providers should include documentation that supports a greater understanding of their tools and associated outputs. While this information should not compromise proprietary methods, it should enable users to be informed of the various data and tools they may rely on. Providers should indicate general methods pertaining to risk rankings, if provided, such as whether they are tied to a specific return interval based on an annualized occurrence or are qualitative in nature. Furthermore, providers should, to the extent reasonably possible, assist users to understand the uncertainty and limitations of the data relied upon and the outputs. Providers should disclose modeling sources, techniques, and modeling strategies as described below. Proprietary algorithms and datasets are permitted; however, providers should identify and describe proprietary algorithms and datasets to the extent reasonable and practical.

7.4 Reporting—Providers should include the following in the PRA report along with the other items outlined in **Appendix X5**:

7.4.1 Type of hazard model or assessment used, for example, government agency, peer-reviewed literature, proprietary; the nature of model used for analysis for each hazard, for example, global or regional, climate projection, stochastic catastrophe model, integrated assessment model (with reasonable disclosure); and describe how the model is validated. A reasonable effort should be made to use the most current model available.

7.4.2 Spatial resolution of the hazard model and the hazard metrics used to describe the intensity of each hazard.

7.4.3 Which hazards were considered, and data sources used for identification for each hazard, for example, specific SLTT or Federal, open-source, proprietary data set (with reasonable disclosure); date range of data used for each hazard; and the uncertainty, limitations, or lack of availability of the data.

7.4.4 The extent to which future climate projections were included in the analysis.

7.4.5 The climate scenario analyses presented, if included, and time frames assessed, for example, RCPs or SSPs, and time horizons.

7.4.6 Hazard recurrence intervals or risk targets considered (for example, 100-year flood or 10 % probability of collapse, etc.).

7.4.7 Frequency and severity for each hazard of concern, if available.

7.4.8 General methods pertaining to the hazard ranking itself, such as whether it is tied to a specific hazard recurrence interval or risk target, frequency and severity, based on an annualized occurrence or is qualitative in nature, and describe how the ranking classes were determined. If available, a minimum of five hazard ranking classes is preferred (for example, low, medium-low, medium, medium-high, high).

7.4.9 If requested by the user or not available, identify hazards omitted from modeling and justification for omission.

7.4.10 The extent to which building characteristics, such as age, construction type, height, occupancy, etc. were considered in the modeling as well as the data points that were used (for example, year of construction, code year).

7.4.11 When more than one hazard model is considered and different ratings are reported for the same hazard, the PRA report should disclose the rationale for selecting the risk rating used.

7.5 Additional Reporting—Providers may also include the following as a best practice:

7.5.1 Input variables included in analysis for each hazard, for example, topography, windspeed (with reasonable disclosure).

7.5.2 The extent to which existing risk mitigation measures, practices, or policies were considered in the risk rating, for example, were not considered, specific building codes evaluated, or specific infrastructure identified.

7.5.3 In-depth discussion of the methods used to validate each hazard, for example, back-testing on historical hazard data such as historical floods or wildfires. To the extent possible, reference data used for validation and statistical or performance metrics used to assess predictive accuracy.

7.5.4 The extent to which community resilience measures were included in the risk rating.

7.5.5 The extent to which site access was considered in the risk rating, for example, flooding of access roads, etc.

7.5.6 Upon request, discuss the expected frequency of the hazard event and the expected severity of the hazard event in a manner understandable and useful to Stage 2 of the PRA and the user.

7.6 Characterize Hazards—The following hazards should be considered in the PRA. While there is no single source for historical and future global climate data, several websites provide information and data on specific weather phenomena. Example sources are listed in **Appendix X1**. The list is not exhaustive, but rather serves as a starting point for further research. The level of specialized knowledge required to use these data varies according to the format in which they are presented, which ranges from online map viewers suitable for generalists to unprocessed raw data that requires considerable experience and expertise. For climate model-based datasets, PRA professionals and users are encouraged to consult **Appendix X6** and **Appendix X7** for more information regarding the hazards and related climate models. The following discussion is intended to raise awareness regarding the hazards listed in 1.3.

7.6.1 Water:

7.6.1.1 Water- and drought-related hazards include those related to precipitation (heavy rainfall, drought, wind-driven rain, freezing rain, freeze-thaw) and flood (storm surge, coastal flood, riverine (fluvial) flood, and surface (pluvial) flood). Water-related hazards associated with extreme temperatures are further discussed in 7.6.4.

7.6.1.2 Precipitation can result in potentially hazardous conditions; for example, intense localized rainfall can trigger pluvial (surface and flash) flooding independent of or in conjunction with

body of water and intense rainfall can saturate soil and trigger landslides. Similarly, sustained moderate-to-heavy rainfall over large regions can trigger fluvial/riverine flooding. Coastal regions can be particularly prone to flooding from high tides and landfalling storms producing storm surge and heavy rainfall onshore. Precipitation and cold temperatures can produce heavy snowfall and structural loading on roofs. Repeated freeze-thaw cycles can also damage building components and systems.

7.6.1.3 Since 1990, a larger percentage of precipitation has come in the form of intense single-day events. The prevalence of extreme single-day precipitation events remained steady between 1910 and the 1980s but has risen substantially since then. Thus, climate change appears to be affecting the intensity and frequency of precipitation (11). Precipitation is highly variable in space, sometimes over short distances, and can also change dramatically from one year to the next due to variability in the frequency and intensity of weather systems. More intense precipitation events may exacerbate coastal flooding in areas subject to sea level rise. Coastal cities are especially vulnerable to flood hazard because of exposure to multiple drivers such as sea level rise, storm surge, river discharge, and precipitation, which can cause groundwater levels to rise. Furthermore, dependence among the drivers can lead to compounding events in which the simultaneous or sequential occurrence of extreme or nonextreme events can lead to an extreme event or impact (12). Evaluating sea level rise and its impact on buildings is critical when considering that numerous major metropolitan areas and commercial centers located in low-lying coastal areas may also be subject to flooding from storm sewer infrastructure.

7.6.1.4 As the climate continues to change, many historically wet areas are likely to experience increased precipitation and increased risk of flooding, while historically dry areas are likely to experience less precipitation and increased risk of drought (13). Many states and local governments include drought in their comprehensive water-management, land-use, and long-term planning strategies and some have separate drought plans. Drought is defined differently in different situations. For example, two months without rainfall during the growing season may result in serious drought conditions for farmers and homeowners in the eastern half of the U.S. The same dry period may be normal for those in the western U.S., where water users may be more concerned with reservoir levels, which in turn are dependent on winter snowpack levels (14). It is also reported that the same region can be both highly exposed to increasing droughts and highly exposed to flooding, as one climate trend is that precipitation tends to fall in fewer, more extreme events, which exacerbates both floods and water stress (11).

7.6.1.5 Different jurisdictions have established regulatory or insurance-based programs to assist in mitigating the financial risk of flooding to the built environment. For example, in the United States, the National Flood Insurance Program (NFIP) is administered by the Federal Emergency Management Agency (FEMA) and provides flood insurance to millions of property owners. FEMA maps are referenced and relied upon by many providers; however, it is recommended that flood risk be

determined by reviewing multiple resources covering the multiple types of flooding and climate change impacts related to flooding, as applicable. Some cities are conducting significant flood risk mapping in their jurisdictions as part of their flood risk planning and it is recommended these resources be reviewed, if available (for example, San Francisco, Boston, and New York City). NFIP information regarding prior flood claims may be available with proper consent as noted at [NFIPservices.floodsmart.gov](https://www.floodsmart.gov).

7.6.2 Wind:

7.6.2.1 Wind-related hazards include tropical cyclone (hurricane, typhoon, tropical storm, and tropical depression), winter storm, severe thunderstorm and tornado, and local and regional wind. Wind damage includes structural failure or damage to building components as well as damage caused by windborne debris.

7.6.2.2 Under the right atmospheric conditions, jet streams can produce damaging downslope winds on the lee side of mountain ranges (15). Downslope winds are often gusty and peak strength occurs near the foot of the mountains, weakening rapidly farther away. They often have local names: Föhn winds in the European Alps, Santa Ana winds in California, and Bora winds along the northeastern shore of the Adriatic Sea. The jet streams slacken in spring and summer and interact with unstable air to drive thunderstorm seasons. Thunderstorms can bring localized, short-duration, yet severe wind events, the most iconic being the tornado. A tornado is a rapidly rotating column of air extending vertically from the surface to the base of a thunderstorm, often with near-surface circulating debris/dust when over land or spray when over water. Tornadoes bring the most extreme and highly localized wind speeds of weather phenomena, often with wind speeds exceeding 500 km/h with a diameter of up to 1.5 km (16).

7.6.2.3 The most damaging winds in the global tropics occur within tropical cyclones—the generic name for hurricanes, typhoons, tropical storms, and tropical depressions. Tropical cyclones strengthen over warm water and rapidly decay at landfall as their energy source diminishes. These storms typically average 200 km to 500 km in diameter and can travel thousands of kilometers and are a significant source of intense precipitation and flooding, dominating extreme rainfall statistics in coastal middle latitude areas (17). Immediate coastal regions are most at risk of tropical cyclone winds, yet inland regions may also be exposed to damaging winds from the strongest storms. For example, it is not uncommon for tropical cyclones to spawn tornadoes when making landfall. Wind from these storms can be responsible for damaging storm surge and wave action along coastlines.

7.6.3 Wildfire:

7.6.3.1 Economic losses from wildfires have dramatically increased in recent years (over \$50 billion in global insured losses between 2011 and 2020, as compared with less than \$10 billion per decade between 1981 and 2010 (18)). There is increasing scientific evidence that anthropogenic (human-caused) climate change may have increased the frequency and severity of fire weather (extreme temperature and aridity), which promotes dry vegetation that fuels fires.

impact of increasing wildfire frequency on the built environment has been exacerbated by the growth in housing density within the Wildland-Urban Interface (WUI), where housing and wildland vegetation intermingle (41 % growth in new homes between 1990 and 2010 (20)). The development of the WUI has increased the potential for urban conflagrations, in which houses become fuel. The combination of climatic and land-use factors makes modeling and mitigating wildfire risk particularly challenging.

7.6.3.2 Various methods have been used to identify existing wildfire risk, with more recent approaches also focusing on projections of fire risk based on changing climate parameters and, in some cases, development patterns (21). The scales of the analyses and associated outputs range from 30 m² grids to as large as 25 km² grids. A detailed treatment of the methodologies, data sources used, inherent assumptions and limitations is included in [Appendix X7](#).

7.6.3.3 Wildfire results in direct, indirect, and cumulative impacts to property, some of which may not materialize until several years after the event. Examples of these impacts include the direct combustion of materials, introduction of soot and ash into the atmosphere and waterways, temporary destruction of forest and urban canopies, burn scars that may later become sites of major erosion due to heavy precipitation (for example, collapse of Pacific Coast Highway in California in 2021). Indirect impacts can also include serious health impacts and the need for increased indoor air filtering due to air quality. The adaptive capacity of the building is an important consideration (for example, is it built to fire-resistant standards) when determining how the wildfire may impact it.

7.6.3.4 While significant attention has been paid to the WUI with respect to adjacent forested land, there have been projections of a shift in wildfire centers based on climate change which may have more intense and frequent fires starting in grasslands within the Great Basin areas and other less “typical” locations (22).

7.6.4 *Extreme Temperature, Snow, and Hail:*

7.6.4.1 *Extreme Temperature*—Extreme variations in temperature, including heat and cold waves, can pose significant risks to property, and consequently to property occupants. Like other physical climate hazards, extreme temperatures can result in severe damage such as causing pipes to freeze and heating systems to fail or overwhelming cooling systems and electrical grids (acute risks). Extreme temperatures can result in spikes in demand for electricity or damage utility infrastructure, resulting in health issues. In the case of low and moderate income (LMI), disabled, or elderly populations, occupants may experience greater impacts from these hazards depending on the population. The risks from temperature can also involve temporal changes in average temperature compared to historical average temperatures (chronic). In the context of assessing temperature-related hazards, both these acute risks and chronic risks are important.

7.6.4.2 Potential damage caused by variations in extreme temperature is, in part, dependent on the construction and resilience of the asset class. To quantify risks from extreme temperatures, it is helpful to use percentile thresholds based on historical temperatures. For example, one definition of “ex-

treme heat” is a day reaching above the 98th percentile of historical daily maximum temperatures (23). Alternatively, the United States Environmental Protection Agency (EPA) defines a “heat wave” as a period of two or more consecutive dates when the daily minimum apparent temperature (the actual temperature adjusted for humidity) in a particular city exceeds the 85th percentile of historical July and August temperatures (1981 to 2010) for that city (24). An important consideration in assessing extreme temperature risk is to consider the broader set of physical risks in the study area. Extreme temperatures are interrelated with many other physical climate risks. An analysis of extreme temperatures should be undertaken not only considering local historical temperatures, but also considering the regional natural and built environment, and projected temperatures due to climate change. In addition, heat conditions can change due to changes in the built environment, such as the addition of large paved areas, etc.

7.6.4.3 *Snow and Hail*—Hail occurs due to convective processes in thunderstorms (25). Hail can damage building components such as windows, HVAC units, and gutters. Hail can also damage roofs, solar panels, and cause water intrusion into a building. Snow can be very variable depending on the location. Snow can also occur even at very low temperatures if there is a source of moisture and force lifting or cooling the air. It is true, however, that most heavy snowfalls occur when there is relatively warm air near the ground, typically –9 °C (15 °F) or warmer since warmer air can hold more water vapor (26). Additionally, increased frequency of snow events may exceed design snow loads for roofs.

7.6.4.4 User engagement is important when considering hail, as building design and layout can influence hail risk tolerance. Although information about past extreme snow and hail events is readily available, it can be difficult to predict hail due to variability associated with convective storms. Also, identifying the precise location of future heavy snow and hail can be challenging, as these events can cover large geographical areas due to a storm’s trajectory and moisture content. Due to the uncertainty associated with the geographic variability of these hazards, the relatively low resolution of screening product outputs, such as county or census tract, is in most cases appropriate for screening these hazards.

7.6.5 *Geologic Phenomenon:*

7.6.5.1 Geologic phenomena include seismic activity, such as tsunami, landslide, land subsidence, and coastal erosion, which are further discussed below.

7.6.5.2 *Seismic*—Seismic activity is considered a potential compounding effect that, when combined with certain hazards, could exacerbate damage. Several industry-accepted methodologies for seismic risk assessment have been developed, and this guide directs users and PRA professionals to those methodologies, as further discussed in [8.3.2.4\(1\)](#).

(1) *Tsunami*—A tsunami is a series of long period ocean waves caused by seismic activity near or under the ocean, and undersea landslides or volcanic eruptions. Strong tsunamis typically consist of multiple waves that rush ashore like a fast-rising tide with powerful currents causing damage to coastal communities and infrastructure. Significant tsunamis mostly occur in association with earthquakes or land subsidence.

subduction zone coastlines, as around much of the Pacific Ocean. Local tsunamis may also be caused by submarine landslides and local fault movement. Resources are available that may mitigate the risk for coastal communities, such as state tsunami maps, ASCE 7-16 Chapter 6 and associated tsunami design geodatabase (<https://asce7tsunami.online/>), seismological networks and sensors, sea level networks, tsunami warning systems, and high-resolution bottom topography.

7.6.5.3 Landslides—The term landslide refers to a wide range of ground movement (for example, rock falls, shallow or deep failure of slopes, and shallow debris flows). Debris flows, also referred to as mudslides, mudflows, lahars, or debris avalanches, are common types of fast-moving landslides. Any natural or human-made processes that steepen slopes or weaken the slope materials can potentially lead to a landslide (27). Earthquakes and rainfall are two primary triggers of landslides. The other factors that can trigger landslides include: (1) erosion by rivers, glaciers, or ocean waves; (2) volcanic eruptions producing loose ash deposits and debris flows; (3) human-made structures stressing weak slopes to failure; (4) excess weight from the accumulation of rain or snow; and (5) wildfires burning vegetation and soil on slopes (28). Landslides are typically assessed at local to regional scales. Increases in the frequency and intensity of extreme precipitation, driven by climate change, can trigger slope instability and ground movement (29). More severe and frequent drought and drought-heavy precipitation cycles triggered by climate change undermine the stability of slopes by triggering the formation and propagation of desiccation cracks in fine-grained soils (30). In coastal regions, sea level rise combined with changes in coastal flooding patterns and wave activity leads to more coastal landslides. Lastly, the melting of permafrost removes ice cohesion, leading to rockfalls and other forms of ground movement.

(1) Currently, no single modeling or monitoring tool or dataset is available that can be used to monitor and map landslides at the property level across the nation. The National Landslide Preparedness Act calls for this type of mapping at the national scale, but a published product will not be available in the near term. The United States Geological Survey (USGS) maintains a national inventory of landslides (31). However, the USGS inventory widely varies in data quality and type. Several states maintain landslide susceptibility maps or inventories, notably Oregon, California, and Washington State.

7.6.5.4 Land Subsidence—Land subsidence is the downward movement of the land surface, which can lead to damage to property, infrastructure (for example, roads, pipelines, levees), and communities. The term subsidence refers to one or a combination of the following processes: (1) compression or compaction of the soil due to the application of external loads, (2) consolidation, which is the time-dependent compression of clays due to fluids being driven out of the voids in the soil, and (3) shrinkage, which is the volume change induced during drying of the soil. Land subsidence is a widespread issue globally, across the United States and in over 30 countries, and can be triggered by natural processes or human activities, or both (32).

(1) The natural drivers of land subsidence include tectonic activities, soil compaction, glacial isostatic adjustment, melting of permafrost, and wind erosion. However, land subsidence is primarily triggered by human activities, including groundwater extraction, oil and gas extraction, mining, and land-use changes. Also, oxidation of soil organic carbon in peats and organic soils and wildfires are among other triggering factors of land subsidence. In the United States, over 80 % of the identified subsidence is attributed to excessive groundwater extraction (33).

(2) Climate change, urbanization, unsustainable farming practices, melting of permafrost, and land-use changes are known to worsen land subsidence and the associated socioeconomic impacts (29). Increases in the frequency and duration of droughts can generate more demand for groundwater extraction, which can result in land subsidence (34). Land subsidence is difficult to monitor since it is a slow and gradual process spanning many years.

7.6.5.5 Coastal Erosion—Coastal erosion is the process by which ocean currents, waves, storm surge, and coastal flooding erode and transport soils and sands along the coast. The extent of coastal erosion primarily depends on the stability of shoreline sediments (for example, induration, slope, etc.), the intensity and frequency of storm waves and surge, and the exposure of coastal lands. As global sea levels rise, the rate of localized coastal erosion is expected to accelerate (35). Coastal regions can be particularly prone to flooding from high tides and landfalling storms producing storm surge and heavy rainfall onshore. Also, rainfall in combination with strong winds can force water into buildings causing damage. By their nature, coastlines are extremely complex and dynamic environments. The type and magnitude of coastal erosion are closely related to coastal exposure and beach setting. Beach setting is the localized geomorphic characteristics of the shore and backshore zones (36).

(1) While significant academic literature exists related to specific coastal areas, public agencies have not developed any one definitive resource or model to describe the current or future risk of coastal erosion associated with specific properties. USGS, NOAA, and FEMA tools and data should be considered when assessing the current and future risk of coastal erosion in the United States.

(2) While development of academic and proprietary models is ongoing, coastal systems are dynamic and complex, which requires multi-variate models with considerable complexity and uncertainty. The resolution of available data and tools varies greatly. Regional screening for potential coastal erosion can be conducted at higher resolution (for example, 20 km or greater); however, more detailed and property-specific assessments may be conducted at finer resolutions such as 1 km to 10 km, if appropriate. The PRA professional should analyze both the immediate risks and the potential future risks when evaluating coastal erosion.

7.7 Compounding and Cascading Weather and Climate Effects—The PRA should consider compounding and cascading effects to the extent feasible. Compounding effects are combinations of weather or climate events that have the potential to cause more severe impacts on infrastructure and communities.

events. Examples include heavy rainfall on saturated ground or on soil compacted due to extended extreme drought, back-to-back winter storms, simultaneous flooding across multiple catchments, or heat waves co-occurring with drought. Compounding effects of less extreme events, such as repeated flooding from nuisance floods, saline incursion into soils and groundwater corroding or otherwise affecting foundations, freeze-thaw action followed by warmer, moister conditions that permit vegetation growth on façades, and material spalling and subsequent rainwater ingress should also be considered. Cascading effects occur when an initial hazard leads to a sequence of effects with consequences of significantly increasing magnitude. For example, extreme precipitation can saturate soil leading to a landslide or mobilizing trees and branches into a river clogging culverts and locally exacerbating flooding. Major challenges of predicting cascading effects are the high complexity, the dependencies, and the increasing uncertainty along the cascade (37). In some instances, this information may be ascertainable in the Stage 1 review; however, modeling complex compounding and cascading effects may not be feasible. The PRA professional should consider that the hazard information available from Stage 1 may not be inclusive of all possible compounding and cascading effects. Additional discussion regarding compounding and cascading effects is provided in [Appendix X8](#).

7.8 Hazard Verification: Stage 1A—Stage 1 should also include verification of initial screening information with other resources, including federal and SLTT hazard maps, models, and data sources, if necessary and where readily available.

7.8.1 Hazard Details—As discussed in [7.1.2](#), the PRA professional should reference available SLTT and national resources, as appropriate, to identify potentially applicable hazards and their respective frequency and severity. SLTT resources may provide greater detail at the property level for some areas. In addition, care should be exercised during Stage 1 to assure the minimum information is provided as required for the performance of Stage 2. Because Stage 1 may not include unique, unusual, or property-specific hazard characteristics, it is possible that more specific hazard identification, not included in Stage 1, may be necessary during the Stage 2 assessment process. For example, the identification of elevated flood risk at Stage 1 will be of limited use in Stage 2 without specific information regarding the depth of predicted flooding.

7.8.2 Community Resilience Considerations—As discussed in [6.17.3](#), any SLTT hazard mitigation plans and community resilience plans should be reviewed, if available, as part of the verification process. The FEMA National Risk Index Social Vulnerability and Community Resilience Scores may provide additional information. Applicable resources are discussed in more detail in [Appendix X6](#) and [Appendix X7](#).

7.9 Uncertainties—Uncertainties are inherent in many aspects of the PRA, including specifically in Stage 1. For example, the magnitude and duration of actual events may vary from projections, along with resulting impacts. Uncertainties may be reduced by more detailed investigations that result in more granular identification of hazards and vulnerabilities. For future climate risk, the IPCC has developed guidance on using

a consistent approach and calibrated language to discuss uncertainties (3). According to the IPCC guidance, it is helpful to provide a level of confidence when discussing findings. The level of confidence is related to the type, amount, quality and consistency of evidence and the degree of agreement among the lines of evidence. A level of confidence is typically expressed using five qualifiers: very low, low, medium, high, and very high. Confidence cannot necessarily be assigned for all findings, and a finding that includes a probabilistic measure of uncertainty does not require explicit mention of the level of confidence. Material uncertainties associated with Stage 1 should be discussed in those instances where they are known and likely to affect the findings of the PRA report.

8. Stage 2: Risk and Resilience Evaluation

8.1 Objective—Risk is determined by integrating hazard, exposure, and vulnerability. Stage 2 provides a risk evaluation, as well as an assessment of the capacity of the target property to prepare for, adapt to, withstand, and recover from the hazards of concern identified in Stage 1. Stage 2 involves the collection and evaluation of property-specific information, such as target property use, emergency preparedness plans, design and construction information to identify and assess the expected (average) damage or vulnerability to acute shocks and chronic stressors, functional recovery time, and safety. The Stage 2 assessment also includes consideration of material dependencies that may affect the target property related to community resilience and critical infrastructure. Uncertainties associated with Stage 2 assessment are further discussed in [8.5](#).

8.2 Assessment Methodology—The Stage 2 assessment typically consists of data collection, field observations, evaluation, and reporting as described below:

8.2.1 Data Collection—The collection and review of existing documentation, interview of key contacts, and site reconnaissance are critical to Stage 2 assessment. Unless otherwise identified herein, all activities conducted during the Stage 2 assessment should comply with the related provisions of the most recent version of Guide [E2018](#).

8.2.2 Stage 1 Report(s)—The Stage 1 report should be reviewed prior to commencement of Stage 2. If additional information or detail, such as hazard frequency or severity information, or higher resolution data, is required for the Stage 2 assessment to be performed, the information should be obtained and incorporated into amended Stage 1 findings, as discussed in [7.8.1](#).

8.2.3 Document Collection—As with other elements of Stage 2, the documents reviewed will vary depending upon the agreed-upon scope of services, objectives of the report, available documentation, and whether it is an existing building or development. The user should provide all available and relevant documents to the PRA professional. The extent of any independent research or document retrieval by the PRA professional should be agreed upon prior to engagement of the work. The following documentation may be useful in an evaluation of the target property:

8.2.3.1 Topographic survey;

8.2.3.2 Geotechnical investigation;

8.2.3.3 Architectural, structural, and mechanical/electrical/plumbing plans for existing improvements;

8.2.3.4 Plans, contracts, budgets, and schedule for improvements under consideration;

8.2.3.5 Emergency preparedness plans;

8.2.3.6 Other existing documentation such as flood elevation certificates, inspection records, property condition assessments, damage and repair estimates, marketing brochures, appraisals, regulatory requirements and records, building permits, base building certificate of occupancy, outstanding and recorded material building and fire code violations, and other documents and information that are likely to be useful in completion of the assessment;

8.2.3.7 Records associated with the impact of prior natural hazard events at the target property (flood damage, wind damage, earthquake damage, etc.) and history of and amount of past insurance claims.

8.2.4 *Interviews*—Interview of the user and key property management or engineering staff can provide useful information concerning past events, planned changes, emergency preparedness, and other issues of concern. Depending on the nature of occupancy, interviews with tenants may also reveal critical information. When included in the Stage 2 assessment, interviews may be conducted orally, via questionnaire, via alternative method, or combination thereof, as appropriate.

8.2.5 *Field Observations*—Construction means and methods, the condition of target property components, building systems and materials, the performance or recovery during previous hazard events, ongoing maintenance, and other factors have the potential to significantly alter a property's ability to respond to a hazard event or chronic stressor. Small differences between building plans and actual implementation of building components can vary and significantly impact building performance. Therefore, field observation should be conducted to review the onsite conditions. The extent of observation, however, will vary depending on issues under consideration. For example, an evaluation of flood hazards is unlikely to benefit from observation of roofing materials. Additional information concerning elements to be observed for the evaluation of various hazards is provided in [Appendix X2](#).

8.2.5.1 *Objective*—The objective of field observations is to collect property-specific data related to the current condition of the relevant components of existing improvements to support the analysis described in [8.3.2](#). This will generally include the observation of building systems consistent with [Guide E2018](#). In addition, the PRA professional or hazard specialist may direct the collection of additional information concerning specific vulnerabilities.

8.2.5.2 *Planned Improvements*—Field observation may not be necessary where existing improvements are not relevant to the assessment; for example, if demolition of existing improvements is planned, or new improvements are in the planning, design, or construction phases, or if substantial redevelopment will incorporate significant modifications to systems, then assessment of existing conditions is not relevant to the extent that those existing conditions will be materially altered or demolished. However, it is recommended that, where possible, a field assessment be completed to confirm the existence of and

correct installation of construction components relative to the target property resilience after completion of the planned improvements.

8.3 *Evaluation and Reporting Methodology*—It is the intent of this guide to provide meaningful information to support the objectives and risk appetite of the user.

8.3.1 *Principles*—The Stage 2 evaluation is generally subject to the principles discussed below.

8.3.1.1 *Limitations*—Certain activities and considerations are beyond the scope of the Stage 2 assessment. Reference [8.5](#) for additional discussion.

8.3.1.2 *Mitigating Factors*—Existing factors, emergency preparedness plans or equipment, and improvements should be considered in the Stage 2 evaluation. For example, existing onsite floodproofing may reduce the potential for damage or provide improved safety or recovery for a flood hazard event. The PRA professional should endeavor to understand all strategies employed at the target property and incorporate any impact to the Stage 2 assessment into the PRA.

8.3.1.3 *Hazard-Specific Considerations*—Considerations and methodologies vary by hazard and are hazard-specific. Additional information concerning data collection, evaluation, and mitigation of specific hazards is provided in [8.3.2.4](#), as well as [Appendix X2](#) and [Appendix X10](#).

8.3.2 *Methodologies*—Typical thresholds and methodologies for the evaluation of information collected are provided below:

8.3.2.1 *Safety Assessment*—An initial evaluation of the risk that occupants may suffer injury or loss of life due to the hazards of concern should be evaluated during Stage 2 of the PRA; however, it is recognized that it may be impossible to rule out potential injury or loss of life. Advanced safety assessments are further discussed in [Appendix X9](#). In the case of LMI, disabled, or elderly populations, safety considerations relevant to those populations should be included.

8.3.2.2 *Damage Assessment*—An evaluation of expected or anticipated physical damage to a target property should be provided for each hazard selected for further evaluation from Stage 1. The objective of the damage assessment is to characterize expected target property damage by performing an assessment of the hazard-specific damageable characteristics of the site and building(s) at specified hazard level(s). The results of the damage assessment may be expressed qualitatively or quantitatively. A quantification is preferred for hazards for which an applicable widely-accepted or peer-reviewed methodology exists to provide an order of magnitude quantification of the potential damage. In evaluating expected damage, granular conclusions may be more useful than generalizations. For some hazards, a quantitative damage assessment may be expressed relative to an estimate of cost to repair the building. This guide recognizes the variation and limitations regarding damage assessment methodologies for the broad range of hazards that may be considered in a PRA, as further discussed in [8.3.2.4](#).

8.3.2.3 *Functional Recovery Time Assessment*—Disruption to the intended use of a property may often represent greater concern than physical damage for certain hazardous events. The PRA should include a reasonable estimate of the

recovery time necessary for a property to be both safely reoccupied and restored to a state of basic function relative to each hazard of concern. In addition, the PRA professional may provide a range of durations necessary to repair the building to the condition prior to the hazardous event occurring. Disruption to the intended use of the property may influence the evaluation of hazard mitigation options. The user and PRA professional should agree on the level of specificity that is both possible and desired regarding recovery time. Refer to 8.5 for additional scope items related to recovery. This guide recognizes the variation and limitations regarding recovery time assessment methodologies for the broad range of hazards that may be considered in a PRA, as further discussed in 8.3.2.4.

8.3.2.4 Limited Methodologies Currently Available—The methods available for the damage and recovery time assessment of each hazard type vary, and there may be limitations to the depth of assessment that can be provided. NIST Technical Note 2209 (38) provides assessment of the codes, standards, and best practices that govern the design and construction of the built environment and notes that minimal data are publicly available to characterize typical repair costs and repair times for many hazard types and a range of damage levels. It is also noted that limited data and guidance are available to define post-event functional requirements and to quantify the time to recovery of function for a building after a hazardous event. NIST Special Publication 1224 (39) indicates there is a need to validate existing and develop new building performance assessment tools to evaluate damage, repair needs and recovery times. New guidance and tools are being developed by FEMA, NIST, ICC, ASCE and others. PRA professionals should reference industry-accepted methodologies, when available, for the hazards of concern, and the users of this guide should recognize that the related tools and practices associated with Stage 2 will continue to evolve. Refer to Appendix X9 for additional information.

(1) Seismic Risk—Seismic risk assessment methodologies for buildings have been developed by several organizations, as detailed in Appendix X1. It is expected that if seismic hazards are included in the scope of the assessment, the PRA professional or hazard specialist and the user will engage to identify, as discussed in 4.7.3, the appropriate type and level of independent seismic risk assessment. In the event there are conflicts between the PRA and the selected seismic risk assessment methodology, the seismic methodology will take precedence. Although it is not required, there is nothing in this Guide that would prevent the seismic risk assessment findings from being included or referenced in the PRA, if desired.

8.3.2.5 Chronic Stressors—For chronic hazards or stressors such as high heat or drought, building and site systems such as heating, cooling, and irrigation may be sized for current needs, but may not meet capacity requirements relative to the hazards of concern during the assessment term. In addition, chronic stressors may reduce the operational life of the equipment if regularly operating at or beyond the anticipated “normal” range. An evaluation of the adequacy of such systems should be conducted to reflect the objectives and risk tolerance of the user.

8.3.2.6 Community Resilience Considerations and Material Dependencies—Although a full evaluation of community or regional resilience is beyond the standard PRA scope of work, it is expected that any readily observable or generally known considerations, such as resilience measures or vulnerabilities outside the target property boundaries which would be likely to have a material impact on the target property should be disclosed in the PRA. The external or community resilience factors that are material to a property may be specific to an individual building type or to a specific user. Examples include the ability of utilities to deliver service to a property following a hazard event, the accessibility of the property to functioning transportation, or the health and availability of the property’s workforce. For some critical property uses, other factors materially contributing to the property’s functional recovery may include the demand for the goods or services produced in the property as a function of the wider impacts on the local community, the amount of redundancy that a user may have to provide similar goods or services elsewhere, or the availability of reconstruction resources either from the user or from external sources such as government entities. Consideration of community resilience factors or other dependencies may involve a discussion with the user as to which factors are material. The PRA professional should perform a limited review of SLTT hazard mitigation plans and community resilience plans or benchmark studies, where ready access is available and where applicable to the target property and identify any actions that are material to the Stage 2 assessment. Where such efforts have not been undertaken, the PRA professional should consider recommending an additional community or regional resilience assessment if the PRA professional believes such an expanded assessment is necessary to complete the Stage 2 assessment. For additional information about cascading and compounding impacts, impacts of power outages, and community resilience considerations, refer to Appendix X8 and Appendix X11.

8.4 Reporting—Reports may be provided in form and substance as agreed between the user and provider. Summary reports are typically provided in letter format, while more detailed reports may be desirable where transparency and validation of reports is desired. Detail should be provided regarding identified safety hazards and contributing factors for damage and functional recovery time, as well as material dependencies and community resilience considerations. For convenience, additional discussion of the suggested contents of detailed reports is provided in Appendix X5.

8.5 Baseline Risk and Resilience Evaluation—The purpose of the Baseline Risk and Resilience Evaluation is to communicate an objective and independent expression of the target property’s ability to prepare for, adapt to, withstand, and recover from the hazards identified in Stage 1 and based on the analyses conducted as part of Stage 2 (detailed in 8.2 and 8.3). It is therefore a description of the current state of the target property, which can then allow the user to quickly understand the nature and severity of concerns identified and make informed decisions concerning the need for and scope of potential Stage 3 resilience measures.

convey an acceptable or appropriate minimum level of assessment and in recognition that a more complex evaluation may be provided as part of an enhanced PRA. The Baseline Risk and Resilience Evaluation should be compared to a user's risk thresholds and resilience objectives, and based on the assessments described in 8.3.2, convey the findings for the following:

8.5.1 Safety—Safety can be expressed in a qualitative hierarchy (for example, high, medium or low) or expressed quantitatively (for example, number of injuries, hospitalizations, fatalities for a given hazard level or annualized). Vulnerabilities that may lead to death or critical safety issues should be identified as such.

8.5.2 Damage—Damage can be expressed as a numeric result (such as a monetary value or ratio), alphabetic scale, color code, or other type of multi-level qualitative system. If a multi-level system is used, the median damage level or score should be calibrated to represent median performance consistent with current national building codes and standards so that the presence of existing resilience measures produces above-median results. It should also be noted that damage may be related to acute hazards or chronic hazards. In the case of chronic hazards, damage over the specified time horizons should be considered.

8.5.3 Functional Recovery Time—Functional recovery time can be expressed as a time estimate, such as an expectation of functional recovery within a number of hours, days, weeks, months, years, etc., or in a multi-level system.

8.5.4 Community Resilience Considerations and Material Dependencies—Community resilience considerations and material dependency concerns can be expressed through an alphabetic scale, color code, or other type of multi-level system. If quantitative data are not readily available, a qualitative description of the considerations and the likely effect on the target property can be provided.

8.5.5 Uncertainties and Limitations—Impacts to a property as a result of future events can vary from predicted impacts due to variations and limitations in the assessment methodologies, the actual impact forces and conditions experienced during hazard events, whether predicted hazard events occur within the assessment term, compounding hazard events, community resilience considerations, unobservable conditions at the target property, changes to the target property condition after the assessment date, or other.

8.5.5.1 Limitations in Predicting Recovery—While a building may not experience a structural failure or loss of life, exterior cladding (for example, walls, windows, doors, roofs, etc.) and interior non-structural systems (for example, sprinklers, communication systems, etc.) or components (for example, HVAC equipment) often have different design requirements and may sustain damage that affects building function. According to NIST, the lack of integration between performance goals for structural, exterior and interior systems may impact the recovery of a building even if the structural systems perform as intended, and therefore, the interactions of these systems is difficult to predict. Additionally, damage to key infrastructure systems including water, power, fuel, transportation, communication, or other services may affect recovery in ways beyond what is possible to predict in the

PRA. The PRA professional should disclose any significant uncertainties associated with the performance of the Stage 2 assessment and may recommend additional in-depth analysis if needed. In addition, any lack of pertinent property information detailed in 8.2.3, should be stated in the PRA report.

8.5.5.2 Limitations in Comparison to Code—According to NIST, benchmarking the performance of a building relative to code requirements is challenging due to the infrequency of hazard events of the magnitude required to verify the performance of a building relative to the design requirements, and the variability of prescriptive design requirements by hazard type. For example, a code-compliant building may require extensive repair after an earthquake although it performed as designed (with failure of certain building components in a way that protects building stability) whereas a building may suffer substantially less structural damage during a design-level wind or snow hazard because building components are not designed to reach their strength limits. Therefore, the extent to which code-compliant buildings satisfy or exceed code objectives may vary by building and hazard types.

8.6 Additional Considerations—Stage 2 addresses specific considerations as discussed throughout Section 8; however, users may benefit from additional evaluation. For informational purposes, following is a partial list of additional tasks that users may wish to consider.

8.6.1 Detailed Repair Cost Estimates—An estimate of detailed repair costs may be beneficial; however, the development of such estimates is beyond the scope of a baseline Stage 2 assessment. Where provided, estimates typically reflect average costs exclusive of surge pricing. Such estimates are subject to a high degree of uncertainty; however, uncertainties may be reduced by the development of estimates that are unlikely to be exceeded.

8.6.2 Development and implementation of resilience and recovery measures;

8.6.3 Community and regional impacts (Reference Guides **E3130** and **E3350** for additional information).

8.6.4 Contents and inventory losses.

8.6.5 Business interruption losses.

8.6.6 Building certifications.

8.6.7 Energy and water use and efficiency except as related to vulnerability.

8.6.8 Regulation and code compliance.

8.6.9 Demand surge in replacement costs and recovery time.

8.6.10 The condition of improvements except as directly applicable to the objectives of the PRA.

8.6.11 The presence, handling, or current or future release of hazardous substances or petroleum products.

8.7 Limitations and Activity Exclusions—The following activities and considerations are beyond the scope of this assessment. Users should consider additional observations where reduced uncertainties are desirable.

8.7.1 Observations typically exclude:

8.7.1.1 Entering, accessing, or evaluating any area of the premises deemed to potentially pose a threat of dangerous or adverse conditions with respect to the field observer's health or safety, including, but not limited to: entering of plenum, crawl, or confined-space areas, entering elevators and pits for

shafts, interiors of chimneys, flues or boiler stacks, walking on pitched roofs, or any roof areas that appear to be unsafe, or roofs without built-in access;

8.7.1.2 Subterranean improvements and conditions;

8.7.1.3 Probing or testing; dismantling or operating of equipment or appliances; or disturbing personal items or property, that obstructs access or visibility;

8.7.1.4 Removing of electrical panel and device covers;

8.7.1.5 Testing of building systems and components;

8.7.1.6 Any procedure that may damage or impair the physical integrity of the target property, any system, or component.

8.7.2 Independent verification or evaluation of information provided by others, though conflicting information should be considered in the development of findings.

8.7.2.1 *Evaluation Exclusions*—Except as appropriate in the evaluation of damage, recovery time, vulnerability to chronic stressors, and risk of injury or loss of life in connection with the hazards of concern, evaluation typically excludes consideration of:

(1) Systems, components and conditions not discovered in connection with the Stage 2 assessment;

(2) The function, design, permitting, adequacy or condition of existing systems except as appropriate;

(3) Systems, components, equipment, and conditions that require specialized knowledge or equipment except as expressly agreed;

(4) Impacts to process-related equipment or equipment owned by a tenant.

NOTE 1—Where field observations are conducted in connection with a property condition assessment, reference Guide E2018, Sections 8 and 11 for additional activity exclusions that may apply.

8.7.3 Observations will typically include, at a minimum, the following:

8.7.3.1 The target property;

8.7.3.2 Ten (10) percent of repetitive building components and 100 % of unique building components;

8.7.3.3 Components with ready access; for example, those that do not require removing, relocating, or repositioning of materials, ceiling, wall, or equipment panels, furniture, storage containers, personal effects, debris material, or finishes;

8.7.3.4 Limited measurement or counting of building components. (Users are cautioned that such information should be considered as preliminary. Verification of measurements and counts is highly recommended to reduce uncertainties of the assessment.)

9. Stage 3: Resilience Measures

9.1 *Objective*—Stage 3 is a systematic approach to identify conceptual measures that can be employed to improve resilience, assess climate adaptation options, and develop a list of priority actions and next steps for protecting the target property. In Stage 3, information from Stages 1 and 2 is utilized to identify and prioritize resilience measures for the target property.

9.1.1 *Property-Specific*—Stage 3 of the PRA is specifically designed for evaluating resilience measures for an individual building or property. The guidance in this section should be

used once a property has been identified as a high priority for developing resilience strategies. This section is not intended to be used to evaluate and prioritize resilience measures for an entire portfolio of properties, as there are additional factors that should be considered when prioritizing which properties are the highest priority within a portfolio.

9.1.2 *Approaches*—Resilience of a property can be viewed from technical, organizational, social, or economic standpoints. Regardless of the differences in each of these viewpoints, it is widely agreed that resilience against disasters or hazards can be enhanced by one or a combination of the following three approaches: (1) reduce probability of failure (damage); (2) reduce consequences of failure (in terms of injury or loss of life and repair cost); and (3) reduce time to recovery.

9.1.3 *Prioritization Considerations*—Prioritization of resilience measures depends on several key factors, including the sensitivity and criticality of the target property, vulnerability of building activities and occupants to the hazards to which the building is exposed, operational expectations for the target property during a disruption, cost of strategy, organizational capacity to implement and the feasibility of implementation of resilience measures, implementation timing relative to when the hazard is projected to impact the target property, and a review of the maintenance, capital planning needs, and future investments for the target property.

9.1.4 *Types of Adaptation Strategies*—Adaptation strategies are characterized by three management categories to align with Guide E3032. The three management categories include: Category 1: Accommodate; Category 2: Protect; and Category 3: Retreat/Relocate. Although the typical user may not include a consideration of “retreat/relocate” in their analysis, it may be relevant for some situations and is an important consideration in climate adaptation or disposition planning. Adaptation may involve retreat and relocate strategies (for example, removing structures) rather than implementation of resilience measures. Appendix X10 provides examples of resilience measures in Category 1 and 2, as well as additional examples related to Category 3.

9.2 *Scope*—Based on the findings of Stage 2, the Stage 3 assessment focuses on identifying resilience measures to enhance the resilience of the target property. As discussed in Appendix X4, the depth of assessment may vary depending on the needs of the users as established at the beginning of the PRA.

9.3 *Methodology*—The following methodology is recommended for identifying and prioritizing resilience strategies:

9.3.1 Identify goals for property performance and recovery;

9.3.2 Review Stage 1 and 2 information regarding the identified hazards and Stage 2 findings. If information is insufficient to proceed to Stage 3, consider augmenting with additional assessment and return to prior Stage for additional information;

9.3.3 When prior data are sufficient, identify conceptual measures that can be employed relative to the findings from Stage 2 when they demonstrate a gap between the current situation and the goals for performance and recovery;

9.3.4 Perform a limited review of community-wide resilience plans relative to those measures;