The impacts of the 1938 tornado devastated the Fiddler's Green community near what is now the Hagood and Lockwood Avenue area. (National Weather Service, weather.gov)

R1 RESILIENCE GUIDANCE: OVERVIEW

VULNERABILITY

Vulnerability is the susceptibility of human settlements to the harmful impacts of natural hazards.

This susceptibility has implications at the individual, household, and community levels, and potentially harmful outcomes such as injuries, deaths, damage to housing and infrastructure, and destruction of businesses and livelihoods. It is therefore important to capture both the physical/exposure and social/human dimensions.

(FEMA)

RESILIENCE

Resilience is the ability to prepare for threats and hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions.

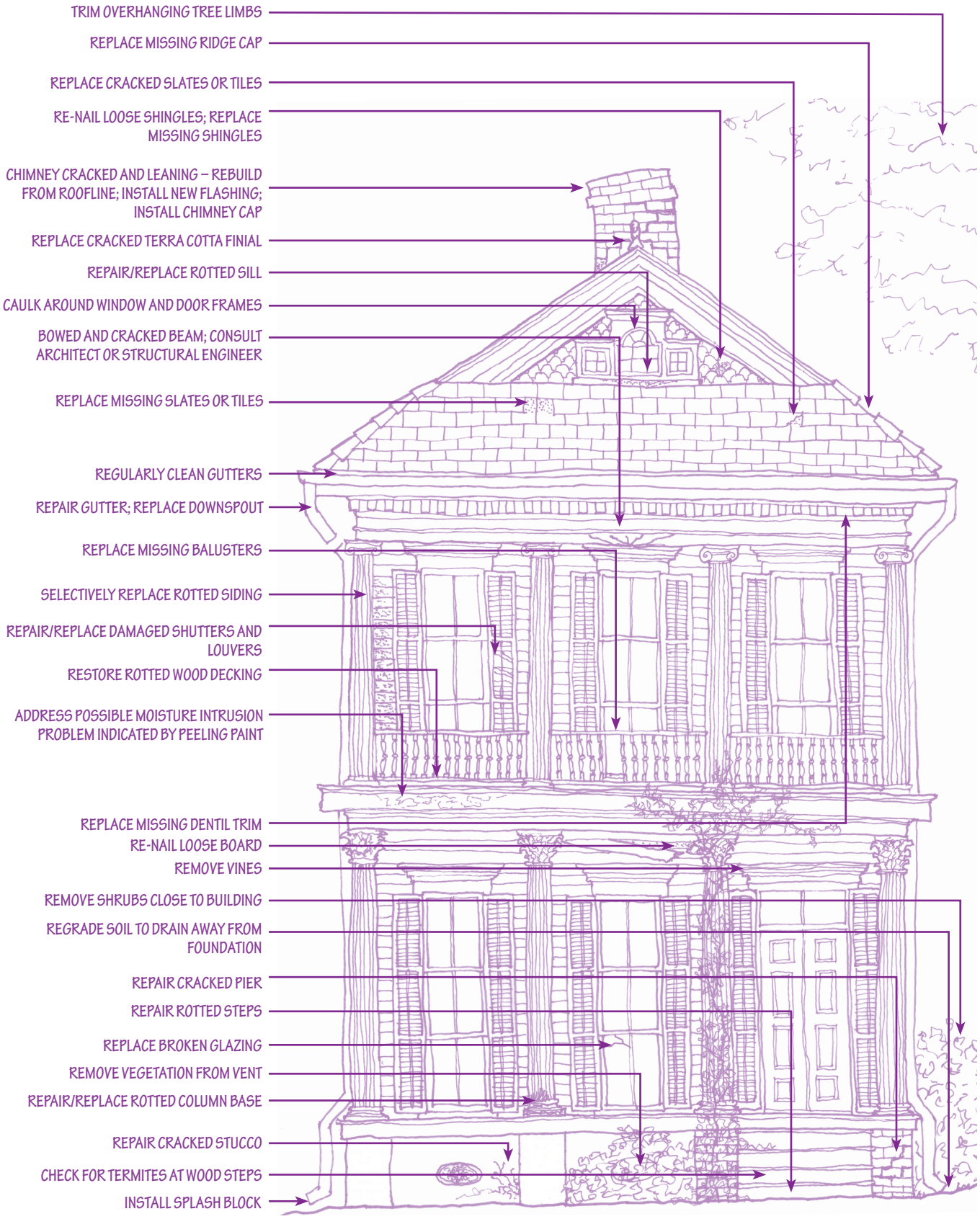
(FEMA)

The goal of this Resilience Guidance for property owners and tenants is to provide enough information for them to make improvements to enhance resilience in place, and to aid recovery until resources allow for the implementation of a more comprehensive strategy.

Climate change, sea level rise, tropical storms, hurricanes, and earthquakes serve as the backdrop to the *Resilience Guidance for Charleston*. The title is intended to describe adaptation measures for these collective environmental forces. Specific vulnerabilities in Charleston include flooding, extreme heat, damaging winds, and earthquakes that are potential sources of building damage and risks to life safety. The *Resilience Guidance* sections offer resilience improvement strategies to reduce the impacts of these vulnerabilities. Properties, buildings, and settings in and out of historic districts are included to provide a resource for all of Charleston's existing buildings.

The organization of the *Resilience Guidance* is divided into specific building or site components, like exterior wood or landscape. A checklist in each topic section provides readers with a tool to quickly identify areas of improvement, relative costs, and level of professional resources that may be needed. Information is also included to successfully navigate the local permit approval process for small-scale projects. Recommendations may not reduce flood, wind, or earthquake insurance premiums, or be sufficient to meet building codes. However, they are intended to provide guidance on accessible, effective strategies for regular maintenance and enhancements that can improve a property's resilience. ***Large and more complex projects, such as elevating a building to mitigate flood risk, are not included.*** Other reference materials and local officials can provide specific resources for these actions.

TYPICAL WOOD FRAME BUILDINGS: GENERAL MAINTENANCE ACTIVITIES



MAINTENANCE: FOUNDATION OF RESILIENCE

Regular maintenance helps preserve buildings, structures, and properties; protects real estate values; and keeps Charleston an attractive place to live, work, and visit. Lack of regular upkeep can reduce property values and damage the building, resulting in accelerated deterioration of a building or property elements and features. Small openings or unpainted surfaces can allow moisture penetration and eventually rot building materials.

Sustained maintenance is imperative to protect a building structure from flooding, high winds, and earthquakes; and can also reduce potential costly repairs. Historic building materials have a longer service life if maintained, but can be more costly or difficult to replace. ***Maintenance is the foundation of resilience planning for a property.***

Property owners and tenants are encouraged to inspect buildings and properties regularly to identify potential problems. Ideally, property inspections will take place twice each year, in the spring and fall. The spring inspection will identify issues that can be addressed in advance of hurricane season, while the fall inspection will allow for storm damage-related repairs and lead-time for larger projects. Regular maintenance items include painting, cleaning gutters and downspouts, and inspecting the roof. The individual topic sections in this *Resilience Guidance* document provide a road map of key issues for different areas of a property and options for improvements.

Wood located on or next to a brick or a concrete foundation or pier is more likely to absorb moisture and rot, as well as attract pests and termites. Open joints provide a path for stormwater and floodwater.

BOARD OF ARCHITECTURAL REVIEW (BAR)

One of the essential goals of BAR is to protect and preserve historic properties for the benefit of future generations. This includes all exterior historic materials found within a local designated historic district. ***To preserve the authenticity of Charleston, particularly in locally designated historic districts, the BAR strongly encourages the retention of historic materials or replacement in-kind whenever work on a property is considered.*** Therefore, recommended repairs are focused on specific areas of deterioration in order to maintain a building's stability and weather resistance, rather than wholesale replacement of a historic building material. Careful attention to detail might be required as part of the effort, and regular maintenance with timely repairs can minimize large repair costs associated with ongoing deterioration. *(Refer to Special District Permitting, sidebar page R1.5.)*

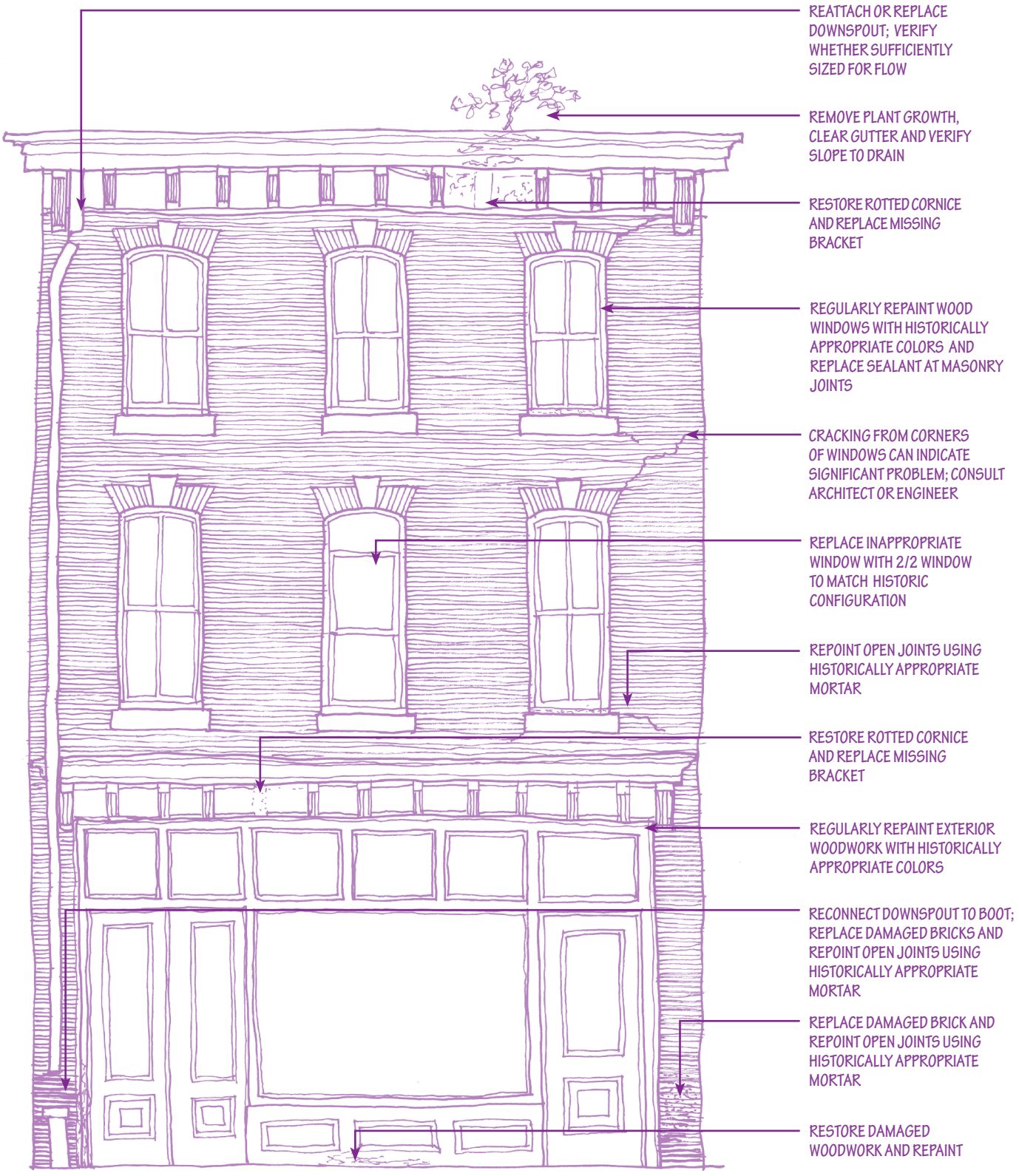
MAINTENANCE MANUAL

Property owners will find it helpful to develop a maintenance manual to track conditions over time, problems, maintenance tasks, and contractors who perform work. The information in the manual generally falls into four categories:

- **General information** should include the names and telephone numbers for emergency services and repairs, warranties, and basic information on specific building equipment, such as maintenance manuals
- **Property documentation** should include historical, construction, alteration, and legal information that is specific to the property's past conditions, including construction drawings, products used, and construction photographs, if available
- **Inspection and maintenance records** should include the preventive maintenance work completed by the owner and contractors; lists of items to be inspected, and how often inspections occur (i.e., annual heating and cooling system reviews); and information on particular repair and upkeep techniques of particular components, materials, and equipment, with receipts specifying work performed
- **Property review documentation** should include dated photographs of the overall building and site, as well as detailed areas of problems that can be used to track whether conditions are worsening over time

The manual can be organized as an electronic document and/or a three-ring binder so it can be easily supplemented over time. In addition to informing physical changes, the maintenance manual may also be valuable when negotiating policies or claims with insurance brokers and should be safely stored.

TYPICAL MASONRY OR STOREFRONT BUILDINGS: GENERAL MAINTENANCE ACTIVITIES



PERMIT CONTACT INFORMATION

Building permit application materials may be submitted online or in person to the Permit Center for review. The Permit Center staff are available to answer all permit and plan review questions.

Applicants with complex projects are encouraged to visit and talk with staff prior to submitting an application.

Permit Center

2 George Street
Charleston, SC 29401
(843) 577-5550
permits@charleston-sc.gov
Websites
www.charleston-sc.gov/permitcenter or
www.charleston-sc.gov/css (to apply or check status of permit)

SPECIAL DISTRICT PERMITTING

Special Districts include properties within historic districts, properties on commercial corridors under design review, and special flood hazard areas.

Board of Architectural Review

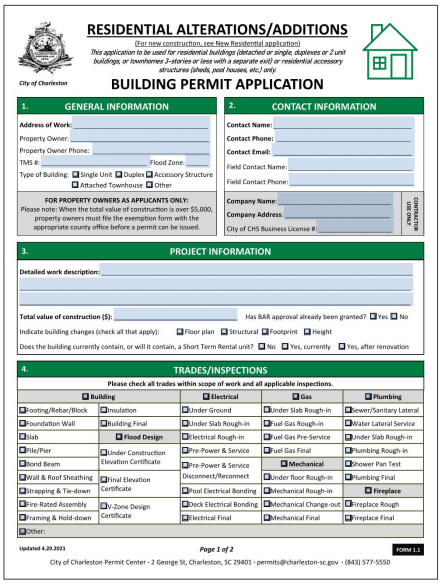
www.charleston-sc.gov/bar
(843)724-3765

Design Review Board

www.charleston-sc.gov/drb

Special Flood Hazard Area

www.charleston-sc.gov/2383/Floodplain-Mapping



City of Charleston

RESIDENTIAL ALTERATIONS/ADDITIONS

(For new construction, see New Residential application)

This application to be used for residential buildings (detached or single, duplexes or 2 unit buildings, or townhomes 3-stories or less with a separate exit) or residential accessory structures (sheds, pool houses, etc.) only.

BUILDING PERMIT APPLICATION

1. GENERAL INFORMATION
Address of Work:
Property Owner:
Property Owner Phone:
TMS #: Flood Zone:
Type of Building: ☐ Single Unit ☐ Duplex ☐ Accessory Structure ☐ Attached Townhouse ☐ Other
FOR PROPERTY OWNERS AS APPLICANTS ONLY:
Please note: When the total value of construction is over $5,000, property owners must file the exemption form with the appropriate county office before a permit can be issued.

2. CONTACT INFORMATION
Contact Name:
Contact Phone:
Contact Email:
Field Contact Name:
Field Contact Phone:
Company Name:
Company Address:
City of CHS Business License #:
CONTRACTOR OR OWNER

3. PROJECT INFORMATION
Detailed work description:
Total value of construction ($): Has BAR approval already been granted? ☐ Yes ☐ No
Indicate building changes (check all that apply): ☐ Floor plan ☐ Structural ☐ Footprint ☐ Height
Does the building currently contain, or will it contain, a Short Term Rental unit? ☐ No ☐ Yes, currently ☐ Yes, after renovation

4. TRADES/INSPECTIONS
Please check all trades within scope of work and all applicable inspections.

☐ Building		☐ Electrical	☐ Gas	☐ Plumbing
☐ Footing/Rebar/Block	☐ Insulation	☐ Under Ground	☐ Under Slab Rough-in	☐ Sewer/Sanitary Lateral
☐ Foundation Wall	☐ Building Final	☐ Under Slab Rough-in	☐ Fuel Gas Rough-in	☐ Water Lateral Service
☐ Slab	☐ Flood Design	☐ Electrical Rough-in	☐ Fuel Gas Pre-Service	☐ Under Slab Rough-in
☐ Pile/Pier	☐ Under Construction Elevation Certificate	☐ Pre-Power & Service	☐ Fuel Gas Final	☐ Plumbing Rough-in
☐ Bond Beam		☐ Pre-Power & Service Disconnect/Reconnect	☐ Mechanical	☐ Shower Pan Test
☐ Wall & Roof Sheathing	☐ Final Elevation Certificate	☐ Under floor Rough-in	☐ Mechanical Rough-in	☐ Plumbing Final
☐ Strapping & Tie-down		☐ Pool Electrical Bonding	☐ Mechanical Change-out	☐ Fireplace
☐ Fire-Rated Assembly	☐ V-Zone Design Certificate	☐ Deck Electrical Bonding	☐ Mechanical Final	☐ Fireplace Rough
☐ Framing & Hold-down		☐ Electrical Final		☐ Fireplace Final
☐ Other:				

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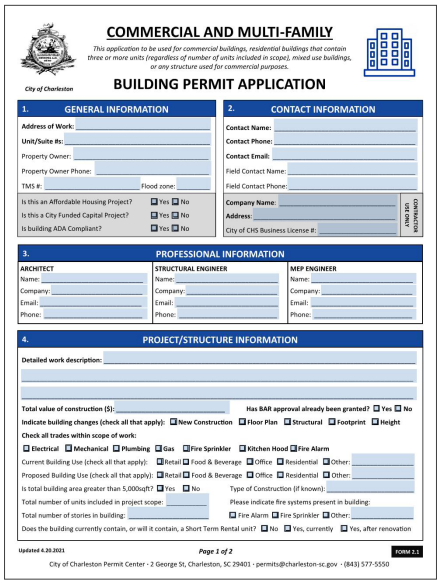
City of Charleston Permit Center · 2 George St, Charleston, SC 29401 · permits@charleston-sc.gov · (843) 577-5550



City of Charleston

COMMERCIAL AND MULTI-FAMILY

This application to be used for commercial buildings, residential buildings that contain three or more units (regardless of number of units included in scope), mixed use buildings, or any structure used for commercial purposes.

BUILDING PERMIT APPLICATION

1. GENERAL INFORMATION
Address of Work:
Unit/Suite #s:
Property Owner:
Property Owner Phone:
TMS #: Flood zone:
Is this an Affordable Housing Project? ☐ Yes ☐ No
Is this a City Funded Capital Project? ☐ Yes ☐ No
Is building ADA Compliant? ☐ Yes ☐ No

2. CONTACT INFORMATION
Contact Name:
Contact Phone:
Contact Email:
Field Contact Name:
Field Contact Phone:
Company Name:
Address:
City of CHS Business License #:
CONTRACTOR OR OWNER

3. PROFESSIONAL INFORMATION

ARCHITECT	STRUCTURAL ENGINEER	MEP ENGINEER
Name:	Name:	Name:
Company:	Company:	Company:
Email:	Email:	Email:
Phone:	Phone:	Phone:

4. PROJECT/STRUCTURE INFORMATION
Detailed work description:
Total value of construction ($): Has BAR approval already been granted? ☐ Yes ☐ No
Indicate building changes (check all that apply): ☐ New Construction ☐ Floor Plan ☐ Structural ☐ Footprint ☐ Height
Check all trades within scope of work:
☐ Electrical ☐ Mechanical ☐ Plumbing ☐ Gas ☐ Fire Sprinkler ☐ Kitchen Hood ☐ Fire Alarm
Current Building Use (check all that apply): ☐ Retail ☐ Food & Beverage ☐ Office ☐ Residential ☐ Other:
Proposed Building Use (check all that apply): ☐ Retail ☐ Food & Beverage ☐ Office ☐ Residential ☐ Other:
Is total building area greater than 5,000sqft? ☐ Yes ☐ No Type of Construction (if known):
Total number of units included in project scope: Please indicate fire systems present in building:
Total number of stories in building: ☐ Fire Alarm ☐ Fire Sprinkler ☐ Other:
Does the building currently contain, or will it contain, a Short Term Rental unit? ☐ No ☐ Yes, currently ☐ Yes, after renovation

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RESILIENCE GUIDANCE: PERMIT REVIEW

The property location, use, and proposed type of work will impact the complexity and timing of the review process. ***The majority of the identified Resilience Guidance topic sections will require a building permit, with additional information/reviews required for properties within a Special Flood Hazard Area (SFHA) or under the purview of the Board of Architectural Review (BAR) or Design Review Board (DRB).*** *(Refer to Special District Permitting sidebar, at left.)*

SIMPLE PERMIT APPLICATION REVIEW

A simple permit application review can be used for most of the *Resilience Guidance* recommendations. After submittal, the Permit Center team will review the application materials for completeness and identify any supplemental information or reviews that may be required. If all required information is submitted, simple projects that do not require BAR or DRB review are typically processed more quickly than larger projects or incomplete applications. Some residential permit applications can be "walked through" the Permit Center by the applicant.

One of the best ways to accelerate the review process is to make sure that the review submission includes the required, completed permit application(s) and all required supporting information. Requests for additional information during review will delay final approval.

Information required for a building permit review includes:

- ❑ Completed Permit Application
- ❑ Photographs showing the proposed area of work, including property context along a street; photos of elements to be modified, removed, or demolished are often helpful
- ❑ Product information for the installation of some proposed materials (such as new windows or doors) to verify they comply with wind impact requirements
- ❑ Project costs for properties located in the Special Flood Hazard Area
- ❑ Site and building plans showing current and proposed conditions

COMPLEX PERMIT APPLICATION REVIEW

Projects that include any type of structural work, from reframing doorways to elevating a building, will require engineering plans. At a minimum, most properties within Special Districts (such as BAR, DRB, or Special Flood Hazard Areas) will require a building permit or a professional certification to be performed by outside experts, such as contractors or design professionals. Applicants for these more complex projects can contact the Permit Center or request assistance with the permitting process from their outside professionals.

WORK BY PROPERTY OWNERS

Property owners are allowed to complete their own permitted work if the building is a single-family structure or duplex and is the primary residence of the owner. In these cases, the property cannot be rented or sold for two years. ***Prior to beginning work, please consult with the City's Permit Center team for requirements and anticipate additional requirements for properties located in the SFHA, a BAR, or DRB district.*** Some maintenance work, including painting, may require a permit. *(Refer to Special District Permitting, sidebar page R1.5.)*

- **Residential Properties:** Residential property owners must file an exemption form and disclosure statement with the Charleston or Berkeley County Register of Deeds office before submitting a permit application with the City of Charleston. City staff will make this determination based on the scope of work when the project valuation is $5,000 or more. All permit conditions must be followed as required.
- **Commercial Properties:** Commercial projects with a valuation equal to or greater than $10,000 must be performed by contractors licensed through the SC Department of Labor, Licensing, and Regulation (SCLLR).

HIRING OUTSIDE PROFESSIONALS

Some projects are beyond the capacity of a property owner. When searching for a contractor or design professional, read online reviews; request permits for successfully completed projects in the area; and ask neighbors, colleagues, and friends, to develop a prospective list of professionals. Price should be considered in addition to the following criteria:

- Active Business License, City of Charleston
- Active SC LLR Contractor, Architecture, or Professional Engineering license *(www.llr.sc.gov)*
- Familiarity with resilience mitigation to improve a property's ability to withstand a severe storm or natural disaster
- Familiarity with the BAR and DRB process and requirements, as applicable
- References for similar projects completed on time and on budget
- Surety bonding for contractors completing more complex projects
- General Liability and Workers Compensation Insurance, as well as Professional Liability Insurance (architect and engineer)
- Communication expectations before and during work
- Qualifications and anticipated presence of site supervisor or architect/ engineer managing the project

When buildings are elevated in a SFHA, there are unique requirements related to the location of mechanical systems and ductwork.

SUBMITTING THE CORRECT BUILDING INSPECTIONS PERMIT APPLICATION

A Building Inspection Permit is required for almost all types of work. A completed permit application, with an accurate description of the proposed scope of work, must be submitted for all projects. There are two building permit applications applicable to the *Resilience Guidance* recommendations; chose the appropriate application based upon the building use.

Residential Existing Building Alterations/Additions Application

Used for existing one- and two-family dwelling buildings (detached, duplexes, and townhomes, three stories or less with a separate exit) and accessory buildings and structures; and accessory buildings and structures such as garages, sheds, pool houses, and accessory dwelling units at existing residences.

Commercial and Multi-Family Application

Used for all commercial buildings and accessory structures. This includes all mixed-occupancy residential buildings with three or more dwelling units, or more than three stories, regardless of the size limited to the project scope.

FLOOD OR FLOODING

The City of Charleston defines flood or flooding as a temporary rise in the level of water which results in the inundation of areas not ordinarily covered by water.

Floods occur naturally and can happen almost anywhere. They may not even be near a body of water, although river and coastal flooding are two of the most common types. (FEMA)

NATURAL FLOOD HAZARDS

Three natural sources of flooding should be considered when assessing the property's vulnerability and developing a response strategy.

- **Coastal (tidal or surge):** Storm surge, tidal shifts, waves, and sea level can all influence coastal flooding
- **Rainfall (pluvial):** Heavy rainfalls resulting in flooding can be the remnants of anticipated storms such as hurricanes, tropical storms, or high-wind seasonal storms (known as compound flooding); or an unpredictable intense rainfall, known as a flash flood or rain bomb
- **Riverine (fluvial):** Added volumes of water cause rivers to rise and flow faster and culverts to be overwhelmed

OTHER FLOOD HAZARDS

Property owners and tenants should also be aware of other flood risks like:

- Interior flooding from storm drains, floor drains, sewers, septic systems, water supply piping, and damaged or faulty appliances
- Dam failure
- Groundwater flooding or rising water tables that can loosen soils and weaken structural integrity
- Buried or hidden urban waterways

Flooding in the West Side. (Photo from PSC Survey, Brandon Hall)

FLOODING AND SEA LEVEL RISE

There are three sources of flooding: coastal, rainfall, and riverine. Each can cause significant damage, but when an area plagued by coastal flooding is struck by a flash flood from a tropical storm, the effects can be compounded. Coastal flooding may also be informally referred to as sunny-day flooding, nuisance, or persistent flooding – appropriate words to describe increasing occurrences due to sea level rise. On its own, coastal flooding can result in traffic problems, road closures, overwhelmed storm drains, and occasional infrastructure damage that often cause public inconvenience and business interruptions. Increased water tables can create groundwater flooding, causing soils to become spongy or soggy. This is particularly true along the banks of waterways and low-lying marshland areas and areas with high or increasing water tables.

Occasional flood events usually have a specific cause, typically a weather event that occurs from natural sources like a storm, heavy precipitation, and king tides. ***Low-lying and flood-prone areas adjacent to or near waterways, called floodplains, are more vulnerable to these weather events even if they are normally dry.*** The Federal Emergency Management Agency (FEMA) identifies floodplains on maps to indicate areas of potential flooding. *(Refer to msc.fema.gov/portal/home for detailed maps.)* While there may be advance warning for severe weather events, other flood hazards may be sudden and result in unpredictable flooding. *(Refer to Other Flood Hazards sidebar at left.)*

RECOGNIZING FLOOD VULNERABILITIES

The City recognizes that "all properties in the City of Charleston are in a flood zone, but not all properties are in the Special Flood Hazard Area (SFHA)." *(Refer to msc.fema.gov/portal/home for detailed maps.)* ***Any existing property in Charleston may experience flooding. Property owners and tenants are encouraged to obtain flood insurance, regardless of location, ownership, or lender requirements.*** Charleston is also increasingly vulnerable due to the impact of climate change and sea level rise. The *2020 City of Charleston All Hazards Vulnerability and Risk Assessment* anticipates three feet of sea level rise between 2030 and 2100, making 15,000 properties inaccessible due to tidal flooding.

Trees can be toppled or uprooted during severe wind or rain events that can damage buildings and block access roads. (SC Emergency Management Division)

Wind damage to roofs can cause significant interior damage if water leaks occur.

WIND AND TORNADOES

Severe storms can include sustained, damaging wind speeds and carry debris that can impact any part of a building. The intensity of hurricanes and tropical storms are increasing over historical trends due to warmer atmospheric and sea surface temperatures from climate change. *(Refer to Vulnerable Cities: Coastal Flood Risk, climatecentral.org.)* While there is usually advance warning of a tropical event, a tornado can often develop too quickly for adequate response time, unless it is associated with other storm events. Most occurrences of tornadoes do coincide with tropical events, which happened in September 2004 and 2017, when Tropical Storm Frances and Hurricane Irma, respectively, spawned tornadoes across South Carolina (SC State Climatology Office).

While flood vulnerability is typically associated with a building's proximity to water, buildings throughout Charleston are potentially vulnerable to wind damage. Secondary damage from high winds include downed trees that fall on buildings or power lines. This can start fires or block roadways, hindering emergency vehicle access.

Wind damage can cause failure to the following building components:

- Roofs
- Chimneys
- Window and door openings
- Structural systems
- Siding materials
- Appendages, such as chimneys, porches, and carports
- Overhead electrical service

There are several improvements that a property owner can implement to reduce the potential damage from high winds, including trimming trees, protecting windows, and improving structural reinforcing. The *Resilience Guidance* topic sections provide recommendations and strategies to reduce potential damage.

WIND DESIGN

The City of Charleston is located in a coastal high-wind zone. New buildings and structures must be designed to withstand 150 mph wind design speeds, based on current code requirements. To ensure compliance, the Building Inspections Division requires signed and sealed plans by a SC licensed structural engineer or architect for modifications and alterations to an existing building structural system including:

- Partial or complete removal of interior or exterior building walls
- New outdoor structures, such as: sheds, pergolas, decks, screened porches
- New building components such as windows, doors, skylights, and garage doors *(refer to Historic Preservation Considerations, for historic windows and doors, page R6.11)*

EARTHQUAKE VULNERABILITY

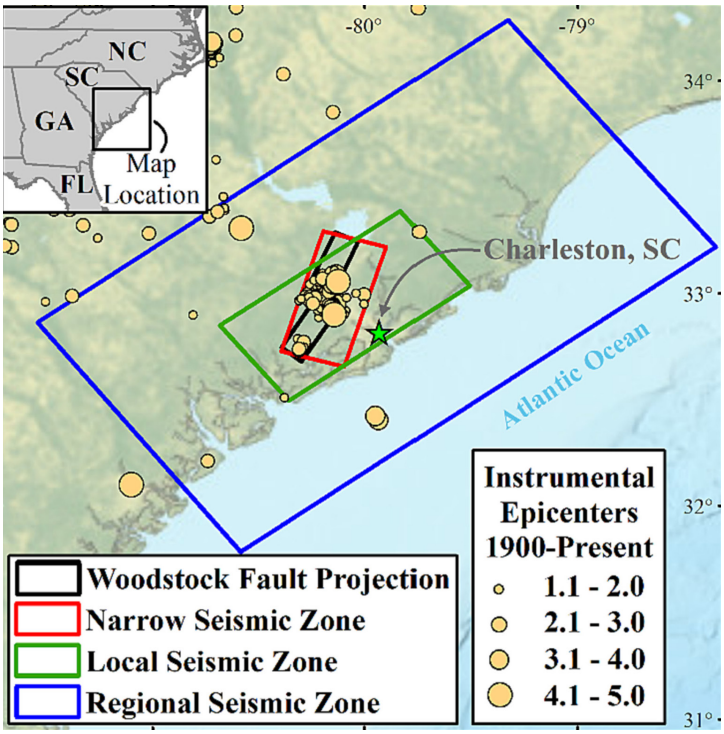
Earthquakes are not an uncommon occurrence in South Carolina. The majority of earthquakes worldwide occur at plate boundaries when plates stick and then jump past each other. The cause of earthquakes in South Carolina is not so clear; the quakes are located within a plate rather than at a plate boundary. In South Carolina, approximately 70 percent of the earthquakes occur in the Coastal Plain, and most are located around three areas west and north of Charleston: Ravenel-Adams Run-Hollywood, Middleton Place – Summerville, and Bowman. ***Geologically, Charleston lies in one of the most seismically active areas in the Eastern United States.*** This seismic cluster is known as the Middleton Place – Summerville Seismic Zone (MPSSZ).

(Charleston Regional Hazard Mitigation Plan)

LIQUEFACTION

When loose soil is shaken by an earthquake, it will compact just like the shaking of a canister of flour. If the spaces between the grains are filled with water, when the soil compacts in the few seconds of an earthquake, the water gets squeezed out from the soil but cannot flow away instantaneously. ***During that time, the soil can no longer support structures above, causing buildings to shift and sometimes sink.*** This action is similar to when you wiggle your toes on the wet sand on a beach, making your feet sink into the sand.

(FEMA P-530)



Woodstock Fault projection (Durá-Gómez and Talwani, 2009a, Durá-Gómez and Talwani, 2009b) and the zonal weighting scheme assigned to the Charleston Seismic Zone in the most recent U.S. National Seismic Hazard Model Project (NSHMP) maps (Petersen et al., 2014, Petersen et al., 2020).

EARTHQUAKES

A deadly earthquake struck the Charleston area in 1886, claiming lives and leaving many buildings in ruins across the city. Since that time, there have been continued reports of earthquakes, particularly northwest of Charleston, although none as damaging. South Carolina is located within a single tectonic plate. Rather than multiple plates shifting and rumbling against each other, like the types of earthquakes experienced on the West Coast, there are no individual plates in this region. *(Refer to Earthquake Vulnerability, sidebar at left.)*

However, Charleston's loose, wet soil conditions can amplify the impacts of an earthquake through a process known as liquefaction. Liquefaction can turn normally solid ground into a quicksand-like state, with the potential for significant harm to residents and damage to buildings and structures. *(Refer to Liquefaction, sidebar at left.)* Property owners and residents should become aware of the serious threat potential of an earthquake, even though the historical earthquake is known as a 1-in-500-year event.

Earthquakes are unpredictable and can cause severe damage within minutes or less, including these factors:

- Unreinforced masonry structures are at greater risk of damage
- Falling debris can impact an otherwise unaffected building
- Items hung or stacked against walls can topple from minor shaking
- Utilities can be damaged, such as water and gas pipes, causing flood or fires

All property owners and tenants should take actions to safeguard the contents of their home or business building, and consider advanced mitigation options.

The southern exposure of this building around 4pm shows the porch with welcomed shade. Landscaping and building design can affect indoor air temperatures and solar panels provide an alternate energy source, all increasing the property's resilience.

EXTREME HEAT

Extreme heat is associated with climate change, causing a particular threat for people's health and well-being in buildings with high internal temperatures. The average temperature in Charleston County was 74.7 degrees Fahrenheit between 1961 and 1990, while the projected average temperature for 2050 is 76–81 degrees. The anticipated number of days exceeding 90 degrees almost doubles in the same time frame. *(Refer to U.S. Climate Resiliency Toolkit, climate.gov.)* Temperature and humidity data collected from a variety of surface temperatures, outdoor workers, and transportation routes in Charleston helped identify the city's most concentrated hot areas, or heat islands. The findings demonstrate the benefits of tree canopies and the careful selection of building and pavement materials and colors, and can serve as a guide to residents for their own properties. *(Refer to Charleston Extreme Heat Initiatives, sidebar at right.)*

The southern exposures of several houses around 5pm see little relief from natural landscaping. Interior blinds can help reduce thermal energy radiating through the windows.

CHARLESTON *EXTREME HEAT INITIATIVES* OVERVIEW

One of the studies outlined in Charleston's *Extreme Heat Initiatives* found a 40-degree differential on and around different materials outdoors on the very same day in the same place. Gravel, manicured grass, and plantings were on the low end of the temperature measurements; with asphalt, brick, and artificial turf on the higher end. Researchers also found a 19-degree difference between a clay tile roof and an asphalt shingle roof on neighboring buildings at Charleston's Gadsden Green public housing complex. Even a lighter hue of asphalt shingle was measured to be almost 10 degrees cooler than a darker color.

(Post and Courier editorial, August 9, 2023)

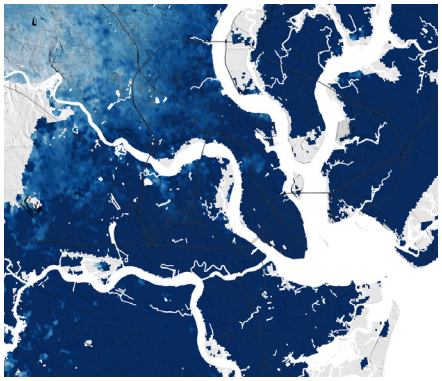
SOCIAL INEQUITIES OF CLIMATE CHANGE

Studies are continuing to find that vulnerable populations are disproportionately impacted by climate change. Their neighborhoods tend to be:

- Prone to increased flooding that causes repetitive financial hardships from repairs
- On a regional scale, located on the frontline of contaminated groundwater from factories and plants
- Under-maintained and have failing infrastructure
- Located in heat island areas with less green space and tree canopies

Charleston's neighborhoods with the highest overall social vulnerability are spread across the city. In the Downtown/Peninsula, Inner West Ashley, and Cainhoy areas there are notable impacts to public housing and food stamp retailers. *(Refer to City of Charleston All Hazards Vulnerability and Risk Assessment, 2020.)*

Lightning struck the steeple of the Second Presbyterian Church of Charleston in 2020, resulting in a localized fire. (www.2ndpc.org/blog/2020/4/20)



Charleston is one of the fastest sinking cities (about 4 mm/year) in the eastern U.S., with a portion of that thought to be the result of human activities, including groundwater pumping. (NASA Earth Observatory Image, earthobservatory.nasa.gov/images/152452/americas-sinking-east-coast)

FLOOD-RELATED EROSION

The collapse or subsidence of land along the shore of a lake or other body of water as a result of undermining caused by waves or currents of water exceeding anticipated cyclical levels or suddenly caused by an unusually high water level in a natural body of water, accompanied by a severe storm, or by an unanticipated force of nature, such as a flash flood or an abnormal tidal surge, or by some similarly unusual and unforeseeable event which results in flooding. (NFIP)

SECONDARY THREATS

FIRE AND LIGHTNING

Fires can occur in the aftermath of a flood or earthquake when fuel containers are damaged or downed electrical lines come in contact with floodwater. Floodwaters, damaged bridges and access roads, and debris can hinder fire-fighting access and efforts, allowing the fire to continue to spread. Lightning can also cause fires, and while often associated with heavy rain events, some strikes are up to 10 miles away from active rainfall.

- Warm temperatures and water will produce thunderstorms and generate lightning
- Lightning is one of the most hazardous and life threatening impacts of a storm event and is difficult to forecast

SHIFTING LANDSCAPES: SUBSIDENCE AND EROSION

Many areas of Charleston, both on and off the peninsula, have coastal edges that were built on top of artificial fill material that compacts differently than adjacent soils. This means that ground surfaces are more likely to shift at different rates, since filled areas have an increased rate of subsidence. Some aspects of shifting landscapes are man-made, such as coastal erosion from boat traffic and historical development of natural areas, but climate change is likely exacerbating the phenomenon.

SUBSIDENCE

Land areas near shorelines are slowly sinking – a gradual process known as subsidence. With subsidence, the negative impacts of rising seas and storm events are increasing. Subsidence is largely attributed to climate change, however, it is also attributed to man-made influences from groundwater extraction. *(Refer to Geophysical Research Letters, by Pei-Chin Wu, Meng (Matt) Wei, agupubs.onlinelibrary.wiley.com.)*

The Charleston Aquifer supplies almost all of the groundwater for Charleston County, and two-thirds of the water for the tri-county area of Berkeley, Charleston, and Dorchester counties. Subsidence can also compromise natural shoreline protection elements – such as marshes, beaches, mangrove stands, coral reefs, and oyster beds – reducing their effectiveness. Invasive species, pollutants, and development can also contribute to increased rates of shoreline loss. Waterfront property owners can encourage the growth and preservation of natural shoreline protection by understanding its function and limiting activities that are harmful. *(Refer to Natural Shoreline Protection, page R2.12)*

EROSION

Shorelines along waterbodies can gradually erode from the action of slow consistent waves or currents over hundreds or thousands of years. However, more significant and noticeable erosion is occurring at an accelerated rate from increasingly severe storms and sea level rise. Erosion can impact coastal waterfront properties, historic maritime resources and military infrastructure, and archaeological resources. *(Refer to Flood-Related Erosion, sidebar at left.)*

HURRICANE AND FLOOD PREPAREDNESS FOR RESILIENCE

PRE-STORM ACTIVITIES

- ❑ **Protective materials:** Collect sandbags, plywood, plastic sheathing, lumber, tools, and flashlights on site
- ❑ **Clean-up materials:** Collect sump pumps, wet-vacuums, bleach, cleaning supplies, rubber gloves, protective clothing, fans
- ❑ **Business operations:** Cancel appointments, reservations, deliveries
- ❑ **Recovery plan:** Identify licensed contractors, electricians, plumbers, clean-up crews, service providers, and telecommunication companies
- ❑ **Regular training:** Train staff/occupants for flood preparation, including installing flood shields/ barriers and wind protection
- ❑ **Important contacts / providers / suppliers / staff:** Telephone numbers and account numbers
- ❑ **Business interruption insurance:** Obtain insurance
- ❑ **Evacuation plan:** Prepare plan
- ❑ **Continuity of operations:** Prepare plan

STORM PREPARATION

PROPERTY

- ❑ **Tree limbs:** Trim overhanging tree limbs that might crash through a roof or take down electric lines
- ❑ **Site debris:** Clear debris that might become waterborne or airborne, clog storm drains, provide fuel for a fire, or damage buildings
- ❑ **Site drains / gutters / downspouts / floor drains:** Clear for water flow
- ❑ **Oil / propane tanks:** Secure barbecue grills and close at main valve
- ❑ **Outdoor furnishings:** Relocate to interior or secure
- ❑ **Document property:** Inventory and photograph property, equipment, furnishings
- ❑ **Swimming pools:** Partially drain

EXTERIOR BUILDING

- ❑ **Roof hatches / skylights / ventilators:** Secure and brace
- ❑ **Roof vents:** Install temporary protection
- ❑ **Shutters:** Secure or install plywood, mylar, or temporary coverings to building wall, not to window/door frames
- ❑ **Windows / doors:** Secure and brace windows and doors
- ❑ **Temporary barriers / shields:** Install sandbags or metal panels at flood vulnerable openings

INTERIOR BUILDING

- ❑ **Furnishings:** Remove breakable items from walls and cabinets; elevate vulnerable items; roll up rugs; close window treatments including interior blinds, drapes and interior shutters; and be mindful that roof and window damage can occur if flooding is associated with a storm event when considering where to temporarily relocate items
- ❑ **Utilities:** Turn off electricity at panel/ gas to equipment, water heater, stoves, oven, dryer
- ❑ **Personal preparation:** Collect medications, hygiene materials, clothing, valuable papers, important contacts
- ❑ **Important documents / computer equipment / files:** Collect insurance policies, deeds, leases, photo albums, and business records and place in a waterproof, fireproof and portable container (maintain duplicates off site)

AFTER THE STORM

SAFETY

- ❑ **Electricity:** Avoid floodwater unless electricity is turned off at circuit breaker; allow system and equipment to dry out, take caution to not cause electrical overload when restarting
- ❑ **Utilities:** Contact power and gas service providers for emergencies, service resumption, or meter inspection if in contact with floodwater
- ❑ **Unsafe buildings / conditions:** Report to local building official
- ❑ **Stabilize building:** Tarp damaged roof and stabilize structure
- ❑ **Secure:** Prevent building intruders

ASSESS AND RECORD DAMAGE

- ❑ **Document losses:** Inventory and photograph property, equipment, furnishings damage
- ❑ **Insurance company:** File claims and save invoices and receipts

CLEANING UP AND DRYING OUT

- ❑ **Remove water:** Use sump pump and wet vacuum
- ❑ **Building materials:** Remove and discard damaged carpets, baseboards, drywall, and insulation
- ❑ **Furnishings:** Discard if not cleanable
- ❑ **Ventilation:** Open windows, operate fans to dry out materials, remove baseboard and cornice to ventilate wall cavities and minimize mold
- ❑ **Clean / disinfect:** Use bleach and water solution, particularly kitchen surfaces, equipment, utensils
- ❑ **Permit:** Obtain building permit prior to repair, demolition, or construction
- ❑ **Health department:** Contact for business inspection

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PRESERVATION SOCIETY ESTD 1920 of CHARLESTON

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