Center for Cultural Sustainability

The University of Texas at San Antonio

Resilience Roadmap








Building a Sacred Places Heritage Network for Disaster Resilience

Presented to the Texas Historical Commission

2023

Prepared by the University of Texas at San Antonio Center for Cultural Sustainability (UTSA-CCS)

Hurricanes Harvey, Irma, and Maria (HIM)
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Introduction

Why We Need a Roadmap

Hurricane Harvey was a Category 4 storm when it hit the Texas Coast. Damages topped $125 billion, and 103 people died. Throughout Texas, approximately 336,000 people were left without electricity, and thousands required rescue.

As bad as it was, the 2017 megastorm is likely just the beginning. Severe weather events such as Harvey are becoming stronger and increasingly frequent. Texas must plan and prepare.

That's why the Texas Historical Commission (THC) has awarded a grant to The University of Texas at San Antonio's Center for Cultural Sustainability (UTSA-CCS). We gathered a team of architects, engineers, and preservationists to investigate the question everyone was asking after Harvey, **"How can we better prepare for next time?"** Our team focused on Sacred Places and studied them in-depth because faith-based groups are among the first to help in a crisis. As a result, they especially need guidance to make sure their buildings are stronger in the face of more frequent storms.

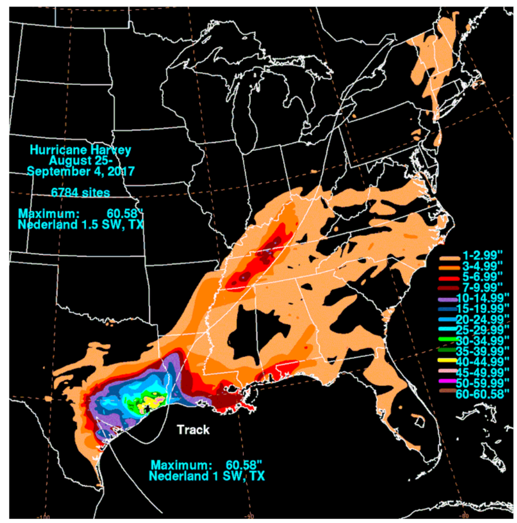


Figure 1: Map of the total rainfall from Hurricane Harvey

This *Resilience Roadmap* you're reading is that guidance. We spent more than a year evaluating nine historic buildings as case-studies. Lessons we learned from those case-studies are included in this *Roadmap* as recommendations that can improve resilience. **Our goal is for houses of worship to be able to continue what they've always done: maintain their traditions on blue-sky days, and help their communities in times of trouble.**

We hope you find the *Roadmap* useful as we all work to make Texas more disaster-proof.

How to Use This Roadmap

This *Roadmap* is organized in five major stages:

1. **Understanding Vulnerabilities** (*page 3*): What makes your property unique and what puts it at risk?
2. **Resilience Priorities** (*page 11*): Guiding principles to make you and your historic property more resilient.
3. **Action Plan** (*page 19*): Implementing an intervention strategy for improving the historic property's resilience.
4. **Resilience Treatments and Strategies** (*page 27*): Specific tasks for each aspect that could be part of a building's significance (and also put it at risk).
5. **Continued Assessment** (*page 62*): Maintenance, monitoring, and evaluation.

These stages are generally in chronological order and are further subdivided into tasks. Keep in mind that you won't have to follow the *Roadmap* from cover to cover. Because many parts of the *Roadmap* relate to each other, related concepts and sections are cross-referenced throughout the *Roadmap* for your reference.

Each project to improve resilience may also require slightly different processes. Stage Four (Resilience Treatments and Strategies), for example, includes examples of many different conditions and specific tasks for each. Most likely, not all of these will be relevant for your property. This should be treated as a reference to help prioritize aspects of your project.

The *Roadmap* also contains many technical terms. These are defined in the Glossary (*see page 69*).

Scope

Hurricanes and flash floods are the primary disasters addressed in this *Roadmap*. We focused our research on three counties: Galveston, Harris, and Victoria, but the lessons learned can be applied to houses of worship all along the coast and even across the state. An overview of our detailed case-study analysis is given in Appendix A (*page 82*).

Additionally, the *Roadmap* points out some common external factors that are beyond the control of individual congregations, yet still need to be considered. You will also need to consider other types of disasters not covered in this *Roadmap*, such as fire.

This *Roadmap* is intended as a general reference to give you an overview of what you need to know to start and implement a project that improves resilience. It is not a substitution for individually-tailored professional advice. Because each historic property is unique, you will likely need to consult professionals (*see page 14*). Additionally, URLs to specific websites may change.

Stage One: Understanding Vulnerabilities

Enhancing resilience at a historic property starts, as it does with any property, with understanding and assessing its unique vulnerabilities. These vulnerabilities refer to **the natural extent that the property is susceptible to damage from threats** or unable to cope with them. Vulnerability is inversely related to resilience, the factor within our control.

Unique to listed and designated historic property, you must first **understand the property's significance.** This is because you need to know what must be protected and preserved when planning for improvements. **Significance can be for historical, cultural, and aesthetic reasons**, and historic buildings can be significant for multiple reasons at local, state/regional, national, and international levels.

Understanding of significance can also evolve over time. For example, if a building was initially recognized only for its physical or aesthetic characteristics, it can also become more significant later for association with historical events or people. So, it is a good idea to revisit why the building is considered significant by **reading the official designation.**

It's good to start with some questions:

- What historic designations apply to the property?
  - For example, is the building listed on the National Register of Historic Places (NRHP)?
    - If so, is it individually listed or is it contributing to a district?
    - If not, has it been officially determined eligible for inclusion on the NRHP? Could it be eligible?
  - Other designations include National Historic Landmark (NHL), Recorded Texas Historic Landmark (RTHL), State Antiquities Landmark (SAL), and local designations.
- Are there historic easements or covenants on the property? You can find these on the property deed.
- On the property's historic designation(s):
  - What reasons were given for the property's listing?
    - For example, the NRHP nomination process includes 4 criteria for eligibility. Which ones were selected for your property?
  - What are the character-defining features of the property as described in the designation?
    - Most houses of worship will have architectural significance because they were designed to be prominent. The specified features often include elements such as towers, entry façades, and windows. Preserving these character-defining features will always be a priority.

Answers to frequently asked questions about the NRHP can be found on the THC's site at: https://www.thc.texas.gov/nrhp-faq

Figure 2: Towers, doors, and windows are often character-defining features in historic buildings

Researching Your Historic Property

If you already know the answers to all of the questions above, you can move on to the next task, Condition Assessment.

If some of the above questions require further research, the next task is to **gain a deeper understanding of why the property is significant**.

Start by searching your property's name in the **Texas Historic Sites Atlas** at https://atlas.thc.texas.gov/. Here you will find information related to your property's Historical Marker or NRHP Listing. This is especially helpful to know your building's specific areas of historical significance.

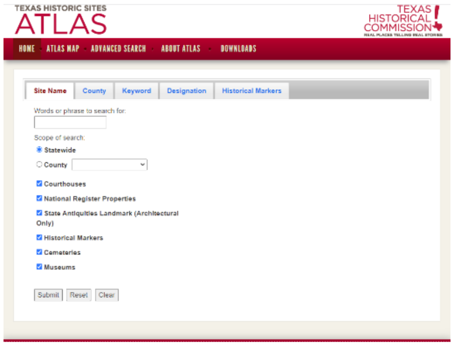


Figure 3: The first step is to check the THC's Atlas

A good next step is to check with your County Historical Commission (CHC) to find out if they have any records related to your historic property. Every Texas county has one. You can also check with other local historical associations. Examples of local resources include the Harris County Historical Commission, Galveston Historical Foundation, and Victoria County Historical Society.

Additionally, check your local library or the following potential resources:

- **The Portal to Texas History**: https://texashistory.unt.edu/
  - The Portal to Texas History helps local repositories such as museums and libraries digitize their collections. It provides free access to many historical newspapers and photographs from across the state.
- **Library of Congress (LOC)**: https://www.loc.gov/
  - The Library of Congress may have drawings and photographs from the Historic American Buildings Survey (HABS). Search for your building's name at https://www.loc.gov/collections/historic-american-buildings-landscapes-and-engineering-records/about-this-collection/.
  - You may also find your building in historic Sanborn insurance maps by searching your location (city or county) at https://www.loc.gov/collections/sanborn-maps.
- **County deed records** are searchable, as well, if you need to look for restrictions, easements, or covenants on the deed of title for the property.
  - These records are typically maintained by a separate county department than the CHC, such as the Tax Assessor-Collector's offices or Appraisal Districts.
  - In many cases, your local CHC can help you find these records if you are unfamiliar with this type of research.
- **Texas Archival Resources Online (TARO)**: https://txarchives.org/home
  - Many local repositories, along with state and university archives, make their finding aids available and searchable in one location. If you find material that relates to your building, contact the archive that has it for more information.

Assessing Conditions

The next task in understanding your property's unique vulnerabilities is an **evaluation of the property and building conditions**. This is called a condition assessment or evaluation, and it serves multiple purposes:

- It provides a baseline for future evaluations.
- It can help you with insurance claims or an emergency relief grant after a disaster. You'll already have the "before" photos on hand if you need them.
- It shows you where your building's weaknesses are located. You'll learn what's most likely to be damaged by extreme weather.

Identifying the present condition of the building is crucial for creating a plan for greater resilience, but you may need expert assistance (*see Hiring Professionals, page 14*).

A condition assessment will consider the following:

1. Identifying Possible Hazards
2. Evaluating Existing Condition
3. Evaluating Critical Infrastructure

Identifying Possible Hazards

Consider the disasters that your property could face. Identifying all hazards your building might be exposed to will help later with defining the building's level of risk (*see Risk Evaluation, page 9*). The main purpose of this task is to **develop an understanding the building's environmental conditions**.

Looking at historical data can be a helpful place to start establishing the frequency and strength of storms in your area. It is important to take into account the likelihood that these storms may become even more frequent and stronger. It is always best to plan for the worst-case scenario.

If you need help with this task, hire an expert. See page 14.

A complete environmental assessment should consider:

1. Availability and quality of environmental information (e.g., hazard maps, forecasts)
2. Features of building incorporated specifically for resilience to hazards
3. History of exposure to destructive events
4. Hazard presented to the site/building by current or forecast flooding events
5. Hazard presented to the site/building by forecast sea level rise
6. Hazard presented to the site/building by current or forecast intensity of hurricanes
7. Hazard presented to the site/building by other natural events or conditions (e.g., tornadoes, wildfires, winter storms)
8. Proximity of site/building to emergency services
9. Proximity of site/building to and relationship with adjacent buildings (e.g., connected by party wall in an urban setting, distanced in a rural setting)
10. Proximity of site/building to hazardous land uses, including:
    - EPA Superfund sites (both sites included and excluded from the National Priorities List)
    - Power stations, sub-stations, and high voltage transmission lines
    - Industrial facilities (e.g., chemical plants, refineries)
    - Commercial hazardous waste treatment, storage, or disposal facilities
    - Incinerators
    - Landfills, trash transfer stations, waste tire piles
    - Large sewage treatment plants or sludge management facilities
    - Gas stations

- Freight rail lines or yards
- Other environmental hazards recognized by the EPA or TCEQ

This *Roadmap* focuses on hurricanes and floods. They are the most common major disasters along the Texas Gulf Coast, and you can read detailed information about them below. A full assessment, though, will go beyond just these two hazards.

Hurricanes

Hurricane paths are very hard to predict. Sometimes, coastal communities take a devastating, direct hit. Examples include Indianola in 1886 and Galveston in 1900. Sometimes the storm misses the city or even heads back to sea. Still, historic properties located near the Gulf Coast are all at risk. Meteorologists believe that storms like the 1900 Galveston hurricane can happen again.

Hurricanes tend to weaken as they move away from warm water, so buildings very close to the coast are typically most at risk. Those at low elevation also have additional risk of being inundated with storm surge (*see Floods section below*).

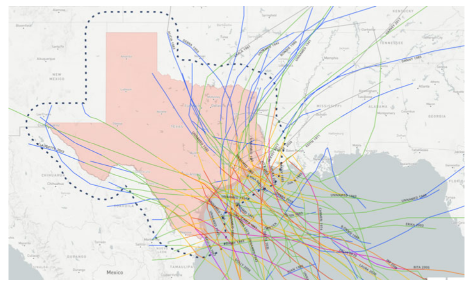


Figure 4: Hurricane paths over Texas since 1920, from NOAA's Historical Hurricane Tracks database

Even properties far inland can be affected by heavy rains and high winds. Hurricanes can also generate tornadoes, a type of threat that many may be unprepared for.

The National Hurricane Center (https://www.nhc.noaa.gov/) by the National Weather Service (NWS) is your best source for information. Before hurricane season, review the NWS's hurricane preparation checklist (https://www.weather.gov/safety/hurricane-plan). As hurricane season begins in the summer, check the NWS's advisories (https://www.weather.gov/safety/hurricane-ww). Keep in mind that the actual path can occur anywhere along the prediction cone. Some areas in the cone will be hit while others might not be.

The Texas Hurricane Center offers information for hurricanes facing Texas (https://gov.texas.gov/hurricane). It is maintained by the Texas Division of Emergency Management and should also be regularly referenced.

Additional resources include the American National Red Cross (https://www.redcross.org/get-help/how-to-prepare-for-emergencies/types-of-emergencies/hurricane.html).

Floods

Find out if your property is in a floodplain. This can be shown on flood maps, which mark areas deemed at risk of flooding based on various criteria or simulated modeling. This information can help assess the site's vulnerability to flood-related events, but should not be the sole source of information to establish flood risk. Combining flood map predictions with local and traditional knowledge of the land, as well as site-specific surveying, can provide a complete picture of the actual flood risk. Together, this information can be used to prevent flooding damage by informing which Resilience Treatments and Strategies to adopt for the building and site.

The Federal Emergency Management Agency (FEMA) provides flood maps of predicted levels of flood risk. These are very important for participation in federal programs, but they have limitations. They do not consider coastal storm surge or certain pieces of infrastructure such as dams. For these reasons, they should be a starting point. More local information may be more accurate. FEMA uses lots of specific terms that this *Roadmap* seeks to clarify:

- In general, properties may fall within two categories of flood risk, commonly known as the 100-year floodplain and the 500-year floodplain (formally referred to as "0.2% Annual Chance Flood Hazard" and "1% Annual Chance Flood," respectively).
- Properties deemed at higher risk may fall within a Special Flood Hazard Areas (SFHA), requiring them to participate in the National Flood Insurance Program (NFIP).
- Whether your property falls within any of these flood zone designations, it is wise to purchase flood insurance and understand what it covers.

To determine general flood risk:

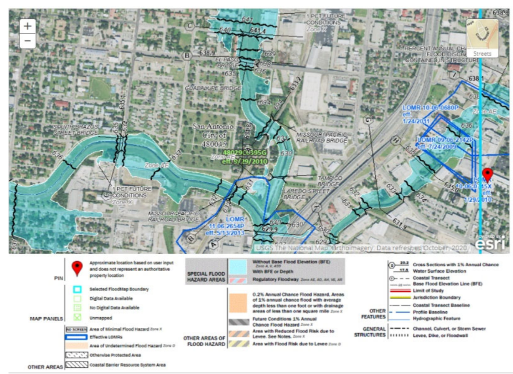


Figure 5: Example of analyzing a property with a dynamic flood map on the FEMA Flood Map Service Center

- Start with the FEMA Flood Map Service Center web search portal (https://msc.fema.gov/portal/home) to determine the federal determination of flood risk.
  - Static and dynamic maps are available
- Check local authorities for more local determination or special information.
  - A county example is the Harris County Flood Control District (https://www.hcfcd.org/), which provides mapping information, including a Flood Warning System (https://www.harriscountyfws.org/)
  - An example of a state agency is the Lower Colorado River Authority (https://www.lcra.org/), which provides flood operations related to the dams it controls (https://hydromet.lcra.org/floodstatus)
- Private companies may also maintain flood maps based on various models
  - An example is the FM Global Flood Map (https://www.fmglobal.com/research-and-resources/nathaz-toolkit/flood-map#)

Because there are different flood maps and existing flood maps are updated frequently, it is important to reassess flood risk periodically. FEMA can also reassess specific properties by request, which may place them inside or outside designated flood zones (see https://www.fema.gov/flood-maps/change-your-flood-zone). This can affect whether a property is legally required to have flood insurance. Keep in mind, however, that many properties outside of flood zones can still flood.

Not being in a flood zone does not mean your property is not at risk. Extreme rainfall in any area can cause flash flooding that can overwhelm active and passive flood mitigation strategies. 65% of homes damaged in tropical storms Claudette (1979, dropping 43 inches of rain) and Allison (2001, dropping 38 inches of rain) were not in FEMA-designated floodplains (Berryhill, 2007).

Technical terms such as "500-year" and "0.2% annual chance" can also be misleading and should not be used as an indication of frequency, but rather magnitude. Houston, for example, has experienced five "500-year" events in an approximately 40-year period (Claudette, Allison, 2015 Memorial Day floods, 2016 Tax Day floods, and Harvey). Three of those were in consecutive years, making recovery even more difficult.

Evaluating Existing Conditions

An important task is to understand the existing conditions of the building. The goal is to identify the specific strengths and weaknesses of your building. You will need to gather:

If you need help with this task, hire an expert. *See page 14*.

1. Drawings, both historic and as-built (current)
   - Architectural
   - Structural
   - Mechanical, Electrical, Plumbing (MEP)
   - Fire protection
2. Photographs of the entire building, both historic and current
3. Previous project information (e.g., files or binders containing memos, photos, receipts, and operating manuals)
4. Current insurance policies, warranties, guarantees
5. Samples of historic materials (if needed by a professional; they can collect samples themselves)

It is a good idea to make copies of all documents and keep them in a safe place off-site. Make sure that relevant people (such as buildings and grounds committee members) know where to find these documents or their copy.

Again, you will probably need expert assistance with documenting and determining the current condition of the whole building. A professional such as an architect or engineer that has experience with historic buildings can perform this task (*see Hiring Professionals, page 14*). Keep in mind that they may need access to parts of the building that are difficult to observe and will have to use special equipment. Some might be simple (e.g., ladders, prybars) and others will need to be planned for (e.g., cherry-picker, scissor lift, or even scaffolding).

If you choose to assess the building's physical condition in-house, be sure to measure all possible Resilience Performance Indicators:

Resilience Performance Indicators

Resilience Performance Indicators (RPIs) are observations and variables that provide information on the physical and social resilience of your building and organization. RPIs are specific, measurable, actionable, realistic, and trackable.

UTSA-CCS has developed a tool designed for building managers to assess their building's performance quantitatively through RPIs. This **RPI tool** requires user-provided input in four categories: physical, infrastructural, environmental, and organizational aspects of the building's current level of resilience.

Using your input, the RPI tool generates category scores and an overall score. It also generates a list of the most vulnerable conditions. When combined with Resilience Treatments and Strategies (RTSs) provided in this *Roadmap* (*see page 27*), the RPI tool can help you prioritize upgrades for disaster preparedness.

More details on the UTSA-CCS RPI tool can be found in Appendix B (*page 85*).

Also, consider the age of the building. Some historic building materials differ from their current-day counterparts. They may perform better or they may not be as resilient as modern materials. Also, construction standards and building codes have changed over time. Your building may have met code when it was built, but might have some violations with the current code.

Evaluating Critical Infrastructure

Beyond the physical building itself, other factors can affect a site's resilience. Critical infrastructure refers to **the systems that support life and operations of the facility**. These need to be identified and protected, as the failure of any of these may have a great impact on the quality of life in a community after a disaster, including how quickly you can recover. It can also affect the everyday performance of the facility, depending on the type and extent of failure.

Think about how infrastructure might be critical to you. Some examples are:

1. Electrical power
    - Can the building generate its own electricity?
2. Potable water
    - Does the building rely on municipal water supply for safe drinking water?
3. Electronic communications
    - Can emergency services be contacted during or after a disaster if phone lines or cell towers go down?
4. Transportation
    - Can people access the property?
5. Sewerage and water treatment facilities
    - Can wastewater contaminate the building? E.g., do you have a backflow prevention device installed on your plumbing?

These are all elements of critical infrastructure. And failure of any one of them can complicate recovery from a storm. They can make the damage worse because of lost time. Think about how your infrastructure performed in previous disasters and whether any of these elements could use a backup. If there were any issues in previous disasters, were those problems solved or might they happen again?

Risk Evaluation

Now that you have all this information, you can determine your overall risk.

Risk is similar to vulnerability, and can be broadly thought of as **the chance that an event will occur that negatively impacts the property**. In fact, a deeper understanding of a property's overall risk includes both vulnerability and probability as major components.

The United Nations Office for Disaster Risk Reduction, professional organizations such as the American Institute of Architects, and the academic community define three factors as contributing to total risk in systems like historic sites. Total risk can be determined via an equation:

RISK = HAZARD x EXPOSURE x VULNERABILITY

Consider the relationship between each component:

- Already, **hazards** have been identified (*see page 5*). They are a component of risk that generally can't be controlled, so they should be considered a fixed variable.
    - However, some Resilience Treatments and Strategies can lower the damaging impacts of these hazards.
- Similarly, **exposure** is also difficult to reduce. Buildings and landscapes are naturally exposed.
- That leaves **vulnerability** as the component of risk that you have the greatest control over. Condition assessment identifies vulnerabilities (*see page 5*).
    - As you adopt Resilience Treatments and Strategies to lower the vulnerabilities, you are also lowering risk.
    - When you lower enough vulnerabilities, overall risk is reduced to a level where your building is considered more resilient. Resilience and risk are inversely related.

Figure 6: Lowering vulnerability increases resilience

It is important to consider all hazards and vulnerabilities, even ones that seem minor or only remotely possible. These "small" risks can add up. A complete risk evaluation will include:

- "Rare" and devastating events (e.g., floods, hurricanes)
- "Common" events (e.g., water leaks, accidents)
- Cumulative processes, or damage over time (e.g., corroding materials, eroding surfaces)

Beyond just the physical aspects, you also need to consider social aspects of coping strategies and recovery operations. These may include operational, financial, legal, and cultural risks.

Changes in risk should also be closely monitored and periodically reassessed.

In a cultural heritage context, **understanding the overall risk establishes what assets are at stake and expected to be lost** if no Resilience Treatments and Strategies are adopted. This is the realm of risk management, and all the steps in this *Roadmap* can be considered a form of risk management.

This *Roadmap* is also primarily concerned with two phases in the disaster management cycle, **mitigation** and **preparedness**. Strengthening your efforts in these phases can reduce your burden later—as well as that of responders and volunteers—in the other two phases, response and recovery.

Stage Two: Resilience Priorities

Stage Two sets priorities to enhance resilience. These will guide the next two stages, making an Action Plan (*see Stage Three, page 19*) and implementing appropriate Resilience Treatments and Strategies (*see Stage Four, page 27*).

Set resilience priorities:

1. Identify Active Stakeholders
2. Define Performance Goals
3. Determine Budget and Strategy
4. Document Cultural Heritage
5. Respect Historical and Architectural Significance
6. Anticipate Disaster Recovery Efforts

Identify Active Stakeholders

You will need to identify all the stakeholders involved in the project. These will typically include decision-makers from several groups:

1. Faith-based representatives
    - Clergy and lay leadership (e.g., pastor, rabbi, imam, rector, deacon, elder, vestryman, parish board members)
    - Representatives from broader adjudicatory body (e.g., council, church, synod)
    - Maintenance staff (e.g., building manager, sexton)
2. Funding stakeholders
    - Grant-making agencies and organizations
    - Potential donors
3. Government agencies, depending on the historic designation, the work being performed, and funds utilized
    - Local representatives can include local preservation offices, preservation commissions, and CHCs
    - The THC is the state representative for preservation projects
    - At the federal level, the National Park Service may be involved (although most NRHP procedures will go through the THC first), as well as FEMA depending on the types of funds used
4. Nongovernmental associations (e.g., "Friends of" groups)
5. Building professionals
    - Architects
    - Engineers (e.g., civil, structural)
    - Local contractors
6. Local emergency management and response representatives

Additional stakeholders, who may not be decision-makers but should still be informed throughout the decision-making process, should naturally include the rest of the congregation. It may also include outside volunteers, neighboring property owners, and other faith-based communities.

Define Performance Goals

In Stage One, the *Roadmap* offers guidance on risk evaluation, your historic property's vulnerability to known hazards. Using the data you gathered in Stage One, establish some goals. They should guide the effectiveness of the Action Plan (*Stage Three, page 19*). Some things to consider include:

1. Addressing risk (*see Risk Evaluation, page 9*)
    - Remember the factors: hazards, exposure, and vulnerability
    - Establish priorities of your congregation. What do you value most?
    - What role do you want to play in your community's disaster preparation and recovery plans?
    - How much resilience do you hope to attain?
2. Administrative capacity to oversee the project
    - Do you have enough people to meet your goals? Is the whole congregation on board?
    - What level of expertise is required? Which tasks may need professional assistance?
    - Can your facility safely store documents and records essential to enhanced resilience?
3. Available funding for the project
    - Estimate costs. Do you have enough money for the level of resilience you hope to attain?
    - List all the feasible funding sources and set financial targets.
    - Define a reasonable schedule for meeting financial goals.
4. Data and analysis required to determine the scope and type of project
    - What don't you know about your building? Make a list of the knowledge gaps you need to fill.
    - What was learned from the UTSA-CCS Resilience Performance Indicators tool? Where and how can you enhance resilience?
    - Do you need to pursue a deeper vulnerability assessment? Will you need professional assistance?
5. Ability to move towards more resilient critical operations as well as building and infrastructure systems
    - Do you need wider community or political support to address things you can't change alone? Many factors impacting vulnerability are off-site and might appear to be outside your control, yet perhaps you can initiate discussion about these matters to influence positive action?
    - Maybe initiate contact with first responders and discuss issues of disaster response? For example, your congregation might like to host a family event for the people in your community whose job includes being on the front line in a disaster?
    - Consider coordination meetings with County agencies and be ready to discuss the role you envision your congregation might play in disaster recovery.

Determine Budget and Strategy

This is one of the most important parts of the process, because it not only involves knowing how much money is going to be used, but how it is going to be used and when. **Set priorities.** Focus on the most vulnerable communities or buildings first.

The strategy and budget are related. Budget is typically considered a limiting factor. As a result, existing available financial resources need to be considered in your performance goals. However, lack of funds should not stop your project from going forward. Fundraising should be a component of the strategy, to be implemented as part of the Action Plan (*see page 22)*. In this way, the selected strategy can also affect the budget, potentially helping fundraising efforts.

Strategy

This step ensures that all the performance goals are met, not only for the current built environment, but also possible future projects. Choosing the appropriate strategy depends on the results of the assessment (*see page 5*), historic designations (including possible regulatory approval), and resources such as funds or time.

It might also be appropriate to choose different strategies for different cultural resources or even different parts of the same building.

You can also phase the implementation of strategies if immediate funds are unavailable, if there is limited or seasonal availability of skilled labor to perform the work, or to ensure continued operations.

Some strategies that may be taken include the following, organized from least intervening to most intervening:

1. Maintenance
    - This is not often considered a preservation or resilience strategy, as it should be an ongoing practice. However, establishing a culture of maintenance is an important and effective way of reducing the impacts of disruptive events (*see page 62*). This includes proactive forms of maintenance (a.k.a. preventive maintenance).
    - It also should not be your only strategy, and should be adopted along with other strategies listed below.
2. Preservation
    - Preservation is defined by the NPS as "applying measures necessary to sustain the existing form, integrity, and materials of an historic property" which primarily includes maintenance and repair of historic materials (as opposed to replacement).
    - This strategy does not involve new construction, although it may include some minor upgrades for systems (e.g., to meet building code).
3. Rehabilitation
    - Rehabilitation is defined by the NPS as making compatible uses for historic properties "through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values."
    - This is the most common type of strategy for historic projects.
    - A rehabilitation strategy may include architectural changes to the building's configuration, such as upgrading accessibility to comply with the Americans with Disability Act (ADA) or to accommodate changes in infrastructure.
    - Lately, some historic buildings are being lifted up to a greater height above the ground and set on new foundations. This is done to increase resilience against floods. However, it is a very expensive rehabilitation, and a solution that may have negative impact on historic integrity because it creates a whole new architectural configuration.
4. Restoration
    - Restoration is defined by the NPS as "accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period."
    - This is a fairly rare strategy, as it requires research to determine how the building appeared in the reconstructed period and can be expensive.
    - This strategy can enhance resilience if earlier configurations of the building were more flexible, such as formerly operable windows that have since been nailed shut. Restoring operability allows the building to be naturally ventilated. This helps the building to dry out after disasters such as floods.
    - Very limited upgrades to systems may be necessary even in a restoration project.
5. Reconstruction

- Reconstruction is defined as by the NPS as using new construction to depict “the form, features, and detailing of a nonsurviving site, landscape, building, structure, or object [to replicate] its appearance at a specific period of time and in its historic location.”
- Partial reconstruction is often necessary following major disasters, especially if they were vulnerable beforehand (e.g., an unstrengthened tower blows over in high winds or an unprotected trace window shatters when struck by debris).
- Complete reconstruction can be a very challenging and expensive undertaking.

6. Relocation
    - Relocation involves moving a building from its original or current location. Moving a building to higher ground, for example, could better protect it from floods.
    - This is a rare strategy that compromises integrity and may result in a building losing its historic designation. However, it may be necessary if the site is so threatened that no other strategies are feasible. Even if a building is at high flood risk, consider alternative strategies to relocation first.
    - There are also degrees of relocation, and preserving as close to the original association and setting is ideal (e.g., moving a building to a higher elevation within the property rather than moving it to another city).
7. Infill or new construction
    - This is not a traditional preservation strategy, but it may be necessary to build features such as enclosures that protect parts of the historic site if they are extremely vulnerable.

Secretary of the Interior's Standards

Preservation and maintenance work performed for many of the above strategies are considered “treatments” for historically designated properties. Treatments should always adhere to a set of principles known as the *Secretary of the Interior's Standards*, established by the National Park Service (https://www.nps.gov/tps/standards.htm). Depending on your property's designation, adhering to *The Standards* may be required by law (they apply to all properties listed on the National Register, for example).

There are four types of standards, which correspond to four of the strategies listed above: Preservation, Rehabilitation, Restoration, and Reconstruction. Most projects, especially dealing with resilience, will fall under Rehabilitation.

The NPS also provides *Guidelines on Flood Adaptation for Rehabilitating Historic Buildings*, which contain many of the Resilience Treatments and Strategies discussed in this *Roadmap* in greater detail (https://www.nps.gov/articles/000/guidelines-on-flood-adaptation-for-rehabilitating-historic-buildings.htm).

Hiring Professionals

All major historic preservation work must be designed and specified by qualified professional practitioners. These include preservation architects, engineers, landscape architects, material conservators, historians, preservation consultants, restoration trades, contractors, artists, and artisans.

For most projects, you should **start with hiring an architect**. An architect will see the big picture and can recognize when other specialists need to be brought on to the project. For many situations, an **engineer who specializes in preservation** projects is needed. You can interview multiple firms to find the best fit for your project (not all architects are experienced with historic properties). Some things to keep in mind:

- What are the firm's qualifications?
- What similar projects have they done in the past?
- How much will this project cost?

Qualifications and experience should be valued more than cost. Many professionals will offer similar billing rates, but a good consultant will save time, money, and as much of the historic assemblies as possible.

All significant preservation and new construction work needs a signed contract (a.k.a. agreement). The contract should clearly lay out the anticipated scope of the work. Most architects will draw up a contract for you, but the American Institute of Architects also offers a standard form. In rare occasions, your lawyer can write up the contract from scratch. If the work is to be *pro bono*, make sure that agreement is written down. Good communication is key.

Document Cultural Heritage

Understanding context is essential to evaluate and preserve cultural heritage, whether physical buildings and artifacts or intangible traditions. Recording existing conditions and setting helps future stewards of these resources take care of them. Keeping and maintaining a good written and photographic record can help keep traditions alive and avoid loss of institutional memory. This documentation becomes part of the cultural heritage, and should be saved for its informational value.

Physical Resources

Any work that is performed as part of your project needs to be carefully documented. Before you begin a project, take photos of everything. Make sure that photos are also regularly taken throughout the project. Conditions should always be documented prior to any physical alteration.

You will also need drawings, which are prepared by the professional you hired. These will eventually become part of the historical record for your building. Complete sets of drawings documenting existing conditions (to HABS-level standards) may not be necessary and are probably not feasible for most projects. Such comprehensive documentation efforts are best reserved for extreme interventions, such as those that involve demolition or relocation of some of the historic resource.

Photographs of damage or uncertain conditions are always recommended and may be required for certain types of funding. While complete drawings and photographs are not always necessary for every feature, **more documentation is a better strategy than less**.

All work performed should also be photographed and maintained in a project binder with all relevant documents pertaining to the project. When the project is complete, make sure that record sets of drawings (showing as-built conditions) and photographs are created. Keep the project binders and the as-built drawings in a safe location and make sure they are preserved. Good documentation and records of physical conditions are essential to effective and successful long-term care of historic properties. They will also be useful for future preservation projects.

Intangible Traditions

Historic buildings, especially houses of worship, are home to intangible traditions that are culturally significant. Preserving these social practices is just as important as preserving the building (a church without its congregation is no longer a church). Intangible traditions include rituals, festive events, oral traditions, performing arts, and education, just to name a few. Think about what is important to your congregation:

- Do you sing the same hymns your grandparents sang?
- Has there been a candlelight service every holiday season for decades?
- Do you have festivals where you invite the outside community?
- Are there food distribution events every Thursday or showers for the homeless every Wednesday?
- Are there families who have been members of your congregation for three or four generations?

Take as many photos as you can of both special events and everyday life.

Such intangible heritage may not be well documented. You should keep a record of these practices, so that they can be carried on authentically for further generations. Take photos, make videos, make scrapbooks, or whatever means are comfortable for you.

These records can help others, such as an architect or government representative, understand the significance of your historic property to its community. One example is posting photos on social media or in news articles about how a church supports citizens in need (e.g., by distributing food and water, providing shelter), which can strengthen ties to a community, to political entities, and may even help with fundraising.

Respect Historic and Architectural Significance

Improving any building's resilience can be a challenging task. To do so while respecting and preserving character-defining features requires extra care. Buildings that have protective easements or are designated as historic by local commissions, state historic preservation offices (the THC), or are recognized nationally by the National Park Service may mean there are a few extra steps to consider. The external appearance of your building may be subject to oversight and regulatory approval if you try to change it.

Some Resilience Treatments and Strategies have minimal visual impact. These might include:

- Writing a Disaster Response and Recovery Plan
- Upgrading to storm windows
- Installing pumps
- Adding emergency generators
- Putting in backflow prevention devices
- Installing alarm systems (e.g., fire, carbon monoxide)

Other possible changes, however, will be a lot more noticeable. These might include:

- Installing flood barriers
- Raising the interior floor level
- Lifting or moving the entire building

A well-qualified architect will know how to get approval from regulatory or supervisory authorities. **Consultation with relevant authorities (e.g., THC) is essential to ensure that visual changes affect the historic character of the building as little as possible.** These discussions should be held early in the planning process to anticipate and incorporate feedback. The dialogue should continue as the project takes shape and as the Action Plan is implemented to ensure that your building does not accidentally lose character-defining features.

The people who designed your building were probably thinking about resilience. Many historic buildings were originally designed to be resilient to their local climate, which might be noticeable from an elevated interior floor level, for example. Sometimes these design features get altered or are lost over time. Also, disasters today and in the future might be worse than what your building was originally designed to withstand. Buildings may have been constructed with an elevated ground floor above anticipated high water marks, but flood levels may have risen beyond what was expected.

Addressing your historic building's vulnerabilities with a rehabilitation strategy may require more care and special expertise than it would take to build a new resilient structure, but it is not necessarily more difficult or expensive. **The historic character of your building can be considered a strength rather than a challenge.** Even if your building has been substantially altered, historic assemblies that were designed for resilience can offer a starting point for new designs. For example, elevated buildings may be raised slightly to return them above high-water levels without changing the visual character too much.

It's possible your building was more resilient in the past than it is now. In these cases, a reconstruction strategy can enhance resilience and historic appearance at the same time. Historic photos may show operable windows, storm shutters, and canopies. Maybe historic materials were more resilient than later replacements. These could be reconstructed, restored, or used as inspiration for other changes.

At times, standards for preservation and concerns for safe occupancy may be in conflict. If this situation arises, property owners should seek advice from the Texas Historical Commission and local agencies with authority to review historically designated property. Review treatment options with the staff and then an appropriate solution can be found. Be sure to speak to all stakeholders before the project begins, and keep them in the loop throughout. Open dialogue will help avoid unpleasant surprises.

Anticipate Disaster Recovery Efforts

When disaster strikes, people want to help. That's a good thing, but **well-meaning volunteers may not know much about preservation.** If your building floods and volunteers come to clean, will they know what is historic and what isn't? Will they know what can be replaced and what needs to be preserved or restored? You have the institutional familiarity and understanding of the building and will have to convey to responders and volunteers what is significant and needs to be protected.

Inventory your cultural resources, including buildings, that are historically or culturally significant. This may include art, ornament, sacraments, books, and antique furniture. Use this opportunity to evaluate the conditions they are stored in:

- Are the current conditions protecting these artifacts?
  - These may include protection from light-damage, acidification, and pest infiltration.
- Will these cultural artifacts be safe in a disaster?
  - These may include ensuring the objects will not float away, or that fragile items would not be directly sprayed by sprinklers.
- Is there a plan to protect or evacuate them?
  - If there isn't, you will need to create one.
- Do you have the supplies needed to respond?
  - These may include plastic sheeting, buckets, mops, and fans.

Keep this inventory and any safe-handling procedures updated and printed in a disaster response manual. Make sure volunteers know where your disaster response manual is so they can reference it in the immediate aftermath of a disaster. They should already be familiar with what must be saved, but you don't want anything to be forgotten in the chaos.

Items that are especially vulnerable to water damage due to their material properties, such as wood, fabric, or paper, should be prioritized. Substantial or special collections (e.g., libraries and archives) might require special care. Preservation procedures from the museum and conservation field can be adapted for these (https://www.culturalheritage.org/about-conservation/caring-for-your-treasures).

Some historic building assemblies may inevitably be inundated in a flood event, such as wood trim, paneled floors, mantelpieces, or decoratively painted wall finishes. If these are character-defining features, they need to be included in your inventory of cultural resources. That way, recovery professionals or volunteers will know not to tear out those assemblies in an attempt to combat mold. Or, they can at least carefully remove them to be restored. If they are not identified, it may not be immediately apparent that they are important. Floods can leave behind a thick coating of mud or grime that obscures their aesthetic qualities.

Recovery volunteers might also accidentally discard artifacts or damaged parts of the building that they may think cannot be saved. In reality, many materials that are highly susceptible to mold, such as paper, can be partially saved and even restored if efforts are swiftly made to rescue and restore them. **Make sure you have a plan for where and how to dry out historic resources**, as conservation and restoration cannot be conducted on waterlogged items.

Stage Three: Action Plan

It is now time to create an Action Plan and begin to implement it.

Action Plan

The Action Plan involves three steps:

1. Estimate the budget for each activity.
2. Place someone in charge of each activity.
3. Make a schedule (timeline).

Resources

Additional resources are available from the following nonprofit organizations plus state and federal agencies:

Preparedness

Texas Ready, from the Texas Department of State Health Services (https://texasready.gov/)

Ready.gov, from the U.S. Department of Homeland Security (https://www.ready.gov/)

Texas Hurricane Center, from the Office of the Texas Governor (https://gov.texas.gov/hurricane)

The American Red Cross (https://www.redcross.org/get-help/how-to-prepare-for-emergencies.html)

Response & Recovery

DisasterAssistance.gov, from the U.S. Department of Homeland Security (https://www.disasterassistance.gov/)

Texas Division of Emergency Management (https://www.tdem.texas.gov/recovery/resources-for-texas-citizens)

List of Declared Disasters, from the Texas Division of Emergency Management (https://www.tdem.texas.gov/disasters)

Disaster Education Network, from Texas A&M University AgriLife Extension (https://texashelp.tamu.edu/browse/disaster-recovery-information/after-a-disaster/)

Houston Responds (https://www.houstonresponds.org/)

Interfaith Ministries for Greater Houston (https://www.imgh.org/)

How FEMA Can Help

The Federal Emergency Management Agency (FEMA) provides many resources that can help prepare for, mitigate, and recover from natural disasters. They also have many go-to resources specifically developed for faith-based groups, which you can learn more about on their faith page (http://www.fema.gov/faith).

Additionally, community leaders are a key source for information about disasters and emergency management. Find out whom to go to on FEMA's website based on your location (https://www.fema.gov/locations). FEMA also provides a free training course to help manage impact to facilities through the Organizations Preparing to meet Emergency Needs (OPEN) program (https://community.fema.gov/opentraining).

If you apply for FEMA aid, be sure to do it within 60 days of the Presidential Disaster Declaration. See FEMA's Emergency Financial First Aid Kit (https://www.ready.gov/sites/default/files/2020-03/ready_emergency-financial-first-aid-toolkit.pdf) for instructions on applying, a list of documents needed (which can be organized before disaster strikes), and a list of additional resources that may be beneficial to a congregation during a disaster.

You can also follow up on the application through FEMA's website (http://www.fema.gov/after-applying). If the request is denied, FEMA has partnered with the American Bar Association to provide *pro bono* legal services to help navigate the appeal process. Find out more about this resource on their website (https://www.americanbar.org/groups/young_lawyers/projects/disaster-legal-services/). Often, the appeal can be resolved easily with additional documentation. If any important documents have been lost or damaged in the disaster, FEMA can also help replace them (http://www.usa.gov/replace-vital-documents).

As another option, **houses of worship may apply for Public Assistance Programs as a Private Non-Profit organization for recovery assistance after a disaster**. Private Non-Profits must apply as a Sub-Applicant and collaborate with state or local governments, which act as the Primary Applicant. More information on this resource is provided on FEMA's website (https://www.fema.gov/assistance/public).

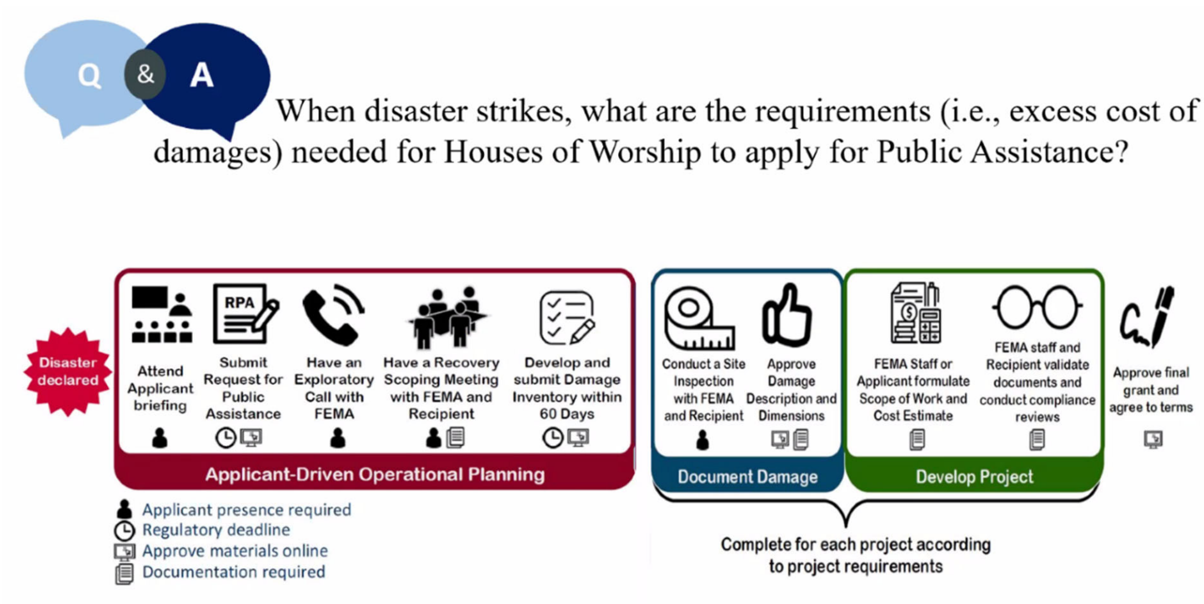


Figure 7: Public assistance for Private Non-Profits

FEMA also offers Hazard Mitigation Assistance (HMA) grants (https://www.fema.gov/grants). These provide a longer window for the application period than the Disaster Assistance program. You can also check on currently available mitigation funding, to find out if any may apply to your area or congregation (https://www.fema.gov/grants/mitigation/fy2021-nofo)

	HMA Grant Programs				Public Assistance
Funding Cycle	Annual Grants Cycle		Disaster Grants Cycle		
Mitigation Funding	Flood Mitigation Assistance (FMA)	Pre-Disaster Mitigation (PDM) Building Resilient Infrastructure and Communities (BRIC)	Hazard Mitigation Grant Program (HMGP)	HMPG Post Fire	Public Assistance (PA) Mitigation
When is the Notice of Funding Opportunity (NOFO) released?	No later than (NLT) August	NLT August	N/A	N/A	N/A
When can applicants apply?	Annually: September – January	Annually: September – January	Following the presidential declaration of a major disaster for 12 months	Following the declaration of a Fire Management Assistance Grant (FMAG) up to 6 months after the following fiscal year	Funding is part of the recovery for each major disaster

Figure 8: FEMA mitigation funding process

County Hazard Mitigation Plans

Every Texas county has a hazard mitigation plan, as required by FEMA. States, tribal, territorial, and local governments must update and submit their hazard mitigation plans to FEMA every five years. These plans identify and evaluate—plus provide mitigation strategies for—natural hazards such as drought, wildfire, earthquakes, tsunamis, erosion, tornadoes, extreme temperatures, subsidence, flood, storm surge, hail, severe winter weather, landslide, severe wind, lightning, sea level rise, and hurricanes.

Samples include:

https://www.galvestontx.gov/1069/Hazard-Mitigation-Plan

https://www.readyharris.org/Contact/After-Action-Reports-And-Other-Resources/Mitigation-Planning

Outreach/Consultation with County/City Officials

County Offices of Emergency Management (OEMs) can be a great help to congregations in disaster prep and recovery. OEM personnel know that faith-based groups do a lot for their congregations and community. But **these government agencies don't always know which member(s) of the faith community to partner with.** Plus, procedures for response and recovery vary by county.

Personnel from congregations and from OEMs need to get to know each other. Leadership of faith-based groups need to identify their counterparts at the county OEM, and vice versa—both entities need to know, before the disaster strikes, who is in charge. Plus, they need to **have each other's contact information.** In Harris County, the local government is already reaching out to houses of worship to coordinate. Communication among various counties within the region would also help. It would let counties with more resources help those with fewer.

Networking and Consultation

Just as communication between faith-based groups and government organizations is important, so too is communication among congregations. This will allow faith-based groups that are more prepared help those that are less so.

- As one example, **Reedy Chapel has started an informal network** of disaster-response services with other Galveston Island congregations. The shared experience of multiple disasters has strengthened this network as well as interfaith ties.
- Less-vulnerable congregations have found ways to serve those that are in harm's way. Houses of worship farther inland can repair and mobilize quickly to aid those in Galveston, which is often hit hardest and takes longer to recover. **Inland congregations can host and house volunteers from across the country** who provide much-needed recovery-related labor.
- There are new efforts to better coordinate congregations across the Houston area to respond to natural disasters. Interestingly, the COVID-19 pandemic has strengthened this network. Some groups, like Houston Responds and Interfaith Ministries of Greater Houston, work to improve communication with **a biweekly call to share information from the Harris County Office of Emergency Management (OEM).** Knowing what's already available will help future efforts to fill in gaps and not duplicate services.

Disaster-proofing is an ongoing process. Congregations should choose a liaison and volunteers before the disaster. This will help them streamline response and know whom to contact. Volunteers are key to solving problems, organizing, and rebuilding before and after disasters. Also, using college students as volunteers could reduce the cost of rebuilding and create greater community connections.

Finally, faith-based groups need to think about how they will distribute information both before and after a disaster. (Harris County already has a platform for this). Keep in mind the age of congregants.

Fundraising

Many resilience treatments and strategies can be expensive, like any construction project. This section is focused on a specialized source of funding that many people do not know about, Preservation Tax Credits. Other funding sources are listed below for the record. These will likely be familiar to all congregations reading this *Resilience Roadmap*.

Funding for special projects or emergencies can come from several sources.

Post-disaster recovery specifically:

- Insurance claims on pre-existing policies can recover costs for repairing damage from a disaster like a hurricane. Insurance companies prefer lots of documents recording past work and photographs of everything. It is a smart idea to review insurance coverages periodically. Take a moment to review files for good records on all construction projects. Capture photos of all existing conditions at the same time.
- Federal agencies have special relief funds after disasters. These will usually require patient adminstrative skills and a willingness to provide detailed paperwork. Just like the records needed for insurance claims, you cannot have too much documentation on pre-disaster conditions.

Preparation/mitigation and maybe post-disaster, too:

- Local or national religious organizations and associations (e.g., Southern Baptist Convention, Catholic Archdiocese, United Methodist Church) have expertise, support networks, and possibly funds which may be available for resileince enhancement.
- Finacial investments managed as an endowment can be a "rainy-day" fund for special needs. Typically, an endowment is managed with a very long view, like a retirement account. Remember that cash in a bank savings or checking account will lose value over time due to inflation. Things will cost more in the future, so financial investments will help you keep pace. Seek guidance from trusted financial professionals.
- Corporate foundation grants, especially corporations with a presence in the local community, are always a good option to pursue. Relationships with corporate foundations need to be cultivated over time.
- Private fundraising through social media or direct appeals to potential donors. Existing members of the congregation will natural be top donors already.
- Preservation Tax Credits, described below.

One of the most important things to be done is virtually free of cost. Planning for disasters can be done with in-house staff and leadership of the congregation. Resilience is greatly enhanced simply by being ready with a plan, and then executing the plan when the time comes for action.

Preservation Tax Credits

Preservation tax credit programs can be a significant source of funds for historic preservation projects. This section provides a brief overview of how they work. More detailed information can be found on the THC's website (https://www.thc.texas.gov/preserve/projects-and-programs/preservation-tax-incentives/about-preservation-tax-incentives).

Tax credits are vouchers, issued upon completion of an approved historic preservation project, that can be used towards owed income tax. Even as a nonprofit organization that doesn't pay income tax, you can utilize tax credits because the vouchers are transferrable and there is a large market for them. In order to find a private buyer, you may have to sell the tax credit to a broker (so you may get about 80% of the value it is good for). There is a national tax credit program as well as a state program, and both are administered by the Texas Historical Commission.

If you need help with applying for tax credits, there are consulting firms that specialize in this process. ***See page 14*.**

The Federal Historic Preservation Tax Incentives Program is a 20% Federal Income Tax credit on qualified expenditures (basically anything historically appropriate that is part of the building which makes it more useful) for the rehabilitation of income-producing buildings. Most churches are nonprofits, so you may not be eligible for the federal credit.

However, the Texas Historic Preservation Tax Credit Program applies to both income-producing and nonprofit buildings. It is a 25% tax credit that can apply to Texas Franchise Tax or Texas Insurance Premium Tax based on qualified expenditures for historic rehabilitation.

If your property is eligible for both, the two programs can stack, providing up to a 45% tax credit, although they are managed by different agencies and have different time limits to use the credits.

Eligibility for both programs requires your building(s) to be listed on the National Register of Historic Places before work is performed. For the state program, your building can also qualify if it is a State Antiquities Landmark.

The Texas Historical Commission also offers a tax credit up to 25% in certain disaster relief scenarios. Like the normal tax credit program, it applies to qualified expenditures. However, it only goes towards items that were not covered under an insurance claim (you must file your insurance claim first).

Also, while interiors are typically not considered in most historic preservation project reviews, preserving them may be necessary for tax credits.

Disaster Response and Recovery Plan

In additon working on distater preparation, it is essential to have a Disaster Response and Recovery Plan that is specific to your congregation and cultural resources. If your congregation does not have such a plan, you will have to write one. It is important to coordinate your plan with your county's Hazard Mitigation Plan. Many local jurisdictions have Offices of Emergency Management that can offer insight, so check with local officials if you need assistance. If your congregation already has a plan, but it's been more than five years since it was updated, the plan should be reviewed and revised as necessary to keep procedures relevant and actionable.

A Disaster Response and Recovery Plan should cover all phases of disaster management: preparedness, response, recovery, and mitigation. Naturally, the focus will be on response and recovery. The hazards identified in this *Roadmap* (*see page 5*) should be emphasized, and realistic and safety-driven responses to each hazard will be the main items of the plan.

The plan should include clearly defined roles and responsibilities so that there is an effective leadership structure at the scene as soon as possible. Key members of the congregation should be designated for each role. It should also include procedures for operating (e.g., disabling and enabling) building and security systems. All movable cultural heritage (artifacts to be protected) should be inventoried in this plan and prioritization procedures provided for their handling and salvage (*see page 17*). The plan should anticipate where each operation will be staged and where emergency equipment (e.g., fans, generators) is stored. If you notice that you do not have equipment that will be necessary to facilitate response and recovery, obtain the missing items as soon as possible. Include necessary operating manuals with the Disaster Response and Recovery Plan.

The plan should also include a contact list of key members of the congregation, maintenance personnel, local agencies, your insurance company (with policy information), and businesses or nongovernmental organizations that can assist or specialize in disaster recovery. If you have special cultural artifacts in your care (e.g., historic paintings, rare or fragile documents, photographs made via early processes), also include contact information for conservators that can be reached out to for special assistance.

When you have drafted the plan, be sure to get it reviewed by a balanced group of knowledgable stakeholders to ensure readiness for a coordinated response. This ensures the plan is accurate, and increases the chance of broad participation in the plan's procedures.

To ensure resilience of the plan itself, make it available in print form and back it up digitally. The print copy (or copies) should be in a place where it can be quickly accessed by those responding to the disaster. Many historic sites find it helpful to **keep a special briefcase with all the key documents and other items (keys, codes, batteries, flashlight, saftey vest, etc.) to be carried out the door as the final step in a disaster response.** Make sure that everyone who may form the disaster response and recovery team is aware of its location, and a complete copy should be left behind at the property, as well. A specially colored binder (e.g., red) is a good idea so that it stands out. Consider putting the pages in sheet protectors or laminating specific pages that may need to be carried into wet conditions. Several printed pages with bullet-point instructions can be handy to pass out to volunteers that may be unfamiliar with your building and congregation.

The following resources offer more information for incorporating hazard planning into historical preservation:

Article/Site Name	Author(s)	Website
FEMA Office of Environmental Planning and Historic Preservation	FEMA	https://www.fema.gov/environmental-and-historic-preservation
R6 Environmental and Historic Preservation (EHP)	FEMA	https://www.fema.gov/r6-environmental-and-historic-preservation
Integrating Historic Property and Cultural Resource Considerations Into Hazard Mitigation Planning State and Local Mitigation Planning How-To Guide	FEMA	https://www.fema.gov/pdf/fima/386-6_Book.pdf
Disaster Recovery Helping Historic Communities Recover from Climate- and Weather-related Disasters	National Trust for Historic Preservation	https://savingplaces.org/disaster-recovery#.XyCCQZ5Kg2w
Promoting Historic Preservation Across the Nation	Advisory Council on Historic Preservation	https://www.achp.gov/
National Archives	National Archives	https://www.archives.gov/
National Conference of State Historic Preservation Officers	NCSHPO	https://ncshpo.org/
Tribal Historic Preservation Office	National Association of Tribal Historic Preservation	http://www.nathpo.org/
National Park Service, Disaster Planning	National Park Service	http://www.nps.gov/stlpg
Foundation of the American Institute for Conservation	Heritage Emergency	http://www.heritageemergency.org/
Preservation Impacts and Disaster	National Center for Preservation Technology & Training	https://ncptt.nps.gov/
National Historic Landmarks Program	National Park Service	https://www.nps.gov/orgs/1582/index.htm
National Register of Historic Places	National Park Service	https://www.nps.gov/subjects/nationalregister/index.htm
State, Tribal, and Local Plans & Grants Division	National Park Service	http://www.nps.gov/orgs/1623/index.htm
Historic Preservation Easements	National Park Service	www.nps.gov/tps/tax-incentives/taxdocs/easements-historic-properties.pdf
ESHP Disaster Assistance Grants for Historic Resources	NC Department of Natural and Cultural Resources	https://www.ncdcr.gov/about/history/division-historical-resources/nc-state-historic-preservation-office/grants-historic-1
Disaster Planning for Florida's Historic Resources	1000 Friends of Florida	https://www.floridadisaster.org/globalassets/importedpdfs/disaster_planning_for_historic_resources.pdf

Training

Your congregation's leadership and key personnel should have a solid understanding of the Disaster Response and Recovery Plan. Every role that needs to be carried out in the plan should be designated to key personnel among your leadership and/or congregation. Those designated people (and backup key figures) need to be trained and prepared for their roles to take charge during a disaster response.

It is also good practice to periodically conduct mock disaster recovery drills. Practicing once every year or two for a different type of disaster ensures readiness and consistency, and lets you engage volunteers that are anticipated to take part in recovery operations. These can also be opportunities to reach out to local emergency response agencies, and are good occasions to make sure everyone has each other's contact information before a disaster strikes.

Stage Four: Resilience Treatments and Strategies

This stage provides an overview of common Resilience Treatments and Strategies (RTS) that can reduce the vulnerabilities of each cultural heritage component.

The following pages are intended to serve as a reference. They simply provide an idea of which types of interventions might be able to be performed in-house and which might require professional assistance:

- RTSs listed as "In-house" on the left column require some tools and skills, but can generally be done without specialized equipment or expertise. Consult with the THC first if any of these treatments will affect character-defining features.
- RTSs listed as "Professional needed [type]" on the right column indicate which type of professional you should reach out to first (*see Hiring Professionals, page 14*). They will be able to diagnose issues and prescribe, oversee, and implement tailored work. Sometimes, additional specialists will be necessary. All of these RTSs will need consultation with the THC and other relevant regulatory authorities.

This section is grouped by components of cultural heritage. Each property's historic, cultural, or aesthetic significance is typically composed of many elements at differing scales:

- The broadest aspect is your congregation. The strategy for enhancing your congregation's preparedness is to create or update a Disaster Response and Recovery Plan and conduct training (*see page 24*). It is also important to continue assessing your operations to ensure they are up to date (*see Continued Assessment, page 62*).
- The broadest physical component is the **cultural landscape**, which encompasses large-scale elements like landscaping and outbuildings. These include:
    - Soil *page 29*
    - Flood risk *page 30*
    - Stormwater control *page 31*
    - Trees *page 32*
    - Surrounding buildings *page 33*
    - Environmental hazards *page 34*
- There are many **building components**, some large and some small. Most are material assemblies, which include:
    - Foundation *page 35*
    - Basements & crawl spaces *page 36*
    - Floor structure *page 37*
    - Floor finishes *page 38*
    - Roof structure *page 39*
    - Roof attachments *page 41*
    - Wall structure *page 42*
    - Exterior wall finishes *page 44*
    - Interior wall finishes *page 46*
    - Windows *page 48*
    - Doors *page 50*
    - Ceilings *page 51*
    - Stairs *page 52*
    - Towers *page 53*
    - Also, building services *page 54*

- The smallest scale (but not least important!) are contained within the building. These are referred to as **movable cultural heritage**, although moving them is sometimes not feasible. These include:
    - Documents, photos & A/V media *page 56*
    - Books *page 58*
    - Paintings, statuary & sacraments *page 60*
    - Furniture *page 61*

A typical property may not have all of these types of heritage (such as towers), so you should refer to just the categories that apply to your historic property.

Also, some of these categories are more important than others to a building's resilience due to their exposure to the elements (such as wind or rain) or their structural nature (they support, enclose, or otherwise protect other building assemblies). The following RTS pages describe the general importance with regards to resilience (very high, high, moderate, low, very low, or negligible). This is to help you prioritize which RTSs to implement in the case of limited resources. It does not reflect importance due to special historic, cultural, or aesthetic significance. Those concerns also need to be considered, as they are unique to each property.

When implementing RTSs, all parties involved should be familiar with the *Secretary of the Interior's Standards* (*page 14*) and adhere to them to the greatest extent possible. This can sometimes be a legal requirement, such as projects involving the exterior of a building designated as an RTHL.

As an additional reference, all individual RTSs are also provided in Appendix C, grouped together and sorted by general importance to resilience.

Soil

An aspect of the **cultural landscape**'s resilience

Description

Commonly referred to as dirt or earth, soil is the natural granular material that often supports and surrounds your building's foundations. There are many types, grouped by size (e.g., coarse- or fine-grained), organic content, plasticity, minerology, and other factors. All of this affects how solidly the soil can support your building and other loads. Soil types are often referred to by their classification by size distribution according to ASTM standards.

Typical risk factor of this component: **Moderate**

Exposure to the elements for soil depends on its cover, but generally the likelihood of failure at a typical site in the Texas Gulf Coast region is moderate. The impact of failure on the building is likely to be high.

Typical damages from floods or hurricanes:

- Erosion, scouring
- Swelling, shrinking
- Site elements settling unevenly from the building
- Uprooted trees

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Exposed topsoil (e.g., no vegetation covering such as grass)
- Soil prone to washout because of its type (e.g., high in sand content)
- Soil shrinks/swells due to moisture fluctuations because of its type (e.g., high in clay content)
- Downspouts missing or do not lead directly to splash blocks or a subgrade drainage system
- No way of directing water away from building

Resilience Treatments and Strategies:

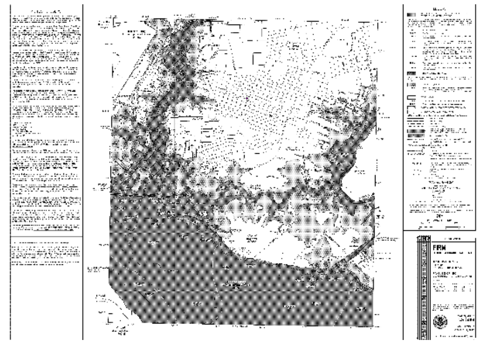
In-house	Professional needed [type]
Plant and maintain light vegetation (e.g., grass) to cover and hold the soil around the building. Irrigate soil if shrinking excessively and if watering is allowed (under drought conditions).	Regrade the site to direct water away from the property (if legal for your local jurisdiction) [**landscape architect or civil engineer**]. Add major landscape elements (e.g., paving, retaining walls, trees) to keep soil in place (may impact the site's integrity) [**landscape architect or civil engineer**]. Replace soil surrounding the building [**civil engineer**].

Flood Risk

An aspect of the **cultural landscape**'s resilience

Description

The likelihood that your property will be inundated by floods. This includes flash floods and coastal storm surge. Several factors are important, including if your property is in a defined floodplain, the local topography, local infrastructure that could fail and cause floods (e.g., dams or levees), and strategies in place that address flooding.



Typical risk factor of this component: **Very High**

The risk of flooding can be low depending on siting and mitigating factors, but flash floods can occur even outside of defined floodplains. The impact a flood would have on the building's condition is always likely to be very high.

Common conditions contributing to vulnerability towards floods or hurricanes:

- Site in FEMA (100-year or 500-year) floodplain
- Site at risk of coastal storm surge flooding

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Adopt a wet floodproofing strategy: move all water sensitive assemblies, services/utilities, and movable heritage above BFE or DFE (you **may need help from an architect or engineer** for this).	Raise building(s) above BFE or DFE. Keep in mind that this would have a substantial visual impact and would likely reduce integrity. You would have to consult with all necessary officials per your building's historic designation [**architect and engineer**]. Adopt a dry floodproofing strategy if appropriate for the type of wall construction: apply a water-resistant coating to exterior walls and enable all openings to be made watertight during a flood [**architect**]. Construct a floodwall around property [**architect, engineer and/or landscape architect**]. Regrade the site to direct water away from the property (if legal for your local jurisdiction) [**landscape architect or civil engineer**].

Stormwater Control

An aspect of the **cultural landscape**'s resilience

Description

Refers to the management of stormwater runoff. The purpose is to minimize your site's contribution to flooding and pollution. Systems designed to control stormwater can include active systems (e.g., engineered containment systems) or passive systems (e.g., berms). The system needs to be sized by an engineer to handle the anticipated volume of stormwater.

Typical risk factor of this component: **Moderate**

Stormwater control systems are typically appropriately sized to handle the anticipated volume of stormwater, so likelihood of failure is low. However, the impact a failure could have on the building's condition is high.

Typical damages from floods or hurricanes:

- Stormwater control system inlets are blocked by debris, impairing functionality and causing ponding

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Stormwater control system is undersized to handle the amount of water for storms in the area
- Lack of integration between building roof drainage and site drainage systems

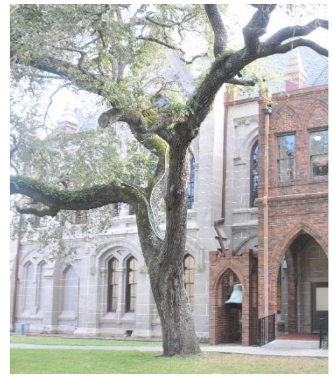
Resilience Treatments and Strategies:

In-house	Professional needed [type]
Maintain (keep debris clear from) drain grilles, culvert mouths, drainage channels, etc. (*see also NPS Preservation Brief #47*). Ensure they are properly connected to the broader stormwater control system. Maximize permeable surfaces in the landscaping, rather than impermeable surfaces. Consider adding detention ponds, rain gardens, rainwater tanks, or other such water control strategies to landscaping. Check regularly for water collection after rain events. Even small rain events can reveal problems that can be devastating in a more severe rain event.	Install a subgrade drainage system (e.g., French drain) that connects to a broader stormwater control system [**landscape architect or civil engineer**].

Trees

An aspect of the **cultural landscape**'s resilience

Description



Large organic landscaping elements. Trees can contribute to your site's significance (e.g., as part of a designed cultural landscape). However, they can also compromise the building's resilience. Scenarios include the tree falling down, branches breaking off, or roots penetrating your building's foundation. Some trees may be protected by local ordinances and you may need approval from city arborists to work on them. Some plants, such as palms, are technically not trees but can still pose a threat due to their size.

Typical risk factor of this component: **Low**

Trees typically have a very high exposure to elements such as wind or rain. However, they have negligible importance to the structure's stability and their failure generally has little impact on building assemblies.

Typical damages from floods or hurricanes:
- Uprooted trees (total/dead or partial/still alive)
- Downed branches

Other common conditions contributing to vulnerability towards floods or hurricanes:
- Tree growing close to building, threatening foundations (as well as drains, sewers, and gas mains) or posing a risk to building from collapse or wind throw

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Prune foliage and cut off small dead limbs from trees that are in immediate vicinity of building. Add permanent anchoring elements to keep trees upright and in place. Provide proper care for trees to keep them healthy and strong. Develop a plan for integrating new trees before older trees reach the end of their life.	Remove large dead limbs or entire trees that are in immediate vicinity of building [**arborist**]. Consider replacing damaged trees that are culturally significant or are necessary to retain soil [**landscape architect**]. Relocate trees in immediate vicinity of building [**landscape architect**]. Create historic landscape inventory and treatment plans to preserve, maintain, and treat culturally significant landscape elements (*see also NPS Preservation Brief #36*) [**landscape architect**].

Surrounding Buildings

An aspect of the **cultural landscape**'s resilience

Description

Nearby buildings may be part of one complex of historic buildings, all contributing to your property's significance. Or, they may belong to other property owners. Surrounding buildings might compromise your historic building's resilience if they are very close (e.g., shedding water onto your building). In urban conditions, adjacent buildings may even be connected, sharing a party wall on the property line. The condition of surrounding buildings can also be a threat (e.g., if parts of them are torn off in a storm and hit your building).

Typical risk factor of this site component: **Low**

In most settings, surrounding buildings are unlikely to pose a significant threat. However, in high-density areas or cases of very poor maintenance, adjacent buildings can have a moderate impact to your building's condition.

Typical damages from floods or hurricanes:

- Windborne debris generated from loose building materials act as projectiles in high winds

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Slope or pitch of adjacent buildings' assemblies directs water towards or onto your building
- Pest intrusion or mold outbreak afflicting adjacent buildings that can spread to your building
- Landscape grade at adjacent sites channeling water towards your site

Resilience Treatments and Strategies:

In-house	Professional needed [type]
For buildings you own, ensure fasteners (e.g., for roofing, siding) are in good condition and rated to withstand high winds. Maintain buildings in good condition (*see also NPS Preservation Brief #47*). For buildings beyond your property line, meet with adjacent property owners to discuss reducing vulnerability.	For buildings you own, design and execute improvements necessary to keep buildings in good condition and for good stormwater drainage [**architect or engineer**]. Treat pest intrusion and mold outbreaks [**specialty contractor**].

Environmental Hazards

An aspect of the **cultural landscape**'s resilience

Description

Nearby industrial sites or infrastructure (a.k.a. brownfield sites) that may pose some level of health or safety risk under ordinary conditions. In a disaster, they become potential sources of contaminants, possibly impeding recovery operations. Examples include power stations and substations, refineries, incinerators, chemical plants or storage facilities, waste treatment plants or disposal sites, freight rail lines or yards, and gas stations. The extent of the hazard can depend on its size/capacity and distance from your property.

Typical risk factor of this component: **Very High**

Environmental hazards typically have a very high exposure to elements such as wind or rain. At many sites, a failure could have a very severe impact to the structure's stability, its assemblies' conditions, and safe occupation.

Typical damages <u>from</u> floods or hurricanes:

- Downed power lines inhibiting access from emergency responders and posing electric shock hazards
- Toxic chemical releases complicate post-disaster occupancy, often requiring special cleanup
- Ruptured tanks or pipes of flammable materials can combust, which can start fires, launch projectiles, and cause damage with the blast shockwave

Other common conditions contributing <u>to</u> vulnerability towards floods or hurricanes:

- Lack of special flood control measures, such as dikes or levees, to protect heavy industry
- Air pollution and acid rain deteriorate many materials at an accelerated rate
- Vibrations from heavy industrial traffic, excavation, or blasting operations near the building can cause seismic-associated deterioration of assemblies

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Report any environmental concerns (e.g., spills, unauthorized dumping) to the relevant authority (e.g., EPA, TCEQ). Monitor and document damages that are associated with environmental hazards. Photograph or video the hazard and what is happening at your property (e.g., building assemblies moving, cracks appearing or worsening, soot/chemical staining). Understand vulnerabilities posed by nearby hazards and plan your responses in advance.	If a facility poses particular concern for safety, consult local authorities and experts on how it may impact disaster recovery in your area and possible solutions [**government, NGO, or legal**]. Install vibration dampers to seismically isolate the building if vibrations cannot be reduced [**engineer**].

Foundation

An aspect of the **building**'s resilience

Description

Part of your building's substructure. The lowest part of the structure that meets the ground and transfers the loads of your building and its contents into the earth. Foundations can be shallow or deep, one way or two way. Many further specific construction types exist (e.g., slab on grade, piles, grade beams, caissons, raft/mat). Some historical foundations, depending on the material and construction, may not be as resilient to disasters as some modern foundations (e.g., they may be less resistant to water infiltration, earthquake damage, or uplift and overturning from high winds).

Typical risk factor of this component: **Moderate**

The foundation has some exposure to floodwaters, but little exposure to the elements such as wind and rain. Its importance to the structure's stability and the impact a failure might have on other assemblies are both moderate.

Typical damages from floods or hurricanes:

- Uneven settling (a.k.a. differential settlement) between building areas or elements
- Rising damp (unprotected materials soaking up moisture from the ground)
- Site elements settling unevenly from the building
- Foundations undermined due to soil washout

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Lack of protective coatings or finishes in basement or crawl space, or damage to existing

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Avoid use of de-icing salts, fertilizers, and bladed devices in the vicinity of foundations while performing maintenance or landscape work (*see also NPS Preservation Brief #47*).	Reinforce or enlarge the foundation and its connections with structural stiffening members to improve strength to resist forces such as rapid-moving floodwaters [**engineer**]. Temporary underpinning may be necessary. Install damp-proofing to the foundation [**architect**]. Replace or tamp soil around building to provide greater strength (*see also Soil, page 29*) [**landscape architect or civil engineer**]. Apply new or repair existing protective waterproof coating (*see also NPS Preservation Brief #39*) [**architect**].

Basements & Crawl Spaces

An aspect of the **building**'s resilience

Description

Part of your building's substructure. The lowest stories of a building, partially or entirely below ground. Finished basements can be occupiable spaces that are climate controlled and furnished. Basements solely for storage and utilities might lack these features, leaving them potentially vulnerable to disasters. Crawl spaces are also considered here, which are not full-height like basements and may or may not be fully enclosed.

Typical risk factor of this component: **Moderate**

A basement has moderate exposure to floodwaters, but little exposure to elements such as wind and rain. Its importance to the structure's stability and the impact a failure might have on other assemblies are both low.

Typical damages from floods or hurricanes:

- Basement walls and/or floors are buckling from exterior forces (e.g., hydrostatic pressure from surrounding soil saturated by water)
- Materials stored in basement become waterlogged and/or moldy

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Lack of protective coatings or finishes in basement or crawl space, or damage to existing

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Carefully pump out water and ventilate walls to allow waterlogged surfaces to dry out.	Install temporary supporting works (e.g., shoring, bracing, planking, strutting, jacking) [**engineer**]. Reinforce basement walls with structural stiffeners (e.g., deep anchoring, buttresses, reinforcement bars) to improve strength against hydraulic forces [**engineer**]. Apply new or repair existing protective waterproof coating (*see also NPS Preservation Brief #39*) [**architect**].

Floor Structure

An aspect of the **building**'s resilience

Description

Part of your building's superstructure (the building's load-bearing elements) that supports each occupiable story. Typical components may include a subfloor (e.g., boards or plywood) on top of frame members (e.g., beams or joists). Framing is often wood, although metal or concrete framing is also common in larger buildings. Masonry vaulting may be found in many historic buildings. The ground floor level, or finished floor elevation, is an important consideration for resilience against flooding.

Typical risk factor of this component: **Low**

The floor structure has little exposure to elements such as wind and water. Localized damage should not impair the structure's overall stability, and the impact a partial failure might have on other assemblies is relatively low.

Typical damages <u>from</u> floods or hurricanes:

- Floor joists or beams have wet/dry rot
- Structural connections loose or damaged
- Wood frame members have become waterlogged and are buckling, bowing, cupping, or swelling
- Substantial pest/insect infestation (e.g., termite damage in wood members)
- Uneven settling (a.k.a. differential settlement) between building areas or elements
- Deflecting or sagging joists or beams
- Concrete carbonizing (losing alkalinity), possibly causing spalling around reinforcement bars within

Other common conditions contributing <u>to</u> vulnerability towards floods or hurricanes:

- Floor framing not protected with coatings or treatment

Resilience Treatments and Strategies:

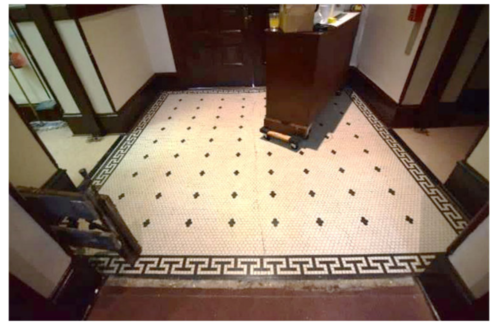
In-house	Professional needed [type]
Air out the building immediately following water infiltration and saturation, limiting the use of forced ventilation to avoid drying surfaces too quickly. If mold is present, consult **specialists that treat hazardous materials**. Investigate (with non-destructive or easily reversible methods) to determine if structural components are damaged (**may require a professional**, depending on the material and access).	Reinforce the joists and their connections with structural stiffening members to improve strength to forces such as rapid-moving floodwaters [**engineer**]. Repair or replace damaged/unstable beams or joists [**engineer**]. Apply protective or consolidating coatings (e.g., borates, intumescent paint) to floor framing to mitigate risk of damage [**architect**].

Floor Finishes

An aspect of the **building**'s resilience

Description

The exposed surface on top of the floor structure. It provides protection from wear to the subfloor, although it is typically not necessary to support structural loads. Floor finishes in historic buildings often have aesthetic significance (e.g., tile mosaics or parquet floors). If unprotected (such as with coatings), surfaces that experience high traffic can deteriorate from wear.



Typical risk factor of this component: **Low**

Floor finishes are typically not exposed to elements such as wind and rain. Localized damage or partial failures will generally neither impact the structure's overall stability, nor affect other assemblies.

Typical damages from floods or hurricanes:

- Mold growth
- Waterlogged or otherwise water-damaged finishes (e.g., buckling, bowing, cupping, or swelling)
- Substantial pest/insect infestation (e.g., termite damage in wood finishes)

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Nonresilient floors (e.g., wood, carpet) not protected with coatings or treatment

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Air out the building immediately following water infiltration and saturation, limiting the use of forced ventilation to avoid drying surfaces too quickly. If mold is present, consult **specialists that treat hazardous materials**. Carefully remove all finishes that are waterlogged and cannot be saved; replace with in-kind elements and refinish/restore elements that can be saved.	Restore decorative flooring (e.g., mosaics, parquet flooring) [**building or art conservation professionals**].

Roof Structure

An aspect of the **building**'s resilience

Description

Part of your building's superstructure (the building's load-bearing elements) that supports the top enclosure of the building. There are many roof construction types which influence the shape and pitch of the roof (e.g., trusses). Both the materials and the form of the roof are very important to the building's resilience. They are among the most exposed faces of the structure and can be thought of as your building's first line of defense from the elements. Partial or total roof failure can lead to water damage to anything inside your building. The roof materials, including flashing and trim, should be well-maintained, warrantied, and insured if possible.

Typical risk factor of this component: **Very High**

The roof has very high exposure to elements such as wind and rain, which constantly cause wear. Its importance to the structure's stability and the impact its failure might have on other assemblies are both very high.

Typical damages from floods or hurricanes:

- Structural connections loose or damaged
- Roof trusses showing oxidation (if metal) or wet/dry rot (if wooden)
- Wood frame members have become waterlogged and are buckling, bowing, cupping, or swelling
- Substantial pest/insect infestation (e.g., termite damage in wood surfaces)
- Roof materials (e.g., metal roof pans) fracture or creep due to high flexure under windy conditions

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Undersized drainage ports (e.g., scuppers and downspouts) handling water shedding from the roof
- Lack of overflow drainage
- Galvanic corrosion occurring between metal roof components (e.g., fasteners and flashing or trim)
- Oxidation (e.g., rust) of metal roof components
- Lack of underlayment (e.g., waterproof membrane, felt, building paper) between roof sheeting and roof structure
- Lack of hurricane-rated clips, anchors, or connectors

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Regularly inspect (at least once yearly) for defects such as loose or missing roof shingles, evidence of ponding, accumulation of debris or vegetation, bird nests or other animal presences, etc. (*see also NPS Preservation Briefs #4 and #29*).	Reinforce roof structure and its connections with structural stiffening members to improve strength to forces such as wind [**engineer**].
Implement an integrated pest management plan.	Repair or replace damaged trusses or beams, and their connections [**engineer**].
Maintain and renew insurance and warranties for roof materials and work.	Adjust size and layout of drainage system to properly shed water and protect building assemblies [**architect**].

Roof structure, continued

Resilience Treatments and Strategies, continued:

In-house	Professional needed [type]
	Install waterproof membrane when applying new roof materials, if appropriate [**architect**].

Roof Attachments

An aspect of the **building**'s resilience

Description

Includes components that connect to the roof to provide drainage, such as gutters, exterior downspouts, scuppers, and associated hardware. These usually connect to a stormwater system or drain out to a public street.

Also includes components that penetrate the roof surface, such as dormers, skylights, vents, chimneys, and hatches. These can affect the structural behavior of your roof and need consideration for proper drainage of water from the roof.

Typical risk factor of this component: **Moderate**

Roof attachments are very exposed to elements such as wind and rain. However, they have negligible importance to the structure's stability and their failure generally has little to no immediate impact on other assemblies. Over time, dysfunctional roof drainage systems will result in damage to other building assemblies.

Typical damages from floods or hurricanes:

- Downspouts missing or do not lead directly to splash blocks or a subgrade drainage system
- Leaking, rusting, or otherwise failing gutters, downspouts, or connections
- Moisture around downspouts

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Undersized drainage ports handling water shedding for roof
- Lack of overflow drainage
- Galvanic corrosion occurring between metal roof components
- No way to direct water away from building
- Gutters blocked with debris such as leaves
- Lack of crickets or flashing around roof penetrations such as chimneys

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Adjust downspouts so that water flows into the drainage system, or replace if necessary (in-kind, may need an **architect** in this case).	Adjust size and layout of drainage system to properly shed water and protect roof structure [**architect**].
Repair any leaking/damaged gutters, downspouts, and their connections.	Install subgrade drainage system [**landscape architect or architect**].
Install splash blocks or use other methods to convey rainwater away from the building without causing soil erosion.	
Inspect, clean, and repair all gutters and downspouts annually (*see also NPS Preservation Brief #47*).	

Wall Structure

An aspect of the **building**’s resilience

Description

The upright parts of your building’s superstructure (the building’s load-bearing elements) that support upper stories or the roof. Load-bearing parts of a wall may include wood framing (dimensional lumber or heavy timbers), solid masonry, metal columns, reinforced concrete, and other construction types. Wall construction can also use a hybrid of different technologies. Except for load-bearing masonry, the wall structure is often concealed behind finishes.

Typical risk factor of this component: **Moderate**

The wall structure generally has little exposure to elements such as wind and rain. However, it is highly important to the structure’s stability and the impact a failure might have on other assemblies is also high.

Typical damages <u>from</u> floods or hurricanes:

- Uneven settling (a.k.a. differential settlement) between building areas or elements
- Large cracks (over 1/8” thick) in masonry walls
- Wood frame members (e.g., studs) have become waterlogged and are buckling, bowing, cupping, or swelling
- Deteriorating bedding mortar
- Adobe or dried masonry becoming waterlogged

Other common conditions contributing <u>to</u> vulnerability towards floods or hurricanes:

- Deformation within walls due to thermal expansion
- Movement of soils (*see also Soil, page 29*)
- Adobe or dried masonry is exposed without being protected from water damage
- Vegetation growing in or through exterior walls
- Metal components oxidizing, expanding, and causing structural damage to surrounding wall

Resilience Treatments and Strategies:

In-house

Air out the building immediately following water infiltration and saturation, limiting the use of forced ventilation to avoid drying surfaces too quickly. If mold is present, consult **specialists that treat hazardous materials**.

Install and check crack monitors on large cracks to determine their stability.

Implement an integrated pest management plan.

Professional needed [type]

Reinforce wall structure and its connections with structural stiffening members to improve strength to forces such as wind and fast-moving floodwaters [**engineer**].

Repair, coat (e.g., paint, galvanize), or replace damaged metal components with similar assemblies that will resist oxidation [**architect**].

Perform deep repointing of bedding mortar, after addressing underlying causes of mortar loss [**architect**].

Wall structure, continued

Resilience Treatments and Strategies, continued:

In-house	Professional needed [type]
	Consolidate wood frame members or reinforce with epoxy if appropriate and necessary to improve strength [**architect or engineer**].

Exterior Wall Finishes

An aspect of the **building**'s resilience

Description

Lightweight materials applied on the outside of exterior walls' structural elements. They protect the structure and also have an aesthetic purpose. Common historic finishes for exterior walls include renders (e.g., stucco), wood siding, and masonry as a veneer. In some historic masonry buildings, the exterior walls are load-bearing and not a veneer. Exterior materials are often coated for their own protection and aesthetics.

Typical risk factor of this component: **Moderate**

Exterior wall finishes are exposed to elements such as wind and rain. Finishes, siding materials, and veneers have negligible importance to the structure's stability and their failure generally has little to no impact on other assemblies. However, if the weather envelope is breached, further damage can follow quickly.

Typical damages <u>from</u> floods or hurricanes:

- Rising damp or salt crystallization within walls
- Moisture around downspouts
- Blistering, peeling, bubbling, scouring, or spalling stucco/render
- Spalling, pitting, or cracking masonry
- Wood siding has become waterlogged and is buckling, bowing, cupping, or swelling
- Eroded masonry pointing
- Lack of protective coatings

Other common conditions contributing <u>to</u> vulnerability towards floods or hurricanes:

- Vegetation growing on exterior
- Metal components oxidizing, expanding, and causing structural and cosmetic damage to surrounding wall
- Uneven discoloration or wetting pattern on wall surface
- Heavy staining, scouring, dirt, efflorescence, or biological growth

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Carefully remove light vegetation by hand and restore finishes. However, if vegetation is severe (e.g., penetrating through wall), consult an **engineer** to restore wall. Monitor visible defects such as discoloration or wetting patterns (*see also NPS Preservation Brief #47*). If these patterns change or get worse, consult an **architect or preservation specialist** to investigate the cause. Repair light damages such as isolated cracks in masonry or stucco/render (*see also NPS Preservation Brief #22*).	Install damp-proofing to the foundation to combat rising damp [**architect or engineer**]. Repair, coat (e.g., paint, galvanize, wax), or replace damaged metal components with similar assemblies that will resist oxidation [**architect**]. Apply water-resistant coatings (e.g., silicone, acrylic resin, linseed oil, paraffin wax, fluopolymers) to exposed surfaces [**architect or building conservation professional**].

Exterior wall finishes, continued

Resilience Treatments and Strategies, continued:

In-house	Professional needed [type]
Gently clean affected masonry (e.g., stains, dirt, biological growth) with a diluted masonry cleaner (*see also NPS Preservation Briefs #1, #6, and #47*). If the condition still appears or quickly returns, talk to an **architect or building conservation professional** to determine cause of the problem and appropriate treatments. Provide small expansion gaps between major exposed wood members and adjacent surfaces to account for expansion when saturated or shrinkage when drying. Cover porous materials prior to storms to prevent them from intensive wetting or other extreme climatic conditions. Repoint mortar joints (see also *NPS Preservation Brief #2*).	Restore or repair cracks, spalls, or other surface defects. Plastic substitute patches (e.g., epoxy resin) may be necessary where replicating the material is impossible. Consolidate or grout unstable masonry as needed after addressing underlying causes. Deformations and cracks beyond surface defects need assessment and possibly immediate stabilization [**architect or engineer**]. Provide protection to sensitive masonry or earthen walls (e.g., adobe) such as with canopies or extended roof eaves (may impact the integrity of design) [**architect**]. Remove excessive salts with poultices or leaching packs [**building conservation professional**].

Interior Wall Finishes

An aspect of the **building**'s resilience

Description

Lightweight materials applied over interior walls' structural elements. They protect the structure and also have an aesthetic purpose. Common historic finishes for interior walls include plaster, wood paneling, and gypsum wall board (a.k.a. Sheetrock®). Interior finishes are often painted for aesthetics, which may be culturally significant.

Typical risk factor of this component: **Very Low**

Interior wall finishes are typically not exposed to elements such as wind and rain. They have negligible importance to the structure's stability and their failure would have little to no impact on other assemblies.

Typical damages from floods or hurricanes:

- Mold growth
- Rising damp or salt crystallization within walls
- Waterlogged or otherwise water-damaged finishes (e.g., buckling, bowing, cupping, or swelling)
- Blistering, peeling, bubbling, or scouring plaster
- Delamination of layered or composite finishes

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Lower interior floor level than exterior grade
- Defects (e.g., scratches, flaking paint, peeling wallpaper) in interior finishes

Resilience Treatments and Strategies:

In-house

Air out the building immediately following water infiltration and saturation. Avoid using forced ventilation to avoid drying surfaces too quickly, unless you know the finish will not be damaged by the practice. If mold is present, consult **specialists that treat hazardous materials**.

Quickly clean and disinfect surfaces after airing them out. Use cleaners and soft brushes that are appropriate for the type of surface and potential biological growth (*see also NPS Preservation Brief #6*).

Carefully remove all finishes that are waterlogged and cannot be saved or if necessary to dry out underlying material (if it is safe to do so, e.g., there is no mold or asbestos). Replace with in-kind elements. Refinish/restore anything that can be saved.

Professional needed [type]

Remove and dispose of hazardous materials such as asbestos and lead paint (*see also NPS Preservation Brief #37*) [**EPA licensed contractors**].

Restore decorative painting, murals, plasterwork, or carvings (*see also NPS Preservation Briefs #23, #28, and #34*) [**building or art conservation professionals**].

Install vapor barrier within wall cavity if appropriate for wall assembly type (*see also NPS Preservation Brief #39*) [**architect**].

Interior wall finishes, continued

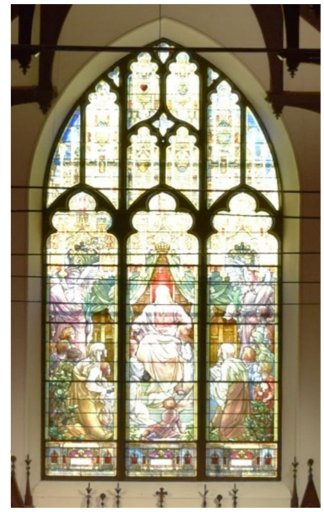
Resilience Treatments and Strategies, continued:

In-house	Professional needed [type]
Patch or repair minor flaws in interior finishes, (*see also NPS Preservation Briefs #21 and #28*). Use finishes that can be cleaned easily, if appropriate. Carefully reattach finishes such as wallpaper with appropriate adhesives (e.g., pure wheatstarch paste). Implement an integrated pest management plan. Consider applying a non-absorptive finish (e.g., a tile wainscot) to the base of walls, if appropriate.	

Windows

An aspect of the **building**'s resilience

Description



Openings in a wall that provide light or ventilation, filled with glass (a.k.a. glazing). Windows can have one layer of glass (single-glazed) or multiple layers (e.g., double- and triple-glazed). Individual panes of glass are referred to as lites. Lites are separated by thin strips (muntins, traditionally made of lead and called cames) or larger dividers (mullions). Windows are often character-defining features of historic buildings. Most historic windows were originally operable, although over the years many have been made fixed (inoperable) and no longer allow ventilation. Protective panels or membranes are very important for resilience, shielding lites from debris in high winds. The condition of the frame is also important because it secures the window and in another place where water can infiltrate the building.

Typical risk factor of this component: **High**

Windows have very high exposure to elements such as wind and rain. They have little importance to the structure's stability, although their failure would have some impact on other assemblies.

Typical damages from floods or hurricanes:

- Deteriorating window frames (e.g., rotting wood sills, rails, stiles)
- Metal lintels over windows oxidizing
- Cracked window lites
- Failing window sealant or caulking

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Lack of hurricane-rated protective panels or membranes
- Sealed condition between window lites and protective panels, allowing moisture to concentrate
- Untempered glazing or plate glass (a safety concern if the window breaks)
- Poor seal or weather tightness
- Inoperable windows

Resilience Treatments and Strategies:

In-house

Install protective polycarbonate (a.k.a. Lexan®) or acrylic (a.k.a. Plexiglas®) panels over windows that are rated to withstand hurricane-force winds. You **may need professional help** if you have unique windows, such as trace windows.

Ventilate space between window lites and protective panels so that water doesn't get trapped there; provide insect screens to prevent infestation.

Apply safety/security window film to untempered glazing.

Professional needed [type]

Install permanent shutters (only if historically appropriate and designed to avoid impeding egress) [**architect**].

Repair, coat, or replace damaged metal components (e.g., steel lintels) with similar assemblies that will resist oxidation [**architect**].

Replace cracked window lites or damaged lead dividers with in-kind elements (*see also NPS Preservation Brief #33*) [**architect, building conservator, or window preservation specialist**].

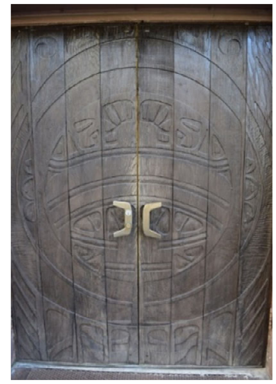
Windows, continued

Resilience Treatments and Strategies, continued:

In-house	Professional needed [type]
Install weather-stripping to sashes of operable windows. Repair damaged pieces of window frame (*see also NPS Preservation Briefs #9 and #13*). If these need to be outright replaced, talk to an **architect** first. Some restoration may or may not be doable in-house. Recaulk window frames where necessary. Replace existing hardware with high-strength hardware. Replacements should be in-kind if possible (may not be feasible if the existing hardware was custom-made). Prepare temporary shutters and develop a strategy for securely installing them while minimizing impact on historic building assemblies. Restore operability to inoperable windows. Keep in mind that this improves resilience by allowing post-disaster ventilation, but can conflict with some types of window protection. You **may need professional help** if you have unique windows. This cannot be done for some window types (e.g., trace windows).	Install protective glazing over individual stained glass lites, which may require rebuilding the window assembly [**architect or window preservation specialist**]. Conduct a blower door test to ascertain the building envelope tightness and reveal the leakages within the building [**specialist trade**].

Doors

An aspect of the **building**'s resilience



Description

Panels that fill openings between spaces, typically mounted on hinges. Exterior doors are often character-defining features of historic buildings. However, they can also be a vulnerability depending on the strength of their hardware and the door slabs themselves. The condition of the door frames and threshold, including good weather-stripping, also impact their overall resilience. Doors are often coated (e.g., with varnish or paint) for both protection and aesthetics.

Typical risk factor of this component: **Moderate**

Exterior doors have a high exposure to elements such as wind and rain. Their importance to the structure's stability and the impact that failure might have on other assemblies are both low.

Typical damages <u>from</u> floods or hurricanes:

- Mold growth
- Metal lintels over doors oxidizing
- Peeling paint or otherwise deteriorating finish
- Deteriorating or otherwise damaged threshold

Other common conditions contributing <u>to</u> vulnerability towards floods or hurricanes:

- Untempered glazing in doors
- Poor seal or weather tightness (e.g., noticeable draft or light visible in gaps)
- Lower interior floor level than exterior grade

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Apply safety/security window film to untempered glazing in door. Install or improve weather-stripping (e.g., door sweeps) around perimeter of door slabs. Refinish door (*see also NPS Preservation Brief #10*). Repair or replace damaged or insufficient thresholds.	Repair, coat (e.g., paint, varnish, wax), or replace damaged metal components (e.g., steel lintels) with similar assemblies that will resist oxidation [**architect**]. If they only need a new coating (are not damaging other assemblies), this can be done in-house. Reconfigure or regrade entry so that exterior finished surface or grade is below interior finished floor. Keep in mind these alterations may negatively impact character-defining features [**architect or landscape architect**]. Conduct a blower door test to ascertain the building envelope tightness and reveal the leakages within the building [**specialist trade**].

Ceilings

An aspect of the **building**'s resilience

Description

Surfaces that cover the underside of your building's roof structure or an above story's floor structure. Sometimes the roof structure may be exposed, such as wood trusses, and the ceiling is between these structural components. Sometimes drop ceilings mimic structural elements (e.g., faux beams or trusses), especially in vaulted spaces. Historic finish materials often include wood and plaster.

Typical risk factor of this component: **Low**

Ceilings are typically not exposed to elements such as wind and rain. Their importance to the structure's stability and the impact their failure might have on other assemblies are both low.

Typical damages from floods or hurricanes:

- Mold growth
- Waterlogged or otherwise water-damaged finishes

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Defects (e.g., flaking paint) in finishes

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Carefully remove all finishes that are waterlogged and cannot be saved (if it is safe to do so, e.g., there is no mold or asbestos). Replace with in-kind. Refinish/restore anything that can be saved.	Restore decorative painting or plasterwork (*see also NPS Preservation Briefs #23, #28, and #49*) [**building or art conservation professionals**].

Stairs

An aspect of the **building**'s resilience

Description

A circulation component of your building, providing passage between stories. Stairs are comprised of treads (horizontal surfaces) and risers (vertical surfaces). The configuration of stairs, such as their shape in plan and the ratio of tread depth to riser height, is important. These affect your building's ability to provide safe access to higher ground inside a structure (such as in the event of a flood) and to exterior egress (a life safety concern, and particularly important in the event of a fire).

Typical risk factor of this component: **Low**

Stairs are typically not exposed to elements such as wind and rain. Their importance to the structure's stability and the impact their failure might have on other assemblies are both low.

Typical damages from floods or hurricanes:

- Mold growth

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Defects (e.g., general wear) in finishes

Resilience Treatments and Strategies:

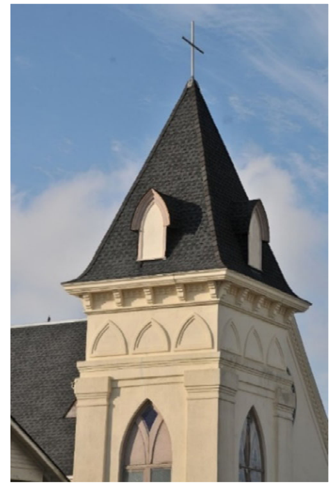
In-house	Professional needed [type]
Repair or refinish non-structural components (e.g., treads and risers).	Reframe or rebuild structural components of stairs (e.g., stringers) [**architect**].

Towers

An aspect of the **building**'s resilience

Description

Tall elements of your building that extend into the sky, such as spires, turrets, cupolas, campaniles, and minarets. Because these components are typically highly exposed to the elements and often have openings (e.g., for belfries within), they are often highly vulnerable to extreme winds and driving rain.



Typical risk factor of this component: **High**

Towers are moderately to highly exposed to elements such as wind and rain. Their importance to the structure's stability is high, as is the impact their failure would have on other assemblies.

Typical damages from floods or hurricanes:

- Towers out of plumb (leaning), cracked, or structurally deformed

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Unprotected openings (not windows, e.g., in belfry)

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Monitor leaning or cracks if the condition is minor (annually or with greater frequency). If unsure, consult an **engineer**. Install netting on unprotected openings to keep out birds and pests.	Extreme leaning or excessive/severe cracking requires professional investigation to determine safety and remediation techniques (such as structural bracing or stiffening, tie rods, masonry consolidation, partial rebuilding, and other solutions) [**engineer and architect**]. Slope exposed floors (e.g., in belfries) to properly sized drainage [**architect**].

Building Services (MEP & Fire)

An aspect of the **building**'s resilience

Description

Comprised of mechanical systems (often including heating, ventilation, and air-conditioning, or HVAC), electrical systems, plumbing systems, fire protection systems, and conveying systems (moving people or objects, typically via elevators). Most buildings will have several services, but your building may not have or need all of them. Services require frequent maintenance and can easily become outdated with modern code requirements (some will need periodic inspection, depending on the jurisdiction).

Typical risk factor of this component: **Moderate**

Each building service (mechanical, electrical, plumbing, and fire suppression systems) by itself typically has little impact on the structural integrity of the building and its assemblies in daily use. However, they are typically necessary for human comfort, and fire suppression systems are especially important in emergency situations.

Typical damages <u>from</u> floods or hurricanes:

- HVAC air handler unit, intakes, or ductwork inundated by floodwater, possibly impairing or destroying functionality and warranty and being out of commission when the building needs to be aired out
- Exposed wiring becomes an electric shock hazard in a flood situation
- Plumbing backflows, potentially contaminating occupied spaces with toxic waste
- Blocked or ruptured pipes can cause localized flooding

Other common conditions contributing <u>to</u> vulnerability towards floods or hurricanes:

- Lack of fire detection and notification systems
- Lack of fire suppression systems (beyond handheld extinguishers)
- HVAC system outdated or undersized
- HVAC system in a location likely to be inundated (e.g., ductwork embedded in floor slab, AHU at grade)
- HVAC system creating excessively positive or negative pressure of interior space, potentially causing moisture to condense within the wall assembly
- Lack of ability to monitor indoor air conditions
- Lack of emergency power
- Electric systems that are not up to code (e.g., knob-and-tube wiring)
- Plumbing components (beyond faucets) exposed and uninsulated (e.g., in open crawl space)
- Abandoned plumbing or ductwork that is unsealed may facilitate water entry

Resilience Treatments and Strategies:

In-house	Professional needed [type]
Train key personnel how and when to shut off each building system. Regularly test and inspect fire detection and suppression equipment.	Design, size, and specify new systems or upgrade existing building systems (*see also NPS Preservation Briefs #3 and #24*) [**engineer**].

Building services, continued

Resilience Treatments and Strategies, continued:

In-house	Professional needed [type]
Permanently seal or remove abandoned ductwork or plumbing.	Install plumbing backflow prevention devices [**engineer**].
Insulate exposed plumbing pipes.	Install emergency generator sufficiently sized to power essential building systems or disaster response equipment [**engineer**].
Monitor building systems, including remotely if possible.	Conduct a blower door test to ascertain the building envelope tightness and reveal the leakages within the building [**specialist trade**].
Keep a portable generator and fuel for minor emergency uses.	
Create/keep an annual maintenance contract with a specialty provider or otherwise exercise proper care and routine upkeep.	

Paper Records, Photographs, and A/V Media

An aspect of resilience for **movable cultural heritage**

Description

Any archival material that may be significant to the history or culture of your property and your organization. They should be located in a climate-controlled part of your building that is not at risk of flooding (e.g., an upper story). If possible, they should be contained in metal furniture (such as filing cabinets), which contains no lignin, to avoid acidification, pest infestation, and light damage. These records should be inventoried or cataloged.

Typical damages from floods or hurricanes:

- Documents or photographs become soaked from floodwater, leaking roof, sprinklers, or ruptured pipes

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Lack of emergency, disaster response, or salvage plan
- Collection not inventoried or cataloged
- Environmental controls not being monitored or lack of climate control (HVAC system)
- Material stored in unstable furniture (e.g., non-archival boxes, wood storage)
- Water-based fire suppression systems installed in libraries or areas with high concentration of fragile paper artifacts or A/V media

Resilience Treatments and Strategies:

The THC offers resources and provides links for more information on salvage and recovery of cultural artifacts [https://www.thc.texas.gov/preserve/projects-and-programs/museum-assistance/additional-resources]

In-house

Inventory collections and develop an emergency plan for the collections, which should include how to safely handle artifacts, prioritization for salvage, and salvage procedures (including the following RTSs).

If paper records or photograph prints become soaked, remove documents/artifacts from water as soon as possible (and safe to do so—if area is contaminated with sewage or other hazardous materials, **contact a professional recovery service immediately**). Mold growth can occur in 48 hours and cause irreparable damage. Prioritize paper media over film media. After removing documents/artifacts from water, air dry each object individually if possible (can lay on absorbent materials, hang dry, etc.).

Professional needed [type]

Waterlogged collections that have been stabilized (air dried or frozen) that have been damaged (e.g., staining) can be restored [**conservator**].

Consult a conservator as soon as possible for documents/artifacts that have suspected mold growth (especially if in large quantities) for evaluation and recommended treatment [**conservator**]. If mold is suspected on just a few items, they can be carefully isolated away from other collections or occupied spaces until a conservator can evaluate them.

A/V material on silver nitrate media is highly flammable and must be carefully handled and safely stored in special containers [**conservator**].

Install an HVAC system (see Building Services section above) [**architect and engineer**].

Paper records / photographs / audiovisual media, continued

Resilience Treatments and Strategies, continued:

In-house	Professional needed [type]
If it is not possible to air dry wet media, freeze as much material if possible (except for rare types of photographs made with very early processes—**these require immediate conservator attention**), interleaving as much material with polyester or waxed paper as possible. After salvaging, consult a **conservator** as soon as possible. A/V or computer media on tape should be kept in water (for up to two days) until a **conservator or professional recovery company** can evaluate them. Do not freeze. A/V media on CDs or DVDs can be rinsed if dirty and air dried. Do not freeze. Monitor environmental controls (temperature and relative humidity) to ensure material is optimally stored.	Modify water-based fire suppression system to a low-flow mist system or change/newly install a non-water-based system (e.g., gaseous agent) [**architect and engineer**].

Books

An aspect of resilience for **movable cultural heritage**

Description

Collections of bound documents should be housed in a climate-controlled part of your building that is not at risk of flooding. Special collections—books that are particularly rare, fragile, old, or valuable—should be limited in everyday use and access. If culturally significant books need to be regularly used in a part of the building that may be at risk (e.g., hymnals in the backs of pews), they should be stored when not in use in a safe place.

Typical damages from floods or hurricanes:

- Books become soaked from floodwater, leaking roof, sprinklers, or ruptured pipes

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Lack of emergency, disaster response, or salvage plan
- Environmental controls not being monitored or lack of climate control (HVAC system)
- Material stored in unstable furniture (e.g., wood shelving)
- Water-based fire suppression systems installed in libraries

Resilience Treatments and Strategies:

The THC offers resources and provides links for more information on salvage and recovery of cultural artifacts [https://www.thc.texas.gov/preserve/projects-and-programs/museum-assistance/additional-resources]

In-house	Professional needed [type]
Inventory collections and develop an emergency plan for the collections, which should include salvage procedures (including the following RTSs) and which books require special treatment. If books become soaked, remove them from water as soon as possible (and safe to do so—if area is contaminated with sewage or other hazardous materials, **contact a professional recovery service immediately**). Mold growth can occur in 48 hours and cause irreparable damage. Choose a salvage technique based on the type and extent of damage. Air drying is often possible in-house, while vacuum freeze-drying or mass dehumidification require professional services. All options, contacts, and steps to carry them out should be in the salvage plan.	Large collections will need to be dried using a commercial process, such as vacuum freeze-drying or commercial-scale dehumidification [**conservation professional**]. Install an HVAC system (see Building Services section above) [**architect and engineer**]. Modify water-based fire suppression system to a low-flow mist system or change/newly install a non-water-based system (e.g., gaseous agent) [**architect and engineer**].

Books, continued

Resilience Treatments and Strategies, continued:

In-house	Professional needed [type]
Change furniture to metal shelving or at least place acid- and lignin-free barriers between books and wood surfaces. Monitor environmental controls (temperature and relative humidity) to ensure books are optimally stored.	

Paintings, Statuary, and Sacraments

An aspect of resilience for **movable cultural heritage**

Description

Any artistic or otherwise culturally significant iconography. Some may be movable and can be evacuated in a disaster, but many may be permanently affixed to or be part of the building (e.g., decorative painting). There should be an evacuation plan for movable artwork. Any artwork that must remain in place should be documented and protected to the greatest care possible when preparing for an imminent disaster.

Typical damages from floods or hurricanes:

- Artwork or objects become soaked from floodwater, leaking roof, sprinklers, or ruptured pipes, causing:
  - Various types of cracking: peeling/blistering, crazing/checking, alligatoring
  - Delamination and partial or total loss of paintings from their substrate
  - Staining

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Lack of emergency, disaster response, or salvage plan

Resilience Treatments and Strategies:

The THC offers resources and provides links for more information on salvage and recovery of cultural artifacts [https://www.thc.texas.gov/preserve/projects-and-programs/museum-assistance/additional-resources]

In-house	Professional needed [type]
Inventory all artistic or culturally significant iconography and include in emergency plan. Prioritize which pieces can be evacuated (and how) prior to a disaster and which are priorities to recover during salvage. Prior to storms, evacuate movable pieces to a safe predetermined location. Immovable pieces may need to be protected with plastic sheeting if possible. Light staining on statuary may be cleaned with appropriate masonry cleaners if performed carefully by someone familiar with its maintenance and conservation needs.	Consolidate delaminating surfaces [**conservator**]. Restore damaged artwork [**conservator**].

Furniture

An aspect of resilience for **movable cultural heritage**

Description

Any movable objects designed to support objects or activities. Many historic furniture pieces are artistically or culturally significant and can be hard to replace if damaged by a disaster. There should be an evacuation plan for small pieces of significant furniture. Large pieces (e.g., baptismal fonts or carved pews) should be affixed to the floor when preparing for an imminent disaster to prevent them from being broken apart by rising and receding floodwaters.

Typical damages from floods or hurricanes:

- Unsecured furniture can become dislodged and thrown about in a flood, possibly breaking up
- Secured or especially heavy furniture is likely to be submerged for an extended period of time in a flood, possibly swelling or distorting if made of wood
- Musical instruments that have become waterlogged are typically damaged to the extent that restoration would cost as much or more than replacement (organs can be an exception)

Other common conditions contributing to vulnerability towards floods or hurricanes:

- Lack of emergency, disaster response, or salvage plan
- Lack of space or ability to relocate delicate or precious items to a safe location prior to a storm

Resilience Treatments and Strategies:

The THC offers resources and provides links for more information on salvage and recovery of cultural artifacts [https://www.thc.texas.gov/preserve/projects-and-programs/museum-assistance/additional-resources]

In-house	Professional needed [type]
Inventory and map culturally significant pieces of furniture and include in the Disaster Response and Recovery Plan. With a plan in hand, first responders will know what to expect when they enter a building and may be able to protect or salvage culturally significant heritage. Prior to a major storm, temporarily anchor light objects, if necessary to prevent them from floating away, or move them to higher storage areas (attic or upper floors). During salvage operations, isolate furniture that exhibits mold growth from other objects that could succumb to it spreading (**may need a disaster recovery professional** if multiple objects are affected). Save all pieces of furniture possible even when waterlogged and distorted as restoration may be possible.	Repair, reassemble, or otherwise restore furniture [**conservator or skilled craft technician**]. If all of the objects are damaged, the professional/technician may need photos or drawings for reference to restore in-kind.

Stage Five: Continued Assessment

Stage Five occurs after you have implemented your Action Plan. This includes long-term practices that keep resilience at a high level, and can also include individual Resilience Treatments and Strategies that were not included in the Action Plan.

As mentioned in the Disaster Response and Recovery Plan section above, it is important to revisit the plan every so often to keep it updated (*see page 24*). Over time, resources and practices change and those need to be reflected in the plan. Otherwise, there may be a false sense of security and the actual plan cannot be effectively followed when it is needed.

Keep up with routine maintenance. That's one of the best ways to increase resilience.

Maintenance Cycle

One of the most proactive measures to be prepared is to stay on top of maintenance. Creating a cycle that involves inspection and treatment can reveal failing conditions before they require immediate action. It can also prevent unnecessary decay. By regularly performing maintenance, knowledge and skills among maintenance staff are also kept up to date.

To ensure the maintenance cycle is adhered to, a Maintenance Plan should be developed. The plan should outline each item to be checked, what actions should be carried out, and a schedule that can be reasonably followed. Some items need to be visually inspected more frequently than others. Keep the *Secretary of the Interior's Standards* in mind when writing or revising your Maintenance Plan (*see page 14*). Further advice and examples of a maintenance checklist and frequency chart are given in the NPS's *Preservation Brief 47* (https://www.nps.gov/tps/how-to-preserve/briefs/47-maintaining-exteriors.htm). By writing the Maintenance Plan, you can ensure special features of your building are included with specific instructions. The plan can then help train new maintenance staff or outside contractors unfamiliar with the building and its unique historic features.

Inspection frequency chart, from NPS Preservation Brief 47

Feature	**Minimum Inspection Frequency**	**Season**
Roof	Annually	Spring or fall; every 5 years by roofer
Chimneys	Annually	Fall, prior to heating season; every 5 years by mason
Roof Drainage	6 months; more frequently as needed	Before and after wet season, during heavy rain
Exterior Walls and Porches	Annually	Spring, prior to summer/fall painting season
Windows	Annually	Spring, prior to summer/fall painting season
Foundation and Grade	Annually	Spring or during wet season
Building Perimeter	Annually	Winter, after leaves have dropped off trees
Entryways	Annually; heavily used entries may merit greater frequency	Spring, prior to summer/fall painting season
Doors	6 months; heavily used entry doors may merit greater frequency	Spring and fall; prior to heating/cooling seasons
Attic	4 months, or after a major storm	Before, during and after wet season
Basement/Crawl Space	4 months, or after a major storm	Before, during and after rain season

Deferring maintenance should be avoided as much as possible because it results in greater damage. Substantial loss of historic material often requires more resources (money, time, labor, and expertise) than those associated with maintenance.

Post-Disaster Evaluation of Plan Efficacy

After recovering from any event that negatively impacts your building, you should evaluate the Disaster Response and Recovery Plan. Consider what worked and what aspects of the recovery process were unanticipated or not properly covered by the plan. If the plan was appropriate but not followed properly, ensure that everyone who may be involved in disaster recovery is aware of the plan, knows where to locate it, and understands its contents. Additional training may be necessary.

Learning and Innovation

As new technologies and procedures for disaster management develop, it is important to keep your congregation aware and prepared. Growing your network and conducting outreach is the best way to stay connected with updating practices. Not only can these agencies, professionals, nongovernmental organizations, advocacy groups, and others inform your congregation's readiness, you can also provide unique insights that add to their knowledge and help refine disaster management techniques.

References

Albright, G., Maloney, A., & Willer, A. M. (2020). *Emergency salvage of wet photographs*. Northeast Document Conservation Center. https://www.nedcc.org/assets/media/documents/Preservation%20Leaflets/3_7_SalvagePhotos_Print_2020.pdf

American Institute of Architects (AIA). (2021). *Disaster assistance handbook* (4th ed.). https://content.aia.org/sites/default/files/2021-09/AIA_Disaster_Assistance_Handbook_4th_Edition_2021-0927.pdf

Aulet, S., & Vidal, D. (2018). Tourism and religion: Sacred spaces as transmitters of heritage values. *Church, Communication and Culture, 3*(3), 237-259.

Baer, R. D., Weller, S. C., & Roberts, C. (2019). The role of regional cultural values in decisions about hurricane evacuation. *Human Organization, 78*(2).

Baja, K. (2019). *Resilience hubs: Shifting power to communities and increasing community capacity*. Urban Sustainability Directors Network. https://www.usdn.org/uploads/cms/documents/usdn_resiliencehubs_2018.pdf

Berryhill, M. (2007). Business as usual: The basic truth about hurricane insurance: The public pays. *Cite, 71*(2).

Birnbaum, C. A. (1994). *Preservation brief 36. Protecting cultural landscapes: Planning, treatment and management of historic landscapes*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/36-cultural-landscapes.htm

Blackburn, J. (2007). Blow-by-blow: An environmental attorney details a major hurricane's potential impact on Houston. *Cite, 71*(2).

Burroughs, S. (2017). Development of a tool for assessing commercial building resilience. *Procedia Engineering, 180*, 1034–1043. https://doi.org/10.1016/j.proeng.2017.04.263

Burton, I., Huq, S., Lim, B., Pilifosova, O., & Schipper, E. L. (2002). From impacts assessment to adaptation priorities: The shaping of adaptation policy. *Climate Policy, 2*, 145-159.

Chase, S. M. (1992). *Preservation brief 28. Painting historic interiors*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/28-painting-interiors.htm

Cimellaro, G. P., Renschler, C., Reinhorn, A. M., & Arendt, L. (2016). PEOPLES: A framework for evaluating resilience. *Journal of Structural Engineering, 142*(10), 04016063. https://doi.org/10.1061/(asce)st.1943-541x.0001514

City of Hoboken (2015). Resilient building design guidelines. https://betterwaterfront.org/wp-content/uploads/2016/05/Resilient-Buildings-Design-Guidelines.pdf

Colbert, T. (2007). Ready or not? As hurricane season progresses, a tone of uncertainty closes in. *Cite, 71*(2).

Curtis, T. (2007). Just a matter of time: Present-day Galveston gambles against its own stormy history. *Cite, 71*(2).

Cutter, S. L. (2015). The landscape of disaster resilience indicators in the USA. *Natural Hazards, 80*(2), 741–758. https://doi.org/10.1007/s11069-015-1993-2

Della Torre, S. (2020). A coevolutionary approach as the theoretical foundation of planned conservation of built cultural heritage. In A. Vandesande, E. Verstrynge, & K. van Balen (Eds.), *Preventive Conservation - From Climate and Damage Monitoring to a Systemic and Integrated Approach* (pp. 11-18). CRC Press.

Drdácký, M., Cacciotti, R., & Kopecká, I. (2020). *Cultural heritage resilience*. Institute of Theoretical and Applied Mechanics CAS. https://doi.org/10.21495/53-6

Feilden, B. M. (1994). *Conservation of historic buildings* (new ed.). Butterworth Architecture.

Flaherty, D. (1990). *Preservation brief 23. Preserving historic ornamental plaster*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/23-ornamental-plaster.htm

Folke, C. (2006). Resilience: The emergence of a perspective for social-ecological systems of analyses. *Global Environmental Change, 16*(3), 253-267.

Grimmer, A. E. (1979). *Preservation brief 6. Dangers of abrasive cleaning to historic buildings*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/6-dangers-abrasive-cleaning.htm

Grimmer, A. E. (1990). *Preservation brief 22. The preservation and repair of historic stucco*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/22-stucco.htm

Hellensley, J. E., & Aguilar, A. (2011). *Preservation brief 3. Improving energy efficiency in historic buildings*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/3-improve-energy-efficiency.htm

Holling, C. S., (1973). Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics, 4*(1), 1-23.

Hoşkara, S., Lombardi, A., & Doğaner, S. (2020). Role of cultural heritage conservation for reaching the sustainable development goals (SDGs): An interdisciplinary approach. In U. Pottgiesser, S. Fatoric, C. Hein, E. de Maaker, & A. P. Roders (Eds.), *Delft LDE Heritage Conference on Heritage and the Sustainable Development Goals – Proceedings* (pp. 165-178), T.U. Delft Open. https://scholarlypublications.universiteitleiden.nl/access/item%3A3147038/view

International Council on Monuments and Sites (ICOMOS). (1964). *International charter for the conservation and restoration of monuments and sites*. https://www.icomos.org/en/participer/179-articles-en-francais/ressources/charters-and-standards/157-the-venice-charter

Keller, J. (2017, September 1). The complicated role churches play in disaster relief. *Pacific Standard*. https://psmag.com/news/the-complicated-role-churches-play-in-disaster-relief

Kron, W. (2002). Keynote lecture: Flood risk = hazard × exposure × vulnerability. In B. Wu (Ed.), *Flood Defence '2002* (pp. 82-97). Science Press.

Levine, J. S. (1993). *Preservation brief 29. The repair, replacement, and maintenance of historic slate roofs*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/29-slate-roofs.htm

Lindell, M. K., & Prater, C. S. (2003). Assessing community impacts of natural disasters. *Natural Hazards Review, 4*(4), 176–185. https://doi.org/10.1061/(ASCE)1527-6988(2003)4:4(176)

MacDonald, M. (1989). *Preservation brief 21. Repairing historic flat plaster – walls and ceilings*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/21-flat-plaster.htm

Mack, R. C., & Grimmer, A. (2000). *Preservation brief 1. Assessing cleaning and water-repellent treatments for historic masonry buildings*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/1-cleaning-water-repellent.htm

Mack, R. C., & Speweik, J. P. (1998). *Preservation brief 2. Repointing mortar joints in historic masonry buildings*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/2-repoint-mortar-joints.htm

Maekawa, S., Beltran, V. L., & Henry, M. C. (2015). *Environmental management for collections: Alternative conservation strategies for hot and humid climates*. Getty Conservation Institute.

Marjaba, G., & Chidiac, S. (2016). Sustainability and resiliency metrics for buildings – Critical review. *Building and Environment, 101*, 116–125. https://doi.org/10.1016/j.buildenv.2016.03.002

McCaig, I., & Ridout, B. (Eds.) (2012). *Practical building conservation: Timber*. Ashgate Publishing Company.

McCaig, I. (Ed.) (2013). *Practical building conservation: Conservation basics*. Ashgate Publishing Company.

Myers, J. H. (1981). *Preservation brief 9. The repair of historic wooden windows*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/9-wooden-windows.htm

National Oceanic and Atmospheric Administration (NOAA). National Centers for Environmental Information (NCEI). (2021). *U.S. billion-dollar weather and climate disasters*. https://www.ncdc.noaa.gov/billions/

National Park Service (NPS). Museum Management Program. (2016). *The museum handbook part I: Museum collections*. https://www.nps.gov/museum/publications/MHI/MHI.pdf

National Park Service (NPS). National Center for Preservation Technology & Training (NCPTT), & Louisiana Division of Historic Preservation. (2015). *Resilient heritage: Protecting your historic home from natural disasters*. https://www.ncptt.nps.gov/wp-content/uploads/Resilient-Heritage-GOHSEP.pdf

Northeast Document Conservation Center (NEDCC). (2017). *Emergency planning*. https://www.nedcc.org/assets/media/documents/Preservation%20Leaflets/3_3_emergency_2017.pdf

Northeast Document Conservation Center (NEDCC). (2020). *Emergency salvage of moldy books and paper*. https://www.nedcc.org/assets/media/documents/Preservation%20Leaflets/3-08-SalvageMoldy-2021.pdf

Northeast Document Conservation Center (NEDCC). (2022). *Introduction to fire detection and automatic sprinklers for cultural heritage*. https://www.nedcc.org/assets/media/documents/Preservation%20Leaflets/3.2_IntrotoFire_2022_Print.pdf

Northeast Document Conservation Center (NEDCC). (n.d.). Emergency salvage of wet books and records. Retrieved from: https://www.nedcc.org/free-resources/preservation-leaflets/3.-emergency-management/3.6-emergency-salvage-of-wet-books-and-records

Office of Energy Efficiency & Renewable Energy (EERE). (2020). Swales, drains, and site grading for stormwater control. Retrieved from https://basc.pnnl.gov/resource-guides/swales-drains-and-site-grading-stormwater-control?disaster_resistance=145080

Office of Energy Efficiency & Renewable Energy (EERE). (2021). Gutters and downspouts. Retrieved from https://basc.pnnl.gov/resource-guides/gutters-and-downspouts?disaster_resistance=145073

Office of Energy Efficiency & Renewable Energy (EERE). (2021). Insulating plumbing pipes. Retrieved from https://basc.pnnl.gov/resource-guides/insulating-plumbing-pipes

Office of Energy Efficiency & Renewable Energy (EERE). (2021). Windows have impact-rated glass, fire-resistant glass, or protective coverings. Retrieved from https://basc.pnnl.gov/resource-guides/windows-have-impact-rated-glass-fire-resistant-glass-or-protective-coverings?disaster_resistance=145076

Park, S. C. (1984). *Preservation brief 13. The repair and thermal upgrading of historic steel windows*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/13-steel-windows.htm

Park, S. C. (1991). *Preservation brief 24. Heating, ventilation, and cooling historic buildings*: Problems and recommended approaches. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/24-heat-vent-cool.htm

Park, S. C. (1996). *Preservation brief 39. Holding the line: Controlling unwanted moisture in historic buildings*. National Park Service. Technical preservation services. https://www.nps.gov/tps/how-to-preserve/briefs/39-control-unwanted-moisture.htm

Park, S. C., & Hicks, D. C. (2006). *Preservation brief 37. Appropriate methods for reducing lead-paint hazards in historic housing*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/37-lead-paint-hazards.htm

Park, S. C. (2007). *Preservation brief 47. Maintaining the exteriors of small and medium size historic buildings*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/47-maintaining-exteriors.htm

Parker, T. A. (2015). Integrated preventive pest management. Northeast Document Conservation Center. https://www.nedcc.org/assets/media/documents/Preservation%20Leaflets/3_10_pests_2018rev119.pdf

Partners for Sacred Places. (n.d.). Repair & maintenance guide. Retrieved from https://sacredplaces.org/info/publications/repair-maintenance/

Pedersoli, J. L., Antomarchi, C., & Michalski, S. (2016). *A guide to risk management of cultural heritage*. International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM). https://www.iccrom.org/wp-content/uploads/Guide-to-Risk-Managment_English.pdf

Pistrika, A. K., & Jonkman, S. N. (2009). Damage to residential buildings due to flooding of New Orleans after Hurricane Katrina. *Natural Hazards, 54*(2), 413–434. https://doi.org/10.1007/s11069-009-9476-y

Pokorny, J. D., O'Brien, J., Hauer, R., Johnson, G., Albers, J., Bedker, P., & Mielke, M. (2003). *Urban tree risk management: A community guide to program design and implementation*. USDA Forest Service. https://www.fs.fed.us/nrs/pubs/na/NA-TP-03-03.pdf

Rice, H. (2017, May 29). Rise in sea level makes hurricanes worse. *Houston Chronicle*. https://www.houstonchronicle.com/news/article/Rise-in-sea-level-makes-hurricanes-worse-11181128.php

Sloan, J. L. (1991). Is stained glass protective glazing necessary? The New York Landmarks Conservancy. *Common Bond 7*(2), 4-7.

Spieler, C. (2007). Code blues. *Cite, 71*(2).

Stapleton, S. O., Nadin, R., Watson, C., & Kellett, J. (2017). *Climate change, migration, and displacement*. (p. 36). Overseas Development Institute, & United Nations Development Programme. https://www.undp.org/sites/g/files/zskgke326/files/publications/MIgration_Report.pdf

Staveteig, K. R. (2017). *Preservation brief 49. Historic decorative metal ceilings and walls: Use, repair, and replacement*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/49-decorative-metal.htm

Sweester, S. M. (1978). *Preservation brief 4. Roofing for historic buildings*. The National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/4-roofing.htm

Texas General Land Office (TxGLO). (2020, October 8). *Hurricane Harvey state action plan: Based on amendment 7*. https://recovery.texas.gov/documents/action-plans/2017-hurricane-harvey/harvey-state-action-plan-overview.pdf

Thornton, J., & Adair, W. (1994). *Preservation brief 34. Applied decoration for historic interiors preserving composition ornament*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/34-composition-ornament.htm

Torraca, G. (2009). *Lectures on materials science for architectural conservation*. The Getty Conservation Institute.

United Nations. Educational, Scientific and Cultural Organization (UNESCO). World Heritage Committee. (1992). *Convention concerning the protection of the world cultural and natural heritage, sixteenth session*. https://whc.unesco.org/archive/1992/whc-92-conf002-12e.pdf

United Nations. Educational, Scientific and Cultural Organization (UNESCO). (2011). *Recommendation on the historic urban landscape*. https://whc.unesco.org/uploads/activities/documents/activity-638-98.pdf

Vandesande A., & Verstrynge, E. (2020). Preventive conservation - From climate and damage monitoring to a systemic approach. In A. Vandesande, E. Verstrynge, & K. van Balen (Eds.), *Preventive conservation - From climate and damage monitoring to a systemic and integrated approach* (pp. 3-8). CRC Press.

Vogel, N. A., & Achilles, R. (2007). *Preservation brief 33. The preservation and repair of historic stained and leaded glass*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/33-stained-leaded-glass.htm

Waller, R. R. (1995). *Risk management applied to preventive conservation*. https://museum-sos.org/docs/WallerSPNHC1995.pdf

Weaver, M. E., & Matero, F. G. (1997). *Conserving buildings: Guide to techniques and materials* (Revised ed.). Wiley.

Weeks, K. D., & Look, D. W. (1982). *Preservation brief 10: Exterior paint problems on historic woodwork*. National Park Service. Technical Preservation Services. https://www.nps.gov/tps/how-to-preserve/briefs/10-paint-problems.htm

Glossary

Assembly or **assemblies**—Various building components or parts.

Base Flood Elevation (BFE)—The elevation of floodwater that is expected to rise during base floods. Floods that are computed to have a 1% chance of equaling or exceeding this elevation are commonly known as "100-year floods."

Biological growth—Living organisms that grow on, and cover, building surfaces. Many types of biological growth are harmless, such as certain moss and lichen. Other types, such as certain bacteria or fungi, can pose a health risk or adversely impact building materials. Biological growth often occurs due to the presence of water or high humidity, and can be a symptom of other issues.

Borate—A salt that is used as a wood preservative to prevent fungal growth.

Bulkhead—A lowered portion of the ceiling or overhead assemblies.

Champion—A person who takes on leadership responsibilities to enhance resilience for the congregation and its property.

Character-defining features—Aspects of a building that make historic buildings unique and contribute to their identities. These include visual aspects of the building, such as form and its landscape, as well as physical features of the structure and its craftsmanship, such as doors, windows, ornament, and other building assemblies. See also https://www.nps.gov/tps/how-to-preserve/briefs/17-architectural-character.htm

Circulation—Movement of people in a building.

Coastal storm surge—A natural phenomenon resulting from hurricane forces pushing a mound of seawater up at the outer edges of the storm mass. The result is elevated seawater levels extending inshore far from the storm's center. Coastal storm surge may be determined separately from other flood risks, which may have insurance implications.

Coating—A liquid applied by brush or sprayer to a building material, product, or assembly. Coatings generally dry on the surface, creating a film, or are absorbed into building materials. Coatings are typically applied to protect underlying materials, and one of the most common types are paints.

Comprehensive insurance—Broad insurance coverage for many types of events except items excluded in writing.

Condition

> **excellent**—Perfectly maintained in a condition where all is performing at or near peak capacity. No improvement work is needed.
>
> **good**—Well-maintained with little evidence of deferred maintenance. All is functioning as designed without any defects disabling performance.
>
> **fair**—Maintenance has been deferred. Functionality is limited or compromised. Routine repairs and upgrades are needed.
>
> **poor**—Obviously broken, damaged, or missing components. Dysfunctional, inoperable, or failing. Beyond repair by normal maintenance methods.

Condition assessment or **condition evaluation**—A technical inspection and assessment of a building that interprets its current (and sometimes future) status. Typical qualities examined include physical condition, performance, probability of failure, and remaining useful life of building assemblies and systems.

Consolidation—Various processes by which building materials that are dissolving, disintegrating, or delaminating are brought together again into cohesive materials. Different methods are used for different materials, such as ejecting resin epoxy to consolidate wood materials or chemicals for stone materials.

Cost

> **initial cost**—The resources and expenses that are necessary to design, construct, and furnish a building. Cost can be measured in financial terms, but also in time, labor, risk, and other ways.
>
> **life cycle cost**—The total of all costs, recurring (such as electricity) and non-recurring (such as new equipment), over the lifespan of a building or its subcomponents.

County Historical Commission (CHC)—A component of county-level government for each county in Texas with the mission to preserve, protect, and promote historic and cultural resources.

Crack monitor—A mechanical device used to continuously record cracks in buildings and structures to record and determine differential movement.

Critical infrastructure—Systems or components of systems that are vital to human life and basic operational needs of the building. Anything that would adversely impair security, health, or safety of a building or its occupants can be considered critical.

Cultural landscapes—Geographic areas that include cultural and natural resources which are associated with historic events, activities, or persons or exhibit other cultural or aesthetic values.

Cupping—Deformation of slender wood members where the long ends of the wood material (such as flooring, siding, or framing) lift upwards, developing a concave surface. Cupping can pose a trip hazard when occurring in floor boards or decking. It is often caused by excess humidity and improper installation.

Damp-proofing—The process of applying coatings or other impervious materials to block moisture transfer into the building's interior or its internal assemblies.

Delamination—An adverse condition where layers of or on a building material (such as paint from a surface or layers of plywood) peel apart or dissolve in flakes due to low or no bonding between the layers.

Design Flood Elevation (DFE) or **Flood Protection Elevation**—The elevation of the highest flood that retrofits are designed to protect against. Typically, this is the BFE or another elevation designated on flood hazard maps adopted by local communities.

Differential settlement—A condition caused by uneven movement of soil beneath or near building foundations. Evidence of differential settlement is often seen in large cracks, displaced sidewalks, or gaps between building walls and steps/ramps alongside the building.

Disaster declaration—A formal statement by a jurisdiction that a disaster or emergency exceeds the jurisdiction's capability for response or recovery. Typically issued in the immediate aftermath of a disaster, sometimes disasters are declared in advance if they are imminent so as to activate measures and ready responses.

Disaster plan—An actively maintained document that contains all the organization's procedures and information necessary to prevent, mitigate, prepare for, respond to, and recover from disasters and emergencies.

Disruptive event

> **shocks**—Acute events, typically physical and natural, that obstruct or impair an organization's routine operations or building's use.
>
> **stresses**—Long-term emergencies that obstruct or impair an organization's routine operations or building's use. Stresses can include financial or social disruptions, and are typically not foreseen or accounted for (differentiating them from routine maintenance or other planned operations). Not to be confused with stresses in the structural sense.

Door

> **door leaf** or **slab**—A single, independently moving or fixed panel or assembly, commonly referred to as simply a "door." A set of French doors, for example, is typically composed of two door leaves.
>
> **door sweep**—A type of weather-stripping in the form of material applied to the bottom of a door leaf to create a strong seal between the door and the threshold.

Efflorescence—Crystalline powders that occur on surfaces, typically masonry, caused by salts moving to the surface from within the material. This is often merely cosmetic, but it can be a symptom of moisture intrusion or failing damp-proofing measures that could lead to more adverse effects.

Egress—Exits or paths of exit travel that are continuous and unobstructed from any point within a building to the publicly accessible exterior.

Endowment—Assets such as money or property that are bestowed to a congregation for a specific purpose, typically investible to generate income.

Environmental hazard—A place or object, condition, or event that poses some sort of risk to a specific place or building. Environmental hazards include industrial hazards, which can pose risk of pollution, cause industrial disasters, or combine harmful effects with natural hazards.

Environmental Protection Agency (EPA)—An agency of the federal government charged with overseeing environmental protection. Maintains lists of contaminated sites and toxic substance releases which may constitute environmental hazards. See also https://www.epa.gov/

EPA Superfund sites—Contaminated sites that are part of the EPA's Superfund program to clean up the most contaminated locations. Thousands of sites are included across a wide range of former or current industrial activities or improper uses.

Erosion—The wearing away of material, particularly used to describe the loss of soil or other geological material from a site.

Exposure—The susceptibility or vulnerability of a building surface being affected by natural or environmental hazards due to lack of protective measures from the exterior elements.

Federal Emergency Management Agency (FEMA)—An agency of the federal government charged with hazard preparation, response, recovery, and mitigation. Defines flood zones through FIRMs. Also offers various types of resources. See also https://www.fema.gov/

Finish(es)—The final surface on a building material. Finishes can serve a decorative purpose and/or a protective one (against water, corrosion, abrasion, and other forces).

Finished floor elevation (FFE) or **finished floor level**—The level of the interior floor at the top of its finishes, typically specified as a height above natural grade at the immediate exterior, above sea level, or above some other known reference point.

Finite element

method (FEM)—A numerical technique used to perform finite element analysis of any given physical phenomenon, such as forces acting on a building or structure. A finite element model is broken up into simple geometric elements which are studied through finite element analysis (FEA).

model—The 3-dimensional computer representation of any given physical object, such as a building, which is then subjected to a finite element analysis through the finite element method.

analysis (FEA)—The simulation of forces on individual components of a finite element model, used to determine overall structural behavior. Part of the finite element method (FEM).

Fire

detection system—An automated system to detect fire and/or smoke. Detection systems are often combined with notification systems.

notification system—An automated system that sounds alarms alerting building occupants to a threat identified by a detection system. Many notification systems also communicate to outside parties, such as an alarm monitoring company, to alert people who are not at the property and thus can respond even when a building is not in use.

suppression system—An automated system used to extinguish or control fire, activated by heat, smoke, or a combination of heat and smoke. Different agents can be used for fire suppression, with water being the most common, but gaseous, chemical, or foam agents are available when a water-based suppression system needs to be avoided.

fire-resistant—A material property that withstands a standard amount of heat for a standard amount of time before losing structural integrity or lighting. Fire-resistant materials are rated to allow safe evacuation during a fire, and are not necessarily fireproof. Different types of occupancy types may require different amounts of fire-resistant materials.

Flashing—Material used in the building envelope that prevents water from penetrating below it into other components of the building material assembly (mostly used in roofing). Flashing materials are typically non-corrosive metals or composite materials.

Flood barrier—Manmade devices used to block or otherwise obstruct the passage of water. At the building scale, flood barriers can be installed in front of doorways, low windows, or other apertures and possible water entry points to keep the interior dry if the envelope is waterproof. See *also Floodproofing > dry floodproofing.*

Flood insurance—See *National Flood Insurance Program.*

Flood Insurance Rate Map (FIRM)—Maps created by FEMA that depict designated Special Flood Hazard Areas, Base Flood Elevations, and risk premium zones for communities throughout the U.S.

Floodproofing

wet floodproofing—A practice that allows floodwaters to enter a structure by making all surfaces and components that would become submerged sufficiently flood-resistant. This can be achieved with permanent measures (e.g., by using specific materials) or contingent measures (e.g., moving vulnerable items to higher floors in preparation of a flood event).

dry floodproofing—A method of keeping a structure safe from a flood by making the enclosure entirely watertight. This typically involves strengthening structural elements to withstand flood forces and closing off openings, such as by placing flood barriers.

Flood-resistant—The capability of withstanding effects of floodwaters, such as their weight and wetness, without incurring significant damage.

Floodplain

100-year floodplain—Land designated by FEMA which is predicted to flood during a "100-year" event, calculated to have a 1% chance of occurring in any given year.

500-year floodplain—Land designated by FEMA which is predicted to flood during a "500-year" event, calculated to have a 0.2% chance of occurring in any given year.

Floodwall—Permanent barriers engineered and constructed to hold back floodwaters, typically made of concrete or masonry.

Floor slab—A structural component of many types of floors, typically a solid piece of concrete.

Foundation—The area(s) of connection between ground and building which give strength and stability to the construction. Foundations include the earth (e.g., soil, sand, rock) as well as building components (such as piles and footings) in contact with the earth.

Framing or **frame members**—Slender structural members that together provide a structural skeleton or system designed to withstand loads. Frame members are often made of lumber, steel, or concrete.

French drain—A method of directing water below ground away from saturated soils, typically found adjacent to building foundations. A common type of French drains is a perforated plastic drain pipe in loose soil, and simpler versions of fabric-lined gravel trenches also exist.

Galvanic corrosion—A type of damage caused when two different metal materials are placed together in the presence of water, creating a corrosive electrolyte. One metal surface will corrode much faster than it would by itself, and the other will corrode at a much slower rate than otherwise. Commonly occurs in roof materials between flashing and fasteners.

Glass or **glazing**—Glass in doors and windows is called glazing. Single panes of glass in historic wood-sash assemblies are secured with glazing points and glazier's putty. Modern windows and doors may have multiple layers of glass in their assembly (e.g., double and triple) to increase their energy efficiency or other performance characteristics. There are many types of glass. Some are rated for safety when they break, such as tempered glass or laminated glass, while others can become hazardous when impacted, such as untempered glass or plate glass.

Grade—The surface level of the earth at a given location. Exterior grade is sometimes used to distinguish outside surfaces (natural or landscaped) from interior floor levels.

Grading—The alteration or reshaping of a landscape to bring the surface level to a desired height.

Hazard—Something that may cause damage to buildings or impair the health or safety of their occupants.

Hazard mitigation plan—Plans by state, tribal, or local governments to proactively minimize potential damage to people and property from future disasters. Requirements are set by FEMA to be eligible for certain types of disaster relief.

Heating, Ventilation and Air-Conditioning (HVAC)—A building system(s) used to control indoor environmental air quality and provide thermal comfort for building occupants. Baseline functionality typically includes the ability to adjust temperature and humidity, while more sophisticated systems control additional variables.

Heritage

> **cultural heritage**—The combined legacy of physical and intangible attributes of societies that spans generations. Physical cultural heritage (including material culture, tangible heritage, and industrial heritage) comprises buildings, sites, artifacts, monuments, art, and other objects that attain significance for a variety of reasons (e.g., historical, aesthetic, scientific, etc.) and helps understand the culture that produced them. Intangible cultural heritage covers societal aspects that are not physical, see *Heritage* > *intangible heritage*.
>
> > **movable cultural heritage**—Objects or artifacts, typically portable, that possess historical significance or are associated with cultural traditions. For the purposes of this *Roadmap*, even objects that may not be easily moved are considered part of movable cultural heritage. This includes large instruments such as organs, heavy furniture such as baptismal fonts, and certain iconological artifacts such as altarpieces.
>
> **intangible heritage** or **intangible traditions**—Aspects and ways of life that have been transmitted from generation to generation, including social practices, rituals and festive events, oral traditions, performing arts, knowledge and skills, and other aspects that some groups would consider part of their cultural heritage. Formally recognized and protected by UNESCO in 2003.

Historic American Buildings Survey (HABS)—A program begun by the federal government in 1933 to document America's architectural heritage. Maintained by the Library of Congress, HABS is a source of drawings and photographs for many historic buildings.

Historic easements or **historic covenants**—Voluntary legal agreements made between property owners and qualified organizations to protect historic aspects of the property by restricting future development or changes.

Hydrostatic pressure—Pressure exerted by a liquid, such as groundwater or floodwater, on an adjacent object, such as a building.

In-house—Capable of being performed within an organization's abilities or using resources (e.g., money or labor) belonging to the organization. For the purposes of this *Roadmap*, work that can be commonly performed by general laborers is considered in-house, as it does not require seeking professional or highly specialized expertise.

In-kind—Appearing, behaving, and performing in the same manner as the material assembly or system did before. When repairing or replacing historic assemblies or character-defining features, most will need to be conducted in-kind.

Integrity

> **historical integrity**—The authenticity of a historic building's physical characteristics from which it gains significance. This includes preserved character-defining features, which visually convey the historical nature of the building or its association with history.
>
> **structural integrity**—The ability of a structure to withstand intended or anticipated loading conditions without suffering or exhibiting adverse effects, such as deformation or fracture. Structural integrity is always necessary for any building to perform its intended use.

Interior partition—Walls that are non-loadbearing, primarily used to separate interior spaces within a building. Certain partitions also provide fire-rated separation to allow safe evacuation of high-occupancy spaces.

Intumescent paint—A type of coating that provides fire protection to structural elements such as metal. Intumescent paint reacts to heat by expanding in a controlled manner, providing an insulating layer to its substrate.

Joist—A horizontal frame member, typically in a series, that spans between other frame members and supports a floor. Joists in many historic buildings are often made of lumber.

Library of Congress (LOC)—An agency of the federal government that serves as a repository of books, photographs, recordings, maps, and manuscripts, including the HABS program. See also https://loc.gov/

Lignin—A component of wood that provides its structure. Lignin is commonly found in most types of paper. The presence of lignin in wood furniture or paper enclosures (e.g., folders, tubes, boxes, etc.) can be a concern for the preservation of archival materials such as records and books.

Lintel—A beam above an opening that supports the weight of the wall above the opening.

Lite—See *Window > Window assembly > lite.*

Maintenance

> **cyclical maintenance**—Maintenance that can be performed on a regular basis (cycle).
>
> **preventive maintenance**—Maintenance undertaken to keep an assembly at a certain level of performance. Before an assembly or component fails, deteriorates, or otherwise diminishes in performance or usefulness, it is proactively repaired or replaced, prolonging the life span of the overall assembly.

Massing—The general form of a building or parts of a building, comprising size and shape.

Mechanical building systems—See *Heating, Ventilation and Air-Conditioning (HVAC).*

Microgrid—A small network of adjacent users sharing electric power that is generated locally, independent of the larger, regional power grid.

Mortar

> **bedding mortar**—A type of mortar high in cement content that structurally adheres masonry units together.

National Center for Preservation Technology and Training (NCPTT)—A branch of the National Park Service, NCPTT conducts research, provides training, and offers technical resources for historic preservation in the U.S. See also https://www.nps.gov/subjects/ncptt/index.htm

National Flood Insurance Program (NFIP)—A program managed by FEMA to provide insurance against flooding through a network of providers. The NFIP also restricts development in floodplains to reduce the risk of flood-based losses. See also https://www.floodsmart.gov/why-buy-flood-insurance

National Historic Landmark (NHL)—The highest form of historic designation at the federal level representing the most significant historic and cultural sites of the U.S. See also https://www.nps.gov/orgs/1582/index.htm

National Hurricane Center (NHC)—A branch of the NWS and NOAA that tracks tropical storms and provides watches and warnings. See also http://www.nhc.noaa.gov/

National Oceanic and Atmospheric Administration (NOAA)—An agency of the federal government charged with monitoring weather conditions and providing weather forecasts, among other research roles. See also https://www.noaa.gov/

National Register of Historic Places (NRHP) or **the National Register**—The official list of historic places in the U.S. deemed worthy of preservation, authorized by the National Historic Preservation Act of 1966 and administered by the National Park Service. See also https://www.nps.gov/subjects/nationalregister/index.htm

National Risk Index—A tool created by FEMA that maps communities deemed most at risk to natural hazards. See also https://hazards.fema.gov/nri/

National Weather Service (NWS)—An agency of the federal government under NOAA charged with providing weather forecasts and issuing warnings of hazardous weather. See also https://www.weather.gov/

Natural disaster—The actual occurrence of a natural hazard and the negative impacts of its aftermath. Hazards become disasters when they overwhelm the capacity of a community to cope with these negative impacts.

Natural hazard—The threat of an event occurring that is likely to have a negative impact on a structure or community.

Occupancy type—In building codes, the designed use for a space. The occupancy type of a church sanctuary would typically be assembly use. The occupancy type, or use, dictates the application of building codes. For example, an assembly use will have higher requirements for emergency exits than an office use.

On-site backup power—The ability to locally generate power when power is not available from usual utility providers. Backup power systems are comprised of a power source and fuel, plus means of transferring power from the source to the building and should be sized to handle the load of critical infrastructure.

Operable windows—Windows designed for and capable of opening for ventilation are called operable, as opposed to fixed windows which cannot be opened. Examples of typical operable window types are casement, double-hung, and awning.

Overflow drainage—Secondary inlets to provide drainage when the primary inlet is blocked, sometimes required by code to handle water drainage from certain roof types (such as flat roofs).

Overturning—Rotation of the building or assemblies about a point, often low to the ground. The structural system often remains intact when a building overturns, but it is still unsafe for occupation.

Oxidation or **oxidizing**—A chemical reaction that occurs when a material is exposed to oxygen, commonly seen in rusting metals that contain iron or a patina developing on copper.

Permeable pathway—A surface comprised of pavers with pores that allow water to pass through to an underlying drainage system or reservoir.

Photovoltaic (PV)—Panels that convert sunlight into electricity.

Preservation tax credits

> **federal**—A program of the National Park Service that issues vouchers for qualifying historic preservation projects that provide a 20% credit towards federal income tax. Administration is conducted through state historic preservation offices, such as the THC in Texas. See also https://www.nps.gov/tps/tax-incentives.htm

> **Texas**—A program of the Texas Historical Commission that issues vouchers for qualifying historic preservation projects that provide a 25% credit towards franchise taxes and insurance premium taxes in Texas. See also https://www.thc.texas.gov/preserve/projects-and-programs/preservation-tax-incentives/texas-historic-preservation-tax-credit

> **qualified expenditures**—In terms of historic tax credits, any physical materials that are used to improve the usability of the building and are deemed historically appropriate are considered qualified expenditures that contribute to the amount of credits awarded at the completion of the project.

Rain garden—In the context of site water management, a planned area of vegetative growth designed to promote good drainage away from structures or roads, slow down the movement of surface water, or increase retention of stormwater.

Rainwater harvesting technology/strategy—Any one of a variety of methods designed to manage rainwater for better utilization and to mitigate harm from surface water movement.

Rainwater management—Reducing the amount of runoff from rainwater and controlling the water quality are the primary concerns of rainwater management. Through rainwater management, the built environment attempts to replicate the natural (undeveloped) hydrology of the site to avoid causing or increasing flooding.

Rapid visual assessment or **screening**—A quick way of assessing building vulnerability through visual inspection.

Recorded Texas Historic Landmark (RTHL)—Properties deemed historically or architecturally significant at the state level by the THC, not to be confused with SALs or other historic designations.

Regrading—See *Grading*.

Resilience

> **of buildings**—The ability for buildings to absorb effects of disruptive events (shocks and stresses such as natural disasters) with minimal damages and rapid recovery. Building resilience requires high standards of design, construction, and maintenance to best protect public health, safety, and welfare.

> **of communities** or **societies**—The ability for groups of people to recover from disruptive events and preserve social operations. Intangible resources are a component of this form of resilience, and include knowledge, skills, networks, values, and other practices.

Resilience Performance Indicators (RPI)—Observations and variables that provide information on the physical and social resilience of building and organizations. RPIs are specific, measurable, actionable, realistic, and trackable.

Resilience Treatments and Strategies (RTS)—Actionable measures and practices that will reduce vulnerability and enhance resilience when implemented or enacted.

Return on investment (ROI)—A measure of the performance and efficiency of investments. Specifically, ROI gives the percentage of profit generated by some amount of capital in a given period of time, minus costs and expenses.

Rising damp—Capillary action causing moisture in the ground to rise upwards into permeable building assemblies, such as masonry walls. Sometimes rising damp causes purely cosmetic changes, but it usually represents a serious condition which can result in damage to the performance of building assemblies if untreated.

Risk—The chance an event will occur that negatively impacts a resource. Risk comprises multiple factors, including types and magnitudes of hazards, the frequency of those hazards, and vulnerability of the resource to the hazards.

Risk management—The identification, analysis, evaluation, and assessment of risks and vulnerabilities and subsequent development of corresponding responses to minimize/mitigate potential damage.

Salt crystallization—The process by which salt crystals are formed from soluble salts naturally occurring in a material. The movement and crystallization of these salts is typically indicative of serious moisture or hydration pressure concerns that may adversely impact the material's structural properties if left untreated.

Sanborn maps—Maps created by the Sanborn Map Company to assess degrees of fire hazard for individual buildings and properties across most cities in the U.S. Historical Sanborn maps from the 19th and early 20th centuries are good sources of documentation that can reveal the historic nature of construction for historic buildings, as well as upgrades in materials and changes to the building's footprint.

Scouring

> **of soil**—See *Soil > scour*.
>
> **of exterior building materials**—The physical abrasion and removal of exterior surface finishes, such as stucco or paint, exposed to the elements caused by strong forces, such as wind or rain, over time.

Sea level

> **Mean Sea Level (MSL)**—A datum used for reference that is defined by the average height of the sea, considering all tidal stages.
>
> **height above sea level**—The elevation of any given point, commonly known as "altitude," measured vertically from a reference datum near the level of the sea (typically MSL).
>
> **sea level rise**—Increases in the sea level caused by changes in the amount of water in the ocean or changes in local topography. Rising sea levels are linked to increased intensity and frequency of flooding and can pose a significant threat to many coastal communities.

Secretary of the Interior's Standards or ***The Standards***—A series of best practices established by the U.S. Secretary of the Interior for maintaining, repairing, and replacing material assemblies on historic buildings. *The Standards* also set guidelines for altering the exterior appearance of historic buildings. See also https://www.nps.gov/tps/standards.htm

Significance—A quality that elevates buildings or properties to historic designations. Different programs define or establish different criteria for evaluating significance. Generally, the criteria conditions for eligibility on the NRHP are applicable to all historic properties, which includes possessing a connection to historical events, being associated with a major historic figure, demonstrating architectural or artistic mastery, or the presence of archeological resources.

Soil

> **cohesion**—The degree to which soil particles will adhere to each other.
>
> **swelling**—Growth in volume of soil when subjected to moisture. This typically occurs in soils that contain clay minerals, which attract and absorb water.
>
> **scour**—A type of erosion in the form of removal of granular soil by water, particularly prevalent around foundations and in structures adjacent to large bodies of water.
>
> **washout**—Rapid wearing away of soil in a specific area as a result of significant environmental forces, such as floodwaters. Soil washout can undermine foundations and cause serious structural failure.
>
> **classification** or **soil types**—The grouping of soils into classes or types based on similar properties, such as physical, chemical, and biological characteristics.

Spalling—A deteriorating condition of masonry or concrete materials where parts of the surface are ejected (can also be described as flaking, cracking, crumbling, or chipping). There can be different causes for spalling, of which water penetration, heating or cooling processes (such as freeze-thaw cycles), and improper installation are common culprits. When large elements of masonry spall, they pose a falling hazard to the safety of pedestrians below the weakened masonry façade.

Splash block—An impervious object designed to divert water away from the building and prevent soil washout. Splash blocks commonly take the form of specially shaped concrete or masonry slabs and are usually placed at the mouth of downspouts so water flows directly into them.

Stair assembly

> **tread**—The horizontal parts of the stair, between risers, upon which a user steps.
>
> **riser**—The vertical parts of the stair, between treads.

Stakeholder—Individuals and groups that are affected by, interested in, or are otherwise involved in a project, such as a major building rehabilitation.

State Antiquities Landmark (SAL)—Historic and cultural resources designated by the THC at the state level which receive legal protection under the Antiquities Code of Texas, not to be confused with RTHLs (which do not receive the same protections).

Storm drain—Underground pipes or channels designed to carry stormwater away from a property and into a discharge area, such as a natural body of water or municipal sewer system.

Storm shutter—Operable, solid protective covering with a specified impact resistance or hurricane rating. In historic buildings, storm shutters might lack a rating yet still be able to provide some level of protection for the primary window.

Stormwater—Excessive water caused by heavy rains which can cause flooding, washout, or other serious adverse effects if not properly drained. Urban sites typically require engineered systems designed to facilitate this drainage (see *Storm drain*).

Stormwater drainage—See *Storm drain*.

Stress (structural)—Behavior in structural members due to various forces are known as various types of stresses on those members. Specifically, stress refers to the amount of force per cross section unit area. Calculating these stresses determines the size that structural members need to be to withstand those forces.

Subfloor—The rough floor before finishes are applied.

Substructure—Weight-bearing elements of a building (walls, floors, piers, and beams) below the surface grade level. The substructure elements are typically associated with basements, crawlspaces, and foundations.

Superstructure—The portion of the building which is constructed above the ground, bearing directly on the substructure.

Tax credit—See *Preservation tax credits.*

Texas Commission on Environmental Quality (TCEQ)—An agency of the state of Texas charged with overseeing environmental protections in the state. See also https://www.tceq.texas.gov/

Texas Historical Commission (THC)—An agency of the state of Texas charged with overseeing historic preservation in the state. As the state historic preservation office, the THC administers many programs of the National Park Service, such as the National Register of Historic Places. See also https://www.thc.texas.gov/

Thermal expansion—The growth (or contraction) of a building material caused by increases (or decreases) in temperature. Different materials have different rates of thermal expansion, and the difference between these rates in adjacent materials can cause damage if not properly accounted for.

Threshold—The sill (typically a long metal plate or strip of wood) below a door leaf. The door sweep in conjunction with the threshold can create a seal that keeps out elements such as water from entering the building's interior, as well as keep controlled indoor air inside, improving thermal efficiency.

Truss—A rigid assembly of structural frame members (such as steel sections) that can span large distances, bearing on structural supports on either end. There are many types of trusses. In some historic buildings and structures, they are exposed and decorated, and in others they are concealed in attic cavities or bulkheads. As structural elements, trusses should be protected from adverse conditions such as water or fire which could cause serious building failure.

Underground rainwater storage—A collection system below ground that stores excess rainwater which can be drawn from in times of water shortages.

Uneven settling—See *Differential settlement.*

United Nations Sustainable Development Goals (UN SDGs)—An initiative by the UN, comprising 17 goals, to encourage actions that benefit the planet. These include sustainable cities and communities and climate action, which are necessary objectives for resilience. See also https://sdgs.un.org/goals

Uplift—Upward forces generated by wind that are applied to a structure, particularly its roof, which may lift off partial or complete buildings assemblies when the pressures are greater than the assemblies were designed for.

Vulnerability

> **of buildings**—The susceptibility to adverse effects, or degree of loss, in a building that results from exposure to environmental factors, including climate change. Any loss of the ability to adapt to change increases vulnerability of buildings.
>
> **of communities or societies (social vulnerability)**—The potential for adverse effects to people or societies from disruptive events (shocks and stresses).

Wall

> **party wall** or **demising wall**—A wall that divides adjacent buildings into distinct properties. In urban environments, party walls typically need to be fire-rated to prevent rapid spread of fire from building to building.
>
> **shear wall**—A rigid wall that is designed to resist lateral (sideways) forces such as wind loads. Buildings need this rigidity in both directions.
>
> **wall-to-window ratio**—The approximate percentage of wall area that is window openings.

Water-resistant—Building products, materials or assemblies capable of shedding water and drying quickly are water-resistant. When a coating or barrier is designed specifically to slow transmission of water in vapor form it is called moisture resistant, commonly used in high-moisture areas such as bathrooms.

Waterlogged—A property or condition where a material has been entirely saturated with water. Depending on the material assembly, this can lead to other adverse conditions, such as swelling, bowing, cupping, cracking, and other effects, while some materials are not adversely affected.

Weather-stripping—Materials installed to cover, bridge, or seal joints or gaps between building assemblies such as doors and windows. Strong weather-stripping can create a weather tight condition which can prevent rain or other environmental effects from reaching the interior, as well as controlled indoor air inside.

Weather tightness—The capacity of a building to keep its interior and internal material assemblies dry during extreme precipitation or humidity. Weather tightness is established by the building envelope (foundations, walls, and roofs working together).

Window

> **operable window**—Windows that can be opened and closed, providing ventilation. Modern operable windows typically utilize seals that prevent air leakage when closed, but these can fail and are not always present in historic windows. In many efforts to seal building envelopes during HVAC retrofits, many historic windows have been made inoperable. This configuration prevents those windows from being used to air out (ventilate) the building when necessary.
>
> **storm window**—Secondary windows that provide protection to the building against inclement weather and improve thermal efficiency, typically mounted outside of the main windows to provide protection to them from damage.
>
> **trace window** or **tracery**—An ornamental type of window commonly found in religious architecture comprised of intersecting or flowery dividing elements, typically stone, metal (such as lead or cast iron), and wood.
>
> **window-to-wall ratio**—See *Wall > wall-to-window ratio.*
>
> **window assembly**—All the parts of a window (e.g., glazing, frame, jamb, sill) plus the structural elements holding it in position constitute the window assembly.
>
> > **lite**—Each individual pane of glass.
> >
> > **sash**—The framework around glass in most rectangular windows. Each sash can be fixed or movable in a sliding manner. Windows that have one sliding sash (typically a lower pane that can be slid upwards) are known as single-hung sash windows and those where two or more panes can slide in both vertical directions are known as double- (or triple-) hung sash windows.
> >
> > **sill**—The horizontal member at the base of a window frame.
> >
> > **jamb**—The vertical members of the sides of the window frame.
> >
> > **rail**—The horizontal members within sashes.
> >
> > **stile**—The vertical members within sashes.

Appendix A

UTSA-CCS Research Methodology

Case-Study Vulnerability Assessments

Research began by identifying nine historic faith-based facilities as case-studies along the Gulf Coast in Galveston County, Harris County, and Victoria County. These houses of worship were either listed on the National Register of Historic Places or deemed eligible, and case-study buildings were selected to include a variety of religious affiliations and building construction types.

Site visits were conducted at each case-study to observe conditions and conduct the UTSA-CCS Survey & Vulnerability Assessment. This form includes the physical condition of seventeen categories of building assemblies and eight categories of the risk posed to the building by site-specific and environmental threats. The condition of each physical element was assessed on a five-point scale ranging from "excellent," meaning perfectly maintained without improvement work needed, to "critical," which included broken, damaged, missing, or failing components beyond repair. The risk posed by site conditions was determined holistically as it is more complex to assess and followed a similar five-point scale from "minimal risk" to "extreme risk."

Each category was then weighted to consider its structural vulnerability, exposure to the elements, likelihood of damage, and impacts of damage to achieve an overall vulnerability score for each case-study. The case-study buildings were visited as follows: Galveston County—Eaton Chapel, Reedy Chapel, and St. Mary's Cathedral in December 2020; Harris County—K'nesseth Israel Synagogue, Antioch Missionary Baptist Church, and Trinity Episcopal Church in March 2021; Victoria County—Temple B'nai Israel, First Church of Christ Scientist, and Trinity Lutheran Church in April 2021. Completed Vulnerability Assessments were submitted to the Texas Historical Commission.

The final case-study analysis provides recommendations to enhance resilience based on each case-study building's capacity to survive extreme weather events. Together, these 9 case-studies form a foundation for strategies to reduce risk, increase the resilience of cultural resources, and mitigate the impact of future disasters at historic sacred places in the Texas Gulf Coast region.

Knowledge Café 1

Findings from the Vulnerability Assessments then informed a series of focus groups and public-input sessions (also referred to as Knowledge Café Workshops). Through these Knowledge Cafés, the research team engaged with national, state, and local nonprofit organizations, private professional practices, local regulatory offices and community leaders, other sacred places in the Texas Gulf Coast region, and the staff and congregation members of each case-study.

In May of 2021, UTSA-CCS hosted the first Knowledge Café remotely via Zoom due to COVID-19 pandemic precautions. Invitees of this Knowledge Café primarily included clergy, staff, and congregation members. A series of questions were asked regarding how these Gulf Coast congregations weather natural disasters and support their communities in recovery.

Stakeholder Maintenance & Preparedness Survey

A stakeholder survey was also made available to congregations along the Texas Gulf Coast. The goal of this survey was to evaluate perceptions and trends in building maintenance and natural disaster challenges and preparedness, in order to inform the resilience plan's accessibility and practicality for congregations. A multiple-choice and essay question Qualtrics survey was developed for an online method to maximize engagement and streamline data collection. The survey was first pilot tested by various representatives of historic houses of worship throughout the country before being shared via email with selected historic faith-based organizations located on the Texas Gulf Coast. Building stewards were chosen by their congregation's leadership to complete the survey, and only one response from each house of worship was used.

Approximately twenty-nine faith-based organization representatives responded to the survey, although the final respondent size was seventeen after the data was subjected to the following filters: 1) Listing on the NRHP or determined eligible for inclusion on the NRHP; 2) Geographically located in counties most impacted by 2017's Hurricane Harvey, as determined by the U.S. Department of Housing and Urban Development (HUD); 3) Survey completion. The compiled data was downloaded and subjected to descriptive analysis, and textual data was diagrammed in "mind maps," a branched tree of key topical words, related ideas, and subtopics.

Knowledge Café 2

A subsequent Knowledge Café was hosted remotely via Zoom in September 2021. Invitees included clergy, staff, and congregation members who had attended Knowledge Café 1, as well as representatives of government disaster response agencies and architectural, engineering, and planning consultants. A series of questions were asked to continue insight into building a sacred places heritage network for disaster resilience in the Texas Gulf Coast region.

The input from Knowledge Cafés and the Stakeholder Survey also helped to identify trends within congregations' disaster response and recovery. Findings from these, as well as the case-study assessments, were used to develop tools for further resilience, including this *Roadmap*, which were then peer reviewed before being shared with a broader audience of Sacred Places.

Findings

Knowledge Café 1

Responses from attendees indicated that the greatest risks in these areas center on flooding and winds from hurricanes affecting the roof, windows, wood surfaces, and structure of buildings. Deferred maintenance puts buildings at greater risk and disasters push this over the edge. Finding the money for post-disaster repairs is very difficult, especially when the building is in a cycle of repair and damage from these disasters. These buildings' Landmarked status often means that specialists are needed for repair. Building damage and lengthy repair times severely limit a congregation's ability to serve and live out its ministries. Building repair resources can also be difficult to find post-disaster since they are in such high demand. Regardless of congregation size, the increase in disasters and various congregation responses have built greater ties within communities. Coordination between many can help to create a general mission and provide specializations for certain people or organizations to more evenly distribute disaster response.

Stakeholder Maintenance & Preparedness Survey

Survey respondents mostly identified as clergy (70.6%), with the remaining respondents made up of nonclergy staff (17.7%) and volunteer/lay leaders (11.8%). Responses indicated that most congregation sizes were less than 75 members. Most had also experienced a natural disaster in the last five years and all congregations had experienced a natural disaster in the history of the historic building. Most congregations have also participated in recovery efforts, despite only 35.5% of congregations reporting a longstanding/permanent disaster response recovery program. The top three response efforts were resource distribution (food, water, supplies), offering shelter, and home repairs.

About one-third (35.3%) of respondents reported a dedicated budget for building maintenance and capital improvements and, of those, nearly two-third (59.3%) invested these funds toward disaster response. Most (70.6%) of the respondents' houses of worship had implemented significant repairs or renovations in the last 15 years but, of those, only a little over half (58.3%) underwent these repairs or renovations as disaster response and recovery efforts. The complexity of historic buildings often requires a dedicated and well-trained maintenance staff. Most (76.5%) reported that their congregations had a dedicated maintenance committee, though only 23.5% had been formally trained in the maintenance of historic buildings.

While slightly over half (52.9%) of respondents felt that there was not a need for *"Regulatory Guidelines"* pertaining to historic houses of worship resiliencies to natural disasters, a vast majority (82.4%) indicated a preference for *"Standard Guidelines"* on natural disaster resilience for historic houses of worship. This was an especially significant finding, showing the need for this *Roadmap* to provide standardized information for the resilience of these historic buildings and faith-based organizations.

Knowledge Café 2

Responses from the second Knowledge Café show a need for communication between the various sectors of disaster preparedness and recovery. Faith-based organizations usually know what repairs are needed but are lacking the funds and resources to do so. State preservation tax credits can be used by nonprofits to fund a substantial part of preservation projects, as well as FEMA disaster repair and preparedness funding. County Offices of Emergency Management (OEM) are a good resource for information on grants, funding opportunities, and coordination efforts with faith-based organizations.

Discussions also showed the need for a network to enhance connections between local disaster response organizers and congregations. Knowing what resources are already available will also help future efforts to fill in gaps rather than duplicate services. Access to information on resources pre-disaster is another key part of recovery and congregations can consider ways to distribute information in the post-disaster status recovery for better coordination. Communication is key in disaster situations and participants shared that some communication issues arise due to a lack of shared language regarding disasters and resilience. This *Roadmap*, as a standardized tool, has potential to become a common language between faith-based organizations and emergency planners.

Appendix B

Resilience Performance Indicator Tool Overview

The Resilience Performance Indicators (RPIs) is a tool that allows stakeholders of historic properties to assess resilience and historic property performance quantitatively. The objective of the RPI is to provide a holistic overview of the current strengths and vulnerabilities of the analyzed historic building and indicate vulnerabilities linked to resilience against natural disasters (such as floods and hurricanes). The RPI tool requires the users to provide inputs to the five categories—General, Building, Infrastructure, Environment, and Congregation—under which the historic building operates. Of the five categories, the first category (General) is not scored and is for informational purposes only. Categories 2–5 include Building, Infrastructure, Environment, and Congregation, and responses are scored. Based on the information provided, the RPI generates scores (Figure B1) and a list of indicators contributing to the vulnerability (Figure B2). The generated scores and the information enable the stakeholders of historic properties to identify vulnerabilities needing attention to enhance resilience. Further, various Resilience Technologies and Strategies (RTS) are listed that can be adopted to decrease vulnerability.

The RPI tool is a Microsoft Excel file. The first step is to download the tool and open it in Microsoft Excel. It includes eight tabs, each of which has a specific function described below:

The first tab is called the "Tool Overview" and provides the RPI users information in the areas of:

1. Tool Overview
2. How to use the Tool
3. Tab Overview in the Tool

Information provided by the users in this category is not scored or evaluated.

The second tab is called "General" and collects information about the historic building being assessed. In this tab, the users are expected to input generic project information, including the evaluated property's name, assessment completion date, property address, and others.

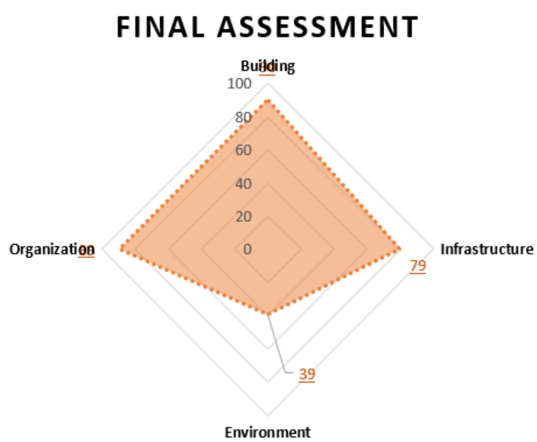
The third tab is called the "Building" and collects information about building components, the condition of installed components, technologies and strategies that can enhance the resilience of the building against natural hazards (specifically flash floods and hurricanes), and the condition of the installed technologies. Based on the input provided by the RPI users in the areas of substructure, shell, interior, building systems, and equipment and furnishing, the tool generates a score for this category—with a higher score depicting a significant ability to offset damages and possess higher resilience. Further, the tab is the first category that provides input to the RPI tool's "Final Project Assessment."

The fourth tab is called "Infrastructure" and collects information about the infrastructure supporting the historic building being evaluated. The tab determines the historic building's reliance on the surrounding infrastructure, and the ability of on-site technologies/strategies to sustain themselves in the case of natural hazards (flash floods and hurricanes). While completing the fourth tab, RPI users are expected to provide information on energy, water, stormwater management, wastewater, and communication. Based on the information provided, the tool generates a score for the historic building—with a higher score depicting a higher ability to offset damages caused by failure of centralized infrastructure that typically support building operations. Further, the tab is the second category that provides input to the RPI tool's "Final Project Assessment."

The fifth tab is called "Environment" and collects information about the physical environment and historical context within which the historic property resides. The tab determines how the historic property is placed in the context of environmental and human hazards, how connected the property is to emergency services, and surrounding land use. While completing the fifth tab, RPI users are expected to provide information on site characteristics, historic events and exposure, emergency services, and land use. The RPI tool generates a score for the historic building based on the information provided. The higher score depicts lower vulnerability to hazards and lower negative impacts of the surroundings on the site. Further, the tab is the third category that provides input to the RPI tool's "Final Project Assessment."

<u>The sixth tab</u> is called "Congregation" and collects information about the readiness of the congregation/organization in response to a natural disaster. The tab generates scores on issues of property management, disaster preparation, and overall awareness. While completing the sixth tab, RPI users are expected to provide information on planning, risk management, economics, congregation communication, and building maintenance. Higher scores depict a higher degree of preparedness on the part of the congregation/organization to minimize the natural disaster's impact. Further, the tab is the fourth category that provides input to the RPI tool's "Final Project Assessment."

<u>The seventh tab</u> is called the "Final Assessment" and automatically collects information from the third (Building), fourth (Infrastructure), fifth (Environment), and sixth (Congregation) tab, as depicted in Figure B1. The tab provides the users with holistic information about project vulnerability.



Category	Score
Total assessment score	**83**
Building	90
Infrastructure	79
Environment	39
Organization	89

Figure B1: Final Assessment of the Historic Building

In addition, when the RPI tool users click "PRESS HERE to list indicators contributing to the vulnerability" in the "Final Assessment" tab, the users can obtain a list of technologies that enhance historic property's resilience. As depicted in Figure B2, the list provides a review of the areas that increase resilience against a potential natural disaster.

Indicators Contibuting to Vulnerability	Responses
Resilience Performance Indicators - BUILDING COMPONENTS (Please answer all questions on this tab.)	
SUBSTRUCTURE	
Foundation	
Do you see soil movement such as subsidence around your building?	Yes: mild
What is the condition of foundation of your building?	Fair
Are there any type of differential settlement in the building?	Yes
Basement/Accessible Crawl Space	
(Please answer all questions in this section even if there is no crawl space)	
SHELL	
Exterior Walls	
Windows	
Is there any plate glass window within the building?	Yes
Exterior Doors	
Do any exterior doors in the analyzed building open inward?	Yes
Roof	
INTERIOR	
Partitions	
Stairs	
Flooring System	
Interior Doors	
BUILDING SYSTEMS	
Elevators	
HVAC & Electrical (*Please select "N/A" from the dropdowns for questions 85 through 90 if the building does not have an HVAC*).	
Fire Protection System	
EQUIPMENT & FURNISHING	
Resilience Performance Indicators - INFRASTRUCTURE (Please answer all questions on this tab.)	
ENERGY	
Backup Power	
Are critical systems (such as HVAC and others) connected automatically to the backup during power disruptions? (Please select "No" if you don't have backup power).	No
Have you lost power in approximately the last five years due to natural disasters?	Yes
WATER	
Water Supply	
Have you lost potable water supply from the city/municipality/town in approximately the last five years due to natural disaster(s)?	Yes
STORMWATER MANAGEMENT	
Stormwater	
Has your building's stormwater management system been overwhelmed within approximately the past five years?	Yes
What approximate percentage of stormwater can be managed on-site?	1% to 24%
WASTEWATER MANAGEMENT	
Wastewater	
What approximate percentage of wastewater generated can be discharged on the site?	1% to 24%
COMMUNICATION	
On-site Communication Equipment	
Resilience Performance Indicators - ENVIRONMENT (Please answer all questions on this tab.)	
SITE CHARACTERISTICS	
Site Hazards	
Please select you property site characteristics with regard to the floodplain:	Located in 100-year floodplain
Are there power station(s) within approximately five miles of the site? (For detailed information, Click Here)	Yes
Are there refineries within approximately five miles of the site? (For detailed information, Click Here)	Yes
Are there waste treatment, storage, or disposal sites within approximately one mile of the site?	Yes

Figure B2: Indicators contributing to the vulnerability of the historic property based on the responses provided

As can be seen in Figures B1 & B2, the demonstrated historic property is extremely vulnerable in the "Environment" category. This relates to the context of natural hazards, how connected the property is to the emergency services, and surrounding land use. The easiest way to raise the score will be to identify items which did not receive any scoring points and take actions to address these items. In many instances, the action steps will require active collaboration with all stakeholders of the historic property and involvement of qualified professionals.

The eighth tab is called the "Glossary," which provides RPI users information about the technical terms that have been used within the tool.

Appendix C

Resilience Treatments and Strategies Matrix

Note that this matrix is not comprehensive but should still be fairly representative of common conditions or practices observed in the Texas Gulf Coast that contribute to vulnerability towards hurricanes or floods. All Resilience Treatments and Strategies (RTS) should be carried in accordance with the *Secretary of the Interior's Standards* (*page 14*) to the greatest extent possible.

Key to urgency for resilience	
Severe	Condition or practice poses a risk to health or safety and should be remedied immediately.
High	Condition or practice compromises the building assembly category, which may be marked poor or critical. Schedule repair as soon as possible.
Moderate	Condition or practice actively adversely impacting other systems or may be worsening. The condition of the category may be marked moderate or poor. Make plans to remedy the condition or change the practice.
Low	Condition or practice may affect other systems or may be worsening, but is minor, isolated, or has limited effects. Maintenance may have been deferred, but continued deferral is discouraged.
Minimal	Condition or practice only concerns appearance, does not adversely affect the resilience of the building, and is generally stable. Maintenance may be deferred.

The matrix is organized by typical severity of observed damage/practice rather than by category (as listed in the *Roadmap*) to aid prioritization of RTS implementation and feasibility studies. Note that the urgency can vary depending on the condition (poor or critical condition assumed here) and is **relative** ("low" or "minimal" is only an indicator to prioritize more urgent conditions, not to ignore such conditions). Also note that lower urgency **only** refers to a low potential to enhance resilience as they typically deal with cosmetic flaws (**not** that the condition is insignificant for historic integrity & condition purposes, which often prioritize exterior appearances).

Condition or Practice	**RTS Category**	**Resilience Urgency**	**Notes** (observe *Standards for the Treatment of Historic Properties*)	**Typical Expertise Needed**
Wood beams or joists have wet/dry rot or termite damage	Floor structure, roof structure	**Severe**	Consult engineer to repair or replace affected beams.	Professional
Structural connections loose or damaged	Floor structure, roof structure	**Severe**	Consult engineer to repair or replace damage	Professional
Building area is unsafe, unstable, or unoccupiable	Floor structure, stairs	**Severe**	Consult engineer to repair or replace damage	Professional
Black mold present	Floor finishes, interior wall finishes, doors, ceilings, stairs	**Severe**	Hire professional cleaner or abatement specialist. Save historic materials.	Professional
Roof trusses have wet/dry rot or termite damage	Roof structure	**Severe**	Consult engineer to repair or replace the affected truss elements or connections.	Professional

Lack of fire detection and notification systems	Services	**Severe**	Consult architect to determine appropriate system and scope.	Professional
Site in FEMA (100-year or 500-year) floodplain or at risk of storm surge flooding	Flood risk	**Severe**	All options to mitigate this concern will negatively impact the historic character of the building and be costly to implement. There are 4 strategies: 1. Consult with an architect about adopting a dry floodproofing strategy, applying a waterproof coating to exterior walls and enabling all openings to be made watertight during a flood. 2. Consult with an architect about adopting a wet floodproofing strategy, moving all water sensitive assemblies, services/utilities, and movable heritage above Base Flood Elevation or Design Flood Elevation. 3. Consult with an engineer, architect, and/or landscape architect about constructing a floodwall around the property. 4. Consult with an architect and engineer about the feasibility of raising building above Base Flood Elevation or Design Flood Elevation. This strategy would have a	Professional

			substantial visual impact. Consult the THC.	
Lack of integrated pest management system or regularly scheduled pest control	All building and movable heritage categories	**High**	Schedule regular pest control treatment and/or create an integrated pest management plan.	Professional
Substantial pest/insect infestation (e.g., termite damage in wood surfaces)	All building and movable heritage categories	**High**	Consult a pest management company to abate the situation. Investigate conditions that facilitated pest intrusion to prevent future infestations. Repair or restore damaged assemblies.	Professional
Uneven settling or differential settlement between building areas or elements, possibly causing cracks	Foundation, floor structure, wall structure	**High**[*]	Consult engineer about necessary interventions to the foundation or other load-bearing assemblies. Monitor conditions. Repair cosmetic damage if the building is determined stable or if the cause has been remedied.	Professional
Deformation within walls, possibly due to thermal expansion	Wall structure	**High***	Consult engineer about necessary interventions to the walls or other load-bearing assemblies. Monitor conditions. Repair resulting cosmetic damage if the building is determined stable or if the cause has been remedied.	Professional
Deflecting or sagging structural beams	Floor structure, roof structure, ceilings	**High***	Consult engineer to determine stability of beam and possible need for repair or replacement. Monitor conditions.	Professional
Deflecting or sagging bulkheads or boxed out beams	Floor structure, roof structure, ceilings	**High***	Investigate the cavity in the bulkhead to assess conditions and determine appropriate remedy. see *Deflecting or sagging beams*.	In-house or professional, depending on material and access

[*] Resilience urgency level depends on extent and location of damage

Undersized drainage ports handling water shedding for roof	Roof structure, roof attachments	**High**	Consult architect to determine appropriate replacement system.	Professional
Lack of overflow drainage	Roof structure, roof attachments	**High**	Consult architect to determine appropriate alteration or replacement	Professional
Downspouts missing or do not lead directly to splash blocks or a sub-grade drainage system, eroding or scouring surrounding soil	Roof attachments, exterior finishes, soil	**High**	Modify downspouts to direct water into drainage system or else replace. Consult with an architect if the system is severely deficient.	In-house or professional, depending on extent
Large crack(s) (over 1/8" thick) in masonry walls	Wall structure	**High***	If the crack(s) is being monitored and confirmed stable by engineer, no further actions necessary; ongoing monitoring typically is necessary.	Professional
Deteriorating window frames (e.g., rotting wood sills, rails, stiles) or caulking	Windows	**High***	Repair or replace damaged frame elements; refinish or caulk as necessary.	In-house or professional, depending on extent
Towers leaning	Towers	**High***[*]	Consult engineer to determine if leaning condition is stable and if intervention is necessary.	Professional
Lack of fire suppression systems (beyond handheld extinguishers)	Services	**High**	Consult licensed professionals to determine appropriate system and scope; install.	Professional
HVAC system outdated or undersized	Services	**High**	Consult licensed professional to determine steps to replace, renew, or upgrade the system.	Professional
HVAC system over-pressurizing interior	Services	**High**	Equalize pressure between the interior and exterior. Program HVAC system to control humidity prior to services and other events, allowing humidity to rise at times when the building is not in use to prevent a high humidity differential between interior and exterior that would cause	Professional

[*] Resilience urgency level depends on extent and location of damage

			condensation within the masonry walls. When unoccupied, the system should maintain the highest level acceptable for the safe storage of sensitive interior finishes and cultural artifacts.	
Adjacent buildings shedding water onto building being assessed	Ancillary buildings	**High**	*If under same ownership*: Install drainage to direct water from buildings and discharge into storm drainage. Or, take other steps to protect primary building. *If under different ownership*: Ask owner to remedy problem (consult local regulations for possible code violation)	In-house
Rising damp or salt crystallization within walls	Foundation, exterior wall finishes, interior finishes	Moderate	Consult architect or engineer about the feasibility and appropriateness of damp-proofing at the foundation or base of wall.	Professional
Floor framing not protected with coatings or treatment	Floor structure	Moderate	Consult architect on appropriateness and feasibility of a coating on floor framing to prevent water damage previously experienced.	Professional
Waterlogged or otherwise water-damaged finishes (black mold not present)	Floor finishes, interior wall finishes, ceilings	Moderate	Refinish/restore elements that can be salvaged. Carefully remove finishes damaged beyond repair; replace with in-kind elements.	In-house
Galvanic corrosion occurring between roof components (e.g., fasteners and flashing or trim)	Roof structure, roof attachments	Moderate	Remove corroded elements and replace with components that contain the same metals or are appropriately isolated from each other.	Professional
Leaking gutters	Roof attachments	Moderate*	Repair.	In-house

* Resilience urgency level depends on extent and location of damage

Leaking or otherwise failing downspouts or connections (oxidization may be visible)	Roof attachments	Moderate*	Replace or repair.	In-house
Moisture concentrating around downspouts	Roof attachments, exterior wall finishes	Moderate*	Investigate for leaks in the roof, downspouts, or their connections. Repair any damages found.	In-house
No means of directing water away from building	Roof attachments, soil	Moderate	Install splash blocks or sub-grade drainage system.	In-house (splash blocks) or professional (system)
Vegetation growing through wall into interior	Wall structure, exterior wall finishes	Moderate	Carefully remove vegetation by hand (as directed by engineer, if wall penetration is extensive) and consolidate masonry. Restore wall and its finishes.	Professional
Steel lintel(s) over opening(s) oxidizing, possibly causing damage to surrounding masonry	Wall structure, exterior wall finishes, windows, doors	Moderate	Consult architect or engineer; repair.	Professional
Severe blistering or spalling stucco	Exterior wall finishes	Moderate	Consult architect, building conservator, or engineer to investigate causes; address problem and repair the stucco.	Professional
Spalling or pitting masonry	Exterior wall finishes	Moderate[*]	Consult architect; investigate cause; address problem and restore wall. *Spalling stone can be a life-safety risk, so this may be an urgent matter requiring closure of the area.*	Professional
Uneven discoloration or wetting pattern on exterior masonry surface	Exterior wall finishes	Moderate*	Monitor to determine cause of pattern (e.g., rising damp). If the pattern changes or intensifies (or if a waterproof coating is known to previously have been installed), consult architect, building conservator, or engineer	In-house or professional, depending on extent

[*] Resilience urgency level depends on extent and location of damage

			about treatments to address cause(s) of the problem.	
Windows unprotected from hurricane forces	Windows	Moderate*	*This may be a higher urgency if the unprotected windows have special aesthetic/cultural value* Install protective polycarbonate panels over windows that are hurricane-rated for impact and wind resistance.	In-house or professional (for numerous or unique windows)
Sealed condition between window lites and protective pane	Windows	Moderate	Install vents (with insect screens) in protective polycarbonate panes	In-house
Untempered glazing in windows and/or doors	Windows, doors	Moderate	Apply safety/security window film to glazing.	In-house
Poor seal/weather tightness (e.g., draft present or gap visibly transmitting light)	Windows, doors	Moderate	Install weather-stripping (e.g., door sweeps) to windows and doors.	In-house
Peeling paint or otherwise deteriorated finish on door exteriors	Doors	Moderate*	Refinish door.	In-house
Lower interior floor level than exterior	Doors, interior finishes	Moderate	Improve weather tightness around perimeter. Consult architect if intensive reconfiguration is necessary because this may affect character-defining features.	In-house (improving weather-stripping) or professional (remodel)
Indoor air conditions not being monitored	Services	Moderate	Monitor temperature and humidity (including during use and when unoccupied). Consult engineer if interior damage observed.	In-house
Lack of emergency power	Services	Moderate	Install and maintain an emergency generator sized to power essential building systems (for a permanent system) or a portable generator for basic recovery needs.	In-house or professional (to specify large systems)
Plumbing components (beyond faucets) exposed and uninsulated (e.g., in open crawl space)	Services	Moderate	Install insulation (e.g., sleeves, wrap, or batts) around existing plumbing, especially supply lines, or upgrade plumbing to	In-house (adding insulation) or professional

			avoid pipes bursting from freezing.	(replacing pipes)
Site elements settling unevenly from the building, possibly causing cracks	Foundation, site landscaping, soil	Low*	Consult engineer about necessary interventions to the foundation or site landscaping elements. Monitor conditions. Repair resulting cosmetic damage if the affected components are determined stable or if the cause has been remedied.	Professional
Lack of protective coatings or finishes in basement or crawl space	Foundation, basement	Low	Consult architect about feasibility and necessity to apply coatings for long-term preservation of masonry; remedy cause(s) of moisture in walls.	Professional
Gutters in need of cleaning	Roof attachments	Low	Clean gutters; install or repair netting if necessary.	In-house
Light blistering, peeling, bubbling, or scouring stucco/plaster	Exterior wall finishes, interior finishes	Low*	Repair stucco/plaster after addressing underlying causes.	In-house or professional, depending on material and extent
Light vegetation (e.g., vines, ball moss) growing on exterior façade	Exterior wall finishes	Low*	Clear vegetation by hand or spray with a gentle masonry cleaning solution at low pressure and repair exterior surface if damaged.	In-house
Masonry in need of repointing	Exterior wall finishes	Low*	Repoint mortar. If historic mortar composition is unknown or difficult to match, consult with a building conservator.	In-house or professional, depending on material and extent
Light staining, scouring, dirt, efflorescence, or biological growth on masonry (other than wetting pattern)	Exterior wall finishes	Low*	Gently clean masonry by hand using water and soft brush. If condition persists or soon reappears, investigate causes; consult architect before use of cleaning agents or application of coatings.	In-house
Cracked window lites	Windows	Low*	Replace the affected lites with in-kind lites. If	Professional

* Resilience urgency level depends on extent and location of damage

			glazing is untempered/ unprotected, consider a protective film or other measure to protect building occupants.	
Window sealant failing	Windows	Low*	Re-caulk window frames.	In-house
Damage to window lead dividers	Windows	Low*	Consult a window restoration professional to remove damaged lead and reassemble affected window with new lead.	Professional
Deteriorating or otherwise damaged threshold	Doors	Low	Repair or replace threshold.	In-house
Unprotected openings (*not windows*, e.g., in belfry)	Towers	Low	Install netting or louvres.	In-house
Previous repairs/patches to blemishes in stucco or plaster do not match color to rest of finish	Exterior wall finishes, interior wall finishes	Minimal	Repaint to match existing stucco/plaster.	In-house
Previous masonry repair does not match historic brick	Exterior wall finishes	Minimal	Remove recent repair and replace with brick to match existing masonry (if such in-kind brick can be located).	In-house or professional, depending on material and extent
Unpatched anchor holes in masonry	Exterior wall finishes	Minimal	Patch or replace brick (if in-kind brick can be located) to match existing masonry.	In-house or professional, depending on material and extent
Defects in decorative painting (e.g., flaking)	Interior wall finishes, doors, ceilings, stairs	Minimal	Restore decorative painting.	Professional
Defects (e.g., dents, scratches, general wear) in nondecorative interior finishes	Interior wall finishes, doors, ceilings, stairs	Minimal	Restore to match historic appearance. Note cause(s) before making repairs and remedy the problem. If caused by high traffic, consider adjustments in use to minimize wear, or add protection.	In-house
Peeling wallpaper	Interior wall finishes	Minimal	Repair.	In-house
Inoperable windows	Windows	Minimal	Restore operability (this may improve resilience, but could conflict with new hurricane-rated protection, which should be prioritized).	In-house or professional, depending on cause

* Resilience urgency level depends on extent and location of damage

Boarded up windows or dormers	Windows, roof attachments	Minimal	Consult architect; restore to historic appearance.	Professional
Cracks in exterior ramps or sidewalks	Site landscaping	Minimal	Ensure that any cracks do not hamper accessibility. Address tripping hazards.	In-house