

M A S S A C H U S E T T S

HOMEOWNER'S HANDBOOK

— TO PREPARE FOR —
COASTAL HAZARDS



4TH EDITION, SEPTEMBER 2026

Acknowledgments

This project partnership aims to increase the resiliency of coastal communities to natural hazards by encouraging actions that reduce the risk to family and property. Preparing for coastal hazards by planning, performing home maintenance, and undertaking preventative retrofits enhances individual resilience and helps create a strong community.

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Introduction

Your home is one of your greatest financial investments. It is a place that shelters you, your family, and most of your possessions from the elements. Yet natural hazards such as coastal storms, floods, and high winds can threaten the inhabitants and contents of your home. When a natural disaster occurs, the impacts can be devastating.

This handbook was created to help you prepare for coastal natural hazards so that risks to people, pets, and property may be reduced. While it is never possible to eliminate all exposure to natural hazards, you can take action and implement many small, cost-effective steps that may significantly lower your risk. Your family and home deserve the protection that you can only provide through preparation.

This handbook can help you:

- ✓ Understand the historic, current, and future risks of severe storms in Massachusetts and their impacts and consequences,
- ✓ Develop emergency plans to protect yourself, your family, and your home,
- ✓ Strengthen your home's physical structure, and
- ✓ Ensure that you have the proper insurance to recover from the impacts of severe storms.

This handbook is available as a free downloadable file through Woods Hole Oceanographic Institution Sea Grant Program at seagrants.whoi.edu.

Your home is one of your greatest financial investments. It is a place that shelters you, your family, and most of your possessions from the elements.





COMMON MYTHS

COMMON MYTHS ABOUT STORMS AND STORM PREPAREDNESS

Many people in Massachusetts have not fully prepared for natural hazards because of a number of misconceptions. To remove some of the major barriers to taking action, and to encourage people to properly prepare for storms, we discuss below some of the most commonly repeated myths.

MYTH

1

“I survived Hurricanes Bob and Sandy, so I am sufficiently prepared.”

When another massive natural disaster occurs, the resulting damage could be much greater than the damage seen with Hurricanes Bob and Sandy. Bob, which was only a Category 2 hurricane when it impacted Massachusetts, drove a surge of 10 to 15 feet into Buzzards Bay and caused over \$680 million in damage in Massachusetts. In reality, while we have been lucky in the past, weather patterns are changing, making strong, damaging storms more likely in Massachusetts.

MYTH

2

“If my house gets hit, we have much bigger problems.”

In the event of a major disaster that can devastate an entire community, recovery will be a long and stressful process. If this happens, you'll still need to ensure the safety of yourself and your family, as well as the financial stability that comes through proper insurance. Government assistance for natural disasters is typically limited to only a few thousand dollars or low-interest loans that need to be repaid.

**MYTH
3**

“I’m not that close to the water, so I will be okay.”

A hurricane or nor’easter can span hundreds of miles. For example, some North Carolina communities devastated by the impacts of the 2024 Hurricane Helene are about 300 miles inland.¹ To put that into perspective, an inland city like Worcester is 40 miles from Boston Harbor and all of Massachusetts is within 150 miles of the coast. Severe impacts can still be seen far from the coast.

**MYTH
4**

“We had a 100-year storm recently, so we won’t see another storm that big again for another 100 years.”

A “100-year storm” is not a storm that occurs only once every one hundred years. Rather, it has a one-in-one hundred (or 1%) chance of happening every year, which equates to a 26% likelihood over the course of a 30-year mortgage. Although statistically unlikely, multiple “100-year” storms can hit in consecutive years.

**MYTH
5**

“Protecting my home is expensive and not worth the effort.”

There are many ways to strengthen your house. For example, hurricane clips that help tie your roof to your walls are relatively inexpensive. Window coverings can range from a couple hundred dollars to a few thousand dollars. The roof structure for many houses can be strengthened with bracing. Foundation upgrades can be expensive, but considering your house is probably your most significant investment, it could be worth the immediate cost. Many of these upgrades can be included during regular maintenance or major repairs. Savings on insurance as a result of these upgrades can also offset the investment.

¹ www.climate.gov/news-features/event-tracker/hurricane-helenes-extreme-rainfall-and-catastrophic-inland-flooding



**PART
1**

Part 1: An Overview of Coastal Hazards

The Massachusetts coastline is a place of extraordinary beauty and heritage, offering a unique connection to the sea through its diverse environments, recreation, and economic opportunities. While living near the shore brings a profound sense of well-being and a restorative connection to the sea, it also requires a deep respect for the power of nature and the hazards it presents. To protect yourself, your livelihood, and property, it is essential to understand the impacts of coastal storms, wind, flooding, and erosion. This guide is designed to help you navigate these risks so you can safely enjoy everything the shoreline has to offer.

1.1 COASTAL STORMS

Massachusetts residents are likely familiar with nor'easters and hurricanes. These low-pressure systems are drivers of rapid change along the coast, often impacting homes and infrastructure, and potentially posing a threat to life. This section will describe the formation and impacts of these storms, including high winds, torrential rain and precipitation, storm surge, and flooding.

Impacts from coastal storms will be forecast prior to a storm event, with guidance and weather models becoming more accurate as the storm approaches. It is critically important to stay up to date on both the timing and severity of impacts. Advisories, watches, and warnings (i.e. flood watch, gale warning) will often be issued for both major and minor storm events.

The following sections will provide a basic overview of coastal storms. Impacts from these coastal storms are discussed in Part 1.2.

1.1.1 Nor'easters and Winter Storms

Nor'easters are frequent in Massachusetts in late fall, winter, and early spring, and are named for their strong winds that blow from the northeast. Nor'easters form outside of the tropics (and are therefore extratropical), typically off the United States' East Coast, between Georgia and New Jersey. These storms can cover a massive geographic area, sometimes engulfing the entire East Coast. Depending on the temperature during a nor'easter, they can bring significant rain or snow that can cause property damage, cause utility outages, and delay first responders during an emergency.



Historic Nor'easters

AND EXTRATROPICAL STORMS



February 1978

THE BLIZZARD OF '78

- 27" of snow in Boston. The storm stalled to the south of Cape Cod
- Hurricane force winds; 5-foot storm surge
- Waves caused serious erosion resulting in seawall breaks, washed-out roads, destroyed parking lots and damage to thousands of homes along the coast
- Caused 73 deaths, 4,324 injuries
- \$500 million in damage
- Set a 40-year record for water levels in Boston 15+ feet above MLLW

1975

1985

1995



October 31, 1991

THE NO-NAME STORM OR THE PERFECT STORM

- 80-foot waves that destroyed over 100 homes and led to extensive coastal flooding throughout the area
- The storm became the subject of a best-selling book and popular film which told how the storm wrecked the shipping vessel Andrea Gail, and caused the death of the six crew members on board

April 1, 1997

APRIL FOOL'S DAY STORM

- 24" of heavy, wet snow fell on Boston
- Public transportation was crippled, about 1,000 motorists spent the night stranded in their cars and 4,000 stayed in shelters

April 15-17, 2007

THE PATRIOT'S DAY STORM

- Tropical storm force winds lashed coastal areas with peak gusts ranging from 50-60 mph from Boston to the north shore, down to Cape Cod and Islands
- The combination of the long easterly fetch, the very low pressure at the storm center, and the high wind, caused significant coastal flooding and wave battery through several successive high tides
- Breached barrier beaches at both Pleasant Bay on outer Cape Cod and Katama Bay on Martha's Vineyard, creating new inlets for the bays

January 4, 2018

THE "BOMB CYCLONE"

- Wind gusts at hurricane-force of 76 mph on Nantucket
- Over 17" of snowfall in Boston
- A new historical record set in Boston with a freezing storm tide of 15.16 ft, flooding areas of the financial district including a subway station.

February 22-24, 2026

HERNANDO

- Hurricane-force wind gusts over 80 mph
- Over two feet of snow for many parts of coastal Massachusetts
- Power outages lasting over a week for some towns

2005

2015

2025

March 2-5, 2018

MARCH 2018 NOR'EASTER

- Wind gusts of 80-90 mph with a gust to 97 mph measured at Wellfleet
- Nearly half-million power outages primarily in southeastern and northeastern Massachusetts
- The structural damage from this major storm created vulnerabilities that led to even greater impacts at some locations when another nor'easter struck just days later on March 7 – 8



Shannon Hulst

In recent years, Massachusetts has seen more significant winter storms with wind out of the south, causing substantial flooding on south-facing coastlines. These storms did not follow the typical winter nor'easter pattern, taking communities and the National Weather Service by surprise.

The Blizzard of '78 and winters of 2015 and 2026 brought immense storms with significant snowfall that made emergency preparedness a critical part of everyone's life. In February of 2026, a blizzard struck Massachusetts that brought heavy snowfall in excess of 24 inches for many locations and wind gusts in excess of 80 miles per hour. This storm caused immense damage to buildings and power infrastructure, brought down trees, and resulted in travel bans and many emergency shelters and warming centers opening for days following the storm.

1.1.2 Hurricanes, Tropical Storms, and Tropical Depressions

Hurricanes (tropical cyclones), tropical storms, and tropical depressions form in the warm waters of the tropics and are fueled by heat energy as they track across the Atlantic. These storms are classified based on wind speed. They generally occur when the ocean is at its warmest, typically June through November, with peak season in September. During this time of year, the warm air holds more moisture. As warm, moist air rises, it cools and condenses, releasing energy and intensifying the storm. This often leads to torrential downpours that cause inland flooding and exacerbate coastal flooding.

Tropical systems such as Hurricane Bob in August 1991, Irene in August 2011, and Sandy in October 2012, have impacted New England many times in the past with significant consequences. The threat to Massachusetts from future tropical systems depends on multiple factors such as the storm's intensity, trajectory, and size. While hurricanes may not be frequent, one could hit Massachusetts in any given year. For more detailed information, review the Hurricanes vs. Nor'easters Marine Extension Bulletin.¹



Figure 1-1. NASA satellite image of Hurricane Sandy in October 2012. The bands of strong winds, rain, and storm surge spread from Florida to New England. Image courtesy of NASA.

¹ seagrant.whoi.edu/hurricanes-vs-noreaster-marine-extension-bulletin/



HURRICANES POSE MULTIPLE THREATS

- high winds
- flooding associated with heavy rains
- storm surge
- potential to produce tornadoes

1.2 NATURAL AND COASTAL STORM HAZARDS

Natural hazards covered in this section include wind, flooding, and erosion. These processes interact with natural and built infrastructure and pose risks to homes, utilities, transportation, trees, and other aspects of our communities that can alter daily life. These hazards can occur at any time, but are often exacerbated by major storm events. It is important to consider the timing of the extreme weather event and therefore how it may intensify the hazard. For example, the storm that occurred January 4, 2018 became the storm of record for much of Massachusetts, seeing a higher water level than that of the Blizzard of '78. While the 2018 storm was a less intense storm overall, a combination of timing and sea level allowed this storm to produce a higher total water level.

1.2.1 Wind Speeds

Wind is the primary characteristic of most coastal storms. The wind field around a storm gains intensity as barometric pressure (the weight of the atmosphere) in the eye of the storm drops. Typically winds are less intense further away from the center of the storm. Intense winds can down trees and power lines, blow debris, and damage property.

In the Northern Hemisphere, winds in major storms spin counter-clockwise due to Earth's shape and rotation, known as the coriolis force. While not classified on a scale like tropical systems, nor'easters typically have 30-40 mile per hour sustained wind with gusts that can exceed hurricane force (74+ miles per hour). They may last for multiple days, either due to a slow moving or a large storm system.

Tropical systems start as tropical depressions and, as they gain strength, may progress to tropical storms, and eventually hurricanes. Hurricanes are classified by their wind speeds based on the Saffir-Simpson scale (Figure 2-2 on p. 27); these classifications are referred to as Category 1-5 storms. In the most severe hurricane, a Category 5 storm, the sustained winds can exceed 157 miles per hour. Sustained winds at this strength will cause extreme damage to areas, rendering them potentially uninhabitable

Historic Hurricanes

AND TROPICAL STORMS



© Woods Hole Oceanographic Institution

Sept. 21, 1938

THE NEW ENGLAND HURRICANE OF 1938 AKA "LONG ISLAND EXPRESS"

- Category 3
- Landfall: Long Island and Connecticut
- Sustained winds in Massachusetts: 121 mph with gusts to 186 mph
- Storm surges: up to 12 feet
- Extensive damage and widespread power outages
- 8,900 buildings were destroyed and 15,000 damaged in New England
- Catastrophic damage to southern New England fishing fleet: over 6,000 vessels destroyed or severely damaged
- In southern New England, 564 people killed and 1,700 injured
- Total damages \$306 million

1935

1945

1955

1965

1975

DONNA



© Woods Hole Oceanographic Institution

Sept. 15, 1944

GREAT ATLANTIC HURRICANE

- Category 2
- Landfall: Rhode Island
- Winds: 100 mph
- More than \$5 million in damage on Cape Cod can be attributed to lost boats, as well as fallen trees and utility damage
- In New England, up to 11 inches of rain fell
- A total of 28 people killed
- Total damages \$100 million

Aug. 31, 1954

CAROL

- Category 3
- Landfall: eastern Long Island and eastern Connecticut
- Winds: 100 mph, gusting up to 135 mph
- In the region, destroyed 4,000 homes, 3,500 cars, and over 3,000 boats
- In New England, killed 65
- Total damages \$460 million

© Woods Hole Oceanographic Institution



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Sept. 11, 1954

EDNA

- Category 2
- Landfall: Massachusetts
- Winds: 96 - 110 mph; gusts of 120 mph
- Storm surges: 6 ft
- Heavy rainfall added 5 to 7 inches already saturated land causing extensive erosion
- Edna caused \$40 million damage across the region

1985

1995

2005

2015

2025

Aug. 19, 1991

BOB

- Category 2
- Landfall: Rhode Island
- Max sustained winds of 100 mph
- 10- to 15-foot storm surge in Buzzard's Bay
- A number of south-facing beaches on Nantucket and Martha's Vineyard lost 50 feet of beach to erosion
- Up to 7 inches of rain was reported to have fallen throughout New England
- Bob is blamed for 18 storm-related deaths
- \$39 m in damages in Massachusetts

Oct. 29, 2012

SANDY

- Category 2
- Landfall: New Jersey
- State of Emergency declared in Massachusetts
- Over \$67 Billion in damage

Sept. 10th, 2017

IRMA

- Landfall: Louisiana with significant Massachusetts impacts

Aug. 29th, 2021

IDA

- Category 4
- Landfall: Louisiana
- Winds: 150 mph
- EF0 Tornado in Dennis
- 9.5 inches of rain in New Bedford

Doc Taylor, National Weather Service



for weeks or months after a storm. These winds are even powerful enough to spin up localized tornadoes, with Massachusetts seeing 19 confirmed tornadoes since 2020, and 200 since 1950. While the most powerful hurricanes are extremely devastating, it is still important to pay attention to tropical storms and tropical depressions, as these can be highly impactful storms.

1.2.2 Flooding

Flooding is one of the most dangerous of all coastal storm hazards, and also one of the costliest.^{2,3} People often underestimate flooding depth, strength of the current, and the speed at which water moves. Flooding can result from a variety of sources, including storm surge, precipitation, and wicked high tides (commonly known as sunny day flooding). If an area experiences rainfall, it can flood, especially near open or flowing bodies of water or in areas with poor drainage.

Precipitation during a storm event results in flooding when sustained rains or microbursts rapidly bring more water to an area than can be absorbed by the ground. High tide or storm surge can prevent water from flowing into the ocean. In winter months with high snowpack, heavy rains can melt the snow and lead to more flooding.

Storm surge (Figure 1-2) is the rise in sea level above the normal or predicted tide level during a storm. In major storms, the highest storm surge usually occurs to the east of the storm due to the counterclockwise rotation of the storm winds. Storm surge can also be caused by low barometric pressure. Low pressure reduces the weight of the atmosphere on the ocean, creating an upward mound. Peak storm surge occurring at or around high tide will increase the likelihood of more severe flooding and erosion.

Storm surge typically accounts for a significant portion of storm-related deaths.⁴ Flooding of dry land from storm surge can happen quickly, stranding—potentially fatally—those who haven't evacuated to higher ground. The highest storm surges can occur in the upper parts of bays and inlets where the water becomes constricted and there is minimal drainage. For example, a surge of over 25 feet is possible at the upper part of Buzzards Bay along the Wareham and Bourne shoreline. Additional information about storm surges is available at www.nhc.noaa.gov/surge.

2 www.nssl.noaa.gov/education/svrwx101/floods/

3 www.ncei.noaa.gov/access/billions/

4 www.noaa.gov/stories/storm-surge-deadliest-threat-from-tropical-cyclones

Sea level is a critical factor in flooding. The relative sea level (i.e., its elevation in relation to the coast) changes due to melting glaciers, expansion of water from heat, and vertical changes in the land among other factors. These changes have caused sea level to increase by about 8 inches since 1970 for much of Massachusetts, establishing a new, higher sea level baseline.⁵ Higher sea levels cause floodwater to move further inland.

Models to predict future sea levels are based on a range of scenarios. Regardless of which of these scenarios is used, the relative sea level is expected to continue to rise for Massachusetts. Under the most likely intermediate scenario, by 2050, sea level is expected to rise by about 11 inches over 2020 sea levels.⁵

Storm impacts can be highly dependent on the timing of tides. Massachusetts typically experiences two highs and two lows per day. Approximately every month, during a full moon and new moon, Earth

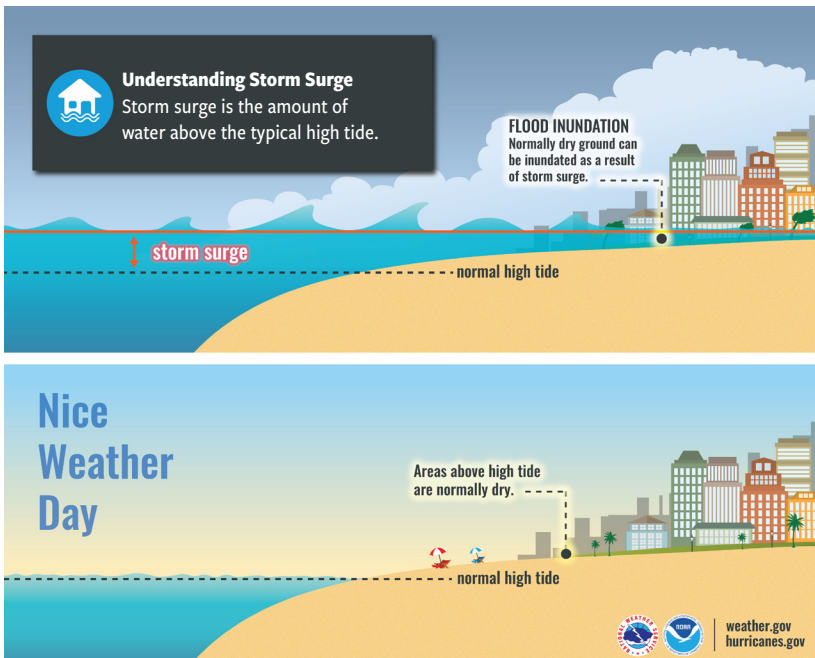


Figure 1-2. Storm surge depiction. Image Credit: NOAA/The Comet Program.

⁵ www.earth.gov/sealevel/us/national-sea-level-explorer/?psmsl_id=235&scope=section_1



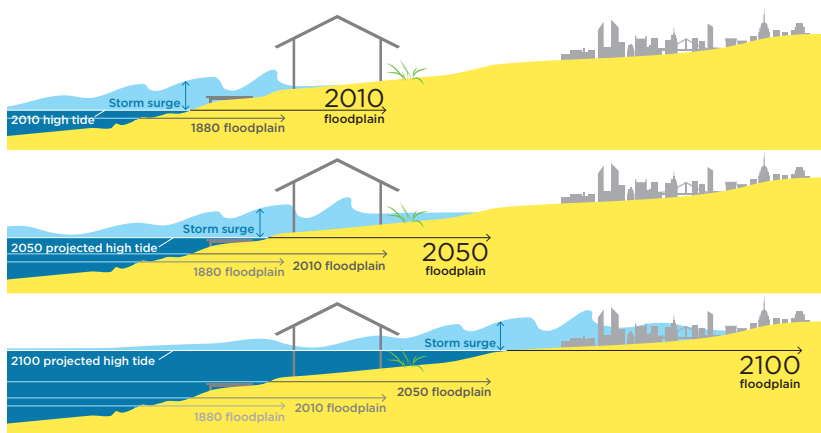


Figure 1-3. Storm surge with sea level rise. Image Credit: NOAA/The Comet Program.

experiences astronomically high and low tides. When a storm's peak impacts occur around low tide, the surge may remain within typical tide ranges, minimizing flooding and damage. A storm that strikes closer to high tide may see water levels that exceed the typical tide range, sometimes by multiple feet. This brings with it the most extensive flooding and coastal impacts.

Sources of Flood Information

An important source of information on your property's flood risk is the Federal Emergency Management Agency's (FEMA) Flood Insurance Rate Maps (FIRMs). The FIRMS include Flood Zones designating the severity of the flood risk or the type of flooding experienced in each zone. Flood maps can be viewed or downloaded from FEMA's Map Service Center (msc.fema.gov) and may also be available for viewing at your town or city hall building or conservation departments. While very helpful, these maps are intended to be used for regulatory and insurance purposes, not to demonstrate all possible flood risk. Even if you are not in a designated high-risk flood zone, you may still be at risk from flooding. According to FEMA, nearly 40% of flood insurance claims come from low-to-moderate risk areas. Furthermore, changes in precipitation, coastal erosion, and sea level can increase the risk of a FEMA-designated flood zone after a map is released, as the maps are typically updated no more frequently than every 10 years.

Another source of flood-risk maps is the Massachusetts Coastal Flood Risk Model, or MC-FRM, funded by the Commonwealth of Massachusetts.

The model examined both hurricanes and nor'easters in Massachusetts in combination with sea level rise. Flood risk for 2030, 2050, and 2070 were modeled to help predict areas of future flooding.

The U.S. Army Corps of Engineers (USACE) have also supported flood-risk mapping in Massachusetts. In response to Hurricane Sandy, USACE drafted hurricane inundation maps for coastal communities in Massachusetts.⁶ These maps are specific to the risk of flooding from hurricanes and correlated with hurricane evacuation planning maps discussed in more detail in Part 3.3.

1.2.3 Erosion

The shoreline is a storm buffer, protecting the land behind it. Major storms can cause extensive, episodic erosion. The amount of erosion experienced depends on a complex range of factors, among them wave height, wind direction, water level, and landforms. The type of sediment on the coast will also play a role, with fine sand being easier to erode than rocky shoreline. Larger waves and elevated water levels bring wave energy higher up on shore, where it may begin to erode our coastal environments, such as banks, dunes, and wetlands. Erosion is an important natural process in maintaining our shoreline; it supplies sediment that maintains our beaches and ecosystems. Human activities, like walking on dunes and coastal development, can interrupt this process and degrade the ability of the coast to respond to natural hazards.

Similarly, erosion causes problems when it intersects with our built infrastructure and homes. Residents that live in erosion-prone areas, such as on an exposed coastal bank or barrier beach, should monitor the erosion around their home. If the house is severely threatened, you should contact your local building department to ensure that the house is safe and habitable. If the house becomes undermined or the foundation is exposed, you may need to evacuate. With severe enough erosion, you may not be able to rebuild your home.

⁶ www.mass.gov/info-details/hurricane-evacuation-zones



Natural coastal features serve as protective barriers from storms. By preserving them, communities retain resilience.

PART
2

Part 2: Protecting Yourself and Your Family

This part of the handbook covers the topic of protecting yourself and your family from coastal hazards like those discussed in Part 1. During such events, it is important that your household has a stock of emergency supplies, an evacuation kit, and evacuation plans. Remember to plan for pets. Your response will differ depending on the nature of the threat. You should discuss and practice the evacuation plan with your family once a year (e.g., when you change your smoke detector batteries) or whenever there is a major lifestyle change (e.g., when a member of the family goes to a new school or is working in a different location).

Things to remember during an emergency:

- Stay alert, stay calm, and be informed.
- Listen to your local radio and television stations carefully. There may be new or changing directions based on updated forecasts and ground conditions. (Part 2.1)
- Gather emergency supplies early. You should be prepared with food, water, and other essentials that can sustain you and your family for multiple days if necessary. You should not drive to get additional supplies during a storm. If you are able to relocate to a safer area well in advance of a storm, consider doing so. (Part 2.2)
- Ensure that your home and property are prepared. Secure anything that may be blown around by winds, prepare for potential power loss, and cover windows if necessary. (Part 2.3)
- Create a plan for evacuating and/or sheltering in place. Include all family members, communicate the plan, and follow it if it becomes necessary. (Part 2.4)
- You might want to consider leaving well in advance of the storm to avoid road congestion, particularly on Cape Cod and other peninsulas where bridges are a constriction point for motorists.
- State and local emergency management agencies may issue a mandatory evacuation. If you are told to evacuate, please do so to protect yourself and first responders who are putting their lives on the line. Be aware that if areas other than your location have mandatory evacuation orders, you should shelter in place to avoid adding to road congestion to allow those people to leave. (Part 2.5)

Figure 2-1

TROPICAL STORM WATCH

A Tropical Storm Watch is issued when **tropical storm conditions are possible**, typically within 48 hours.

Prepare your home by securing loose items outside or moving them indoors. Have an emergency supply kit ready and charge your devices.

Tropical Storm Winds Possible

TROPICAL STORM WARNING

A Tropical Storm Warning is issued when **tropical storm conditions are expected**, typically within 36 hours.

Follow the advice of local officials and be ready to seek shelter in a sturdy structure.

Tropical Storm Winds Expected

HURRICANE WATCH

A Hurricane Watch is issued when **hurricane conditions are possible**, typically within 48 hours.

Prepare your home by boarding up windows and moving loose items indoors. Have an emergency supply kit ready.

Hurricane Winds Possible

HURRICANE WARNING

A Hurricane Warning is issued when **hurricane conditions are expected**, typically within 36 hours.

Be ready to seek shelter in a sturdy structure or evacuate if ordered.

Hurricane Winds Expected

- You should avoid flood waters at all costs. If you find yourself in a situation where you have no choice but to enter floodwaters, use extreme caution. (Part 2.6)
- Reach out to your town to find out what your town is doing on a broader scale and how you can get involved.

2.1 EMERGENCY NOTIFICATION AND INFORMATION SYSTEMS

When preparing for and responding to an emergency, it is important to understand the terms being used, i.e., the difference between a “watch” and a “warning.” See Figures 2-1 and 2-2 for help understanding the levels of “watches and” warnings associated with coastal hazards. If a situation or event becomes a potential threat to Massachusetts residents and visitors, the public will be alerted by one (or several) of the methods below, as appropriate.

Community Notification Systems: Many communities (and some counties) in Massachusetts operate local emergency notification (“reverse 911” type) systems that may require registration in order to get local notifications. These notifications may be sent to cell phones, email addresses, or landline phones. These systems provide the most localized emergency information and are operated by local officials. The public is encouraged to contact local public safety agencies such as police, fire, or emergency management departments for information about notification systems. A list of local Emergency Management Directors can be downloaded from the Mass.gov website.¹

Emergency Alert System/Wireless Emergency Alerts: These systems, activated by federal or state government agencies, can disseminate urgent messages via TV, radio stations, and cell phones with important emergency information.

Social Media: Local community governments and the Massachusetts Emergency Management Agency (MEMA) use social media accounts to provide information during emergencies. Users may need an account to view information on these platforms.

¹ www.mass.gov/doc/community-emergency-management-directors-emd-list/download

Saffir-Simpson Hurricane Wind Scale

While not part of the Saffir-Simpson Scale, tropical depressions (TD) have sustained winds up to 38mph and tropical storms (TS) have sustained winds from 39-73mph.

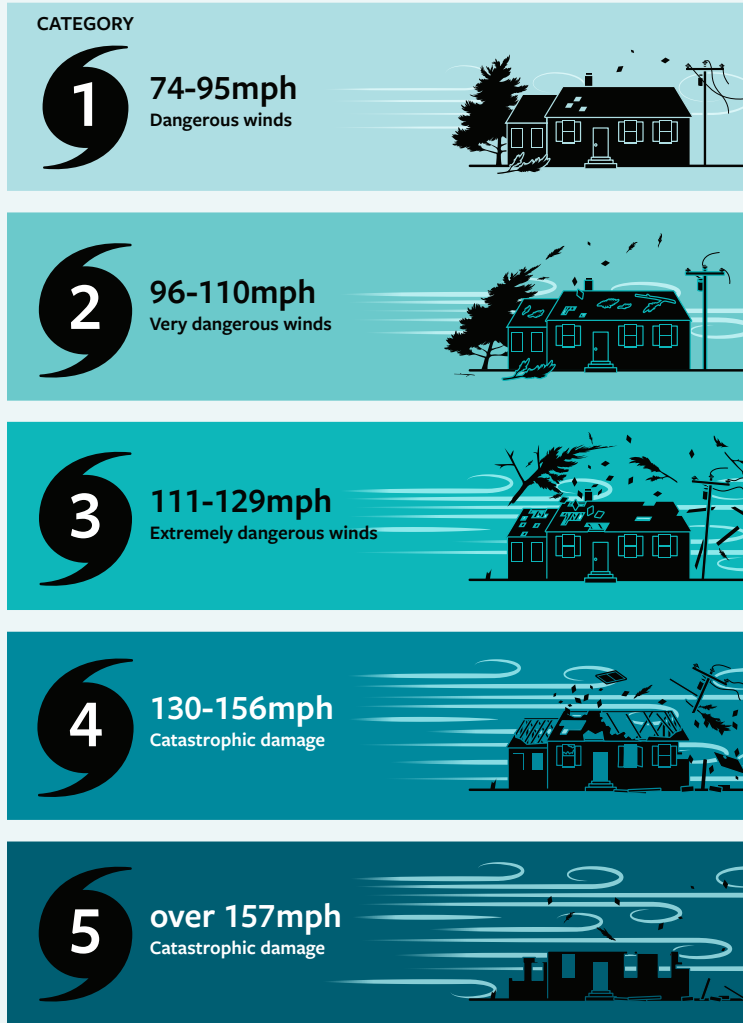


Figure 2-2. Illustration by Charin Park, WHOI Creative, Adapted from Encyclopedia Britannica.

Below are other sources of information that can be available during an emergency.

- **Media:** Local news media may provide up-to-date, real-time emergency information.
- **Towns/Counties:** Local (town/county) public information officers put out information through social media. Police and fire department personnel may use loudspeakers and make door-to-door contacts. The Barnstable County Regional Emergency Planning Committee website has up-to-date notifications for shelters and situational awareness through the storm (www.bcrepc.org).
- **NOAA:** NOAA Weather Radios provide an excellent source of up-to-date, real-time emergency information, particularly severe weather alerts (www.weather.gov/nwr).
- **Mass 211:** 211 is the primary call center during times of emergency. Callers can get updated disaster and shelter information, numerous post-disaster programs, and interpreter services 24 hours per day. Information is also available at www.mass211.org.
- **MEMA website:** The front page of the MEMA website www.mass.gov/mema is updated to provide information during major emergencies and disasters.
- **TTY:** A message on Teletypewriters (TTYs) can be sent if you have registered with a community Emergency Management Office to be notified over TTY in case of an emergency.

2.2 EMERGENCY SUPPLIES

During a hazard event, basic necessities may be unavailable so it is wise to have supplies for three or more days depending on the type and extent of the disaster. Strong storms can also knock out power for multiple days.

Emergency kits should be gathered as soon as possible and checked regularly to ensure that food and medicine have not expired. Table 2-1 provides a general supply list: you should



consider limitations such as the weight of a bag or your car's storage capacity. A great resource for preparedness kits, tools, and information is the federal government's Ready site (ready.gov).

2.3 SECURING YOUR HOME AND PROPERTY BEFORE A COASTAL STORM

The following precautions should be taken well before a severe coastal storm arrives:

- Deploy window protections well in advance of the arrival of any winds. For those who have already prepared plywood shutters, partial deployment could begin before there is any official coastal storm warning. Closely monitor advisories and warnings to guide your deployment.
- Fully charge cell phones, laptops, radios, backup batteries, or any other electrical device that may be needed for communication.
- Turn refrigerators and freezers to their coldest setting.
- If you are going to evacuate for a warm-weather storm, shut off electricity at the main breaker, and gas and water at their main valves.
- Package your important documents and valuables, such as jewelry, titles, deeds, insurance papers, licenses, passports, etc., for safe-keeping in waterproof/fireproof containers. Take these with you if you are going to evacuate and consider their security at a shelter.
- Check door and window locks to ensure they will not blow open. Lock and brace sliding glass doors to prevent them from being lifted from their tracks or being ripped loose by wind vibrations.
- Check and secure outdoor items and furniture that may blow away or be torn loose. Remove or roll up and secure canvas awnings.
- Store chemicals, fertilizers, or other toxic materials in a safe area above flood waters (but not overhead) on a secure area of the premises.
- Secure propane tanks (both portable tanks for grills and larger tanks typically stored outside). They should not be stored near sources of heat (like your water heater or other appliances) or below expected flood levels.
- Fill the gas tank of your car and fuel cans for generators.
- See Part 3—Protecting Your Home for improvements to strengthen your home.

TABLE 2-1. EMERGENCY SUPPLY LIST

Items	At-home	Evacuation	Shelter
NOAA weather radio w/ AM FM; spare batteries	✓	✓	✓
Flashlight w/ spare batteries and bulbs	✓	✓	✓
Medications clearly marked with your name, dosage, type of medication, and prescribing physician	✓	✓	✓
Water	✓	✓	✗
First-aid kit in waterproof box	✓	✓	✓
Pet supplies include items such as bowls, food, medications, bedding, waste disposal bags, pet carrier/cage, and extra leash/harness. Pets should have I.D. tags, as well as records of current, up-to-date license and vaccinations.	✓	✓	Be aware that some shelters will only allow service animals. Pet-friendly shelters will be noted when shelter locations are announced during an evacuation.
Three-day supply of non-perishable food and any special dietary food, e.g. diabetic, low salt, liquid diet	✓	✓	No need to bring food, but DO bring special dietary food, e.g. diabetic, low salt, liquid diet
Baby supplies (diapers, food, bottles, clothes, blankets, medication)	✓	✓	✓
Clothing and bedding - One complete change of clothing including footwear. Rain gear and sturdy shoes. Sleeping bag, air mattresses, blankets, and pillows	✓	✓	Portable baby bed, cots for elderly (cots might not be provided)
Personal care items: washcloth, small towel, soap, toothbrush, toothpaste, sanitary napkins, tampons, paper towels, toilet paper, towelettes, hand disinfectant, etc.	✓	✓	✓

Items	At-home	Evacuation	Shelter
Manual can opener	✓	✓	✗
Cell phone with a car charger	✓	✓	✓
Copies of important documents: name & address of doctors, lists of medications. Name & address of nearest relative not living in area, driver's license, social security card, proof of residence, insurance policies, wills, deeds, birth & marriage certificates, tax records, medical records, family pictures, etc.	✓	✓	✓
Grill (hibachi with charcoal, camp stove w/ fuel, BBQ w/ propane)	✓	✗	✗
Matches/lighter	✓	✗	✗
Disposable plates and utensils	✓	✗	✗
Tarp or sheeting, string/rope, duct tape	✓	✗	✗
Sunscreen and bug repellent	✓	✗	✗
Bleach	✓	✗	✗
Alternate power supplies (generators, inverters, power stations, and battery chargers). See Part 4 of this book for descriptions of alternative power sources.	✓	✗	✗
Games, toys, books, and other diversions	✓	✓	✓
Cash	✓	✓	✓

The following additional precautions should be taken in advance of a nor'easter or winter storm:

- If outside temperatures are going to be low, turn up your heat in case you lose power.
- If using any open flames for heating, ensure carbon monoxide detectors are functioning.
- If using a space heater, keep it a safe distance from flammable objects.
- If power goes out, turn off appliances that could pose a fire risk such as stovetops.
- Clean chimney for wood burning stoves and fireplaces.
- Be prepared to remove snow and ice from entryways, driveways, etc. to ensure your home is accessible in case of emergency. Have a supply of salt or sand.
- Clear any icicles above walkways.
- Take steps to avoid your pipes freezing if you're evacuating.
- Make sure outside spigots are turned off.
- Clear snow away from plumbing and dryer vents.
- Check your roof for ice dams.
- Only use gas generators outside. Keep them free of snow and ice.

See the Commonwealth of Massachusetts website for additional extreme cold weather tips.²

2.4 EVACUATION PLANNING

If you live in one of Massachusetts' coastal communities you should "Know Your Zone".³ Massachusetts officials may use this MEMA initiative to determine when coastal areas need to be evacuated during a major storm or hurricane. These areas correlate to flood risk, and are based on hurricane modeling. Residents should know which zone they live in, if any, so that they can evacuate if an order is given. They should be familiar with the best evacuation route and have a backup route in mind. Residents can also use the maps to decide if they want to pre-emptively evacuate, before an order is issued by authorities.

The National Hurricane Center's storm surge maps are another resource

² www.mass.gov/info-details/extreme-cold-safety-tips

³ www.mass.gov/info-details/hurricane-evacuation-zones



The Cape Cod Canal effectively makes Cape Cod an island. The bridges over the canal provide the only escape by land from Cape Cod during an emergency. Image courtesy of Richard LaTour, MEMA.

for evacuation planning during hurricanes. These maps show possible worst-case flooding from an imminent storm and are updated every six hours. When available, they can be accessed through the National Hurricane Center's webpage (nhc.noaa.gov), specific to each active storm. Remember, if there is an evacuation order, it is because of a serious threat to life and you should relocate to a safer place.

Traffic flow should factor into your evacuation planning. Check with your community to find out if there is a formal traffic control plan. For example, the Commonwealth has a plan to facilitate the flow of a high volume of traffic in the event of a hurricane or other potential high hazards on Cape Cod, particularly during peak tourist season. The Cape Cod Emergency Traffic Plan (CCETP) is a traffic management plan that can be used under any circumstance when public safety officials deem it necessary to facilitate the flow of traffic off of the Cape.⁴ Designed around Cape Cod and the potential issues that could exist with large traffic volumes prior to storms, this plan establishes various traffic control points to help mainstream traffic off Cape Cod and provides for shelters to take in motorists who are unable to leave the Cape due to the closure of the Bourne and Sagamore Bridges. During an activation of this plan, message boards will be

4 www.mass.gov/info-details/cape-cod-emergency-traffic-plan

on main roads with updates on the plan and advisories for motorists.

When you put your evacuation plan together, here are some things to consider:

- Your evacuation plan should consider yourself, the members of your family, those with special health needs for whom you take responsibility (like babies, the disabled, or elderly), and your pets. Practice evacuation procedures with your family through yearly drills.
- As part of your evacuation plan, determine how family members will communicate if they become separated. Each family member should have a list of cell phone numbers and email addresses of everyone in the family and other appropriate contacts, such as family friends. This list should be readily accessible and not require power to access (e.g., not stored on a cell phone or computer).
- If needed, develop a plan to help those who cannot help themselves, such as disabled neighbors or those with limited mobility. If people with special health needs are with a care provider, confirm that the care provider has an evacuation plan. Otherwise, you, your relatives, your friends, or a specified designee can take responsibility for that person.
- Parents should be familiar with the evacuation plans that are in place for their child's school, specifically, where the students will be held and for how long during each type of natural hazard. Special consideration should also be made for the needs of babies and toddlers, and toys and games should be included for children of all ages.
- Develop a plan for your pets. If you plan to go to a public shelter it is important to understand that pets may not be allowed inside. Plan in advance for shelter alternatives that will work for both you and your pets. Consider staying with loved ones or friends outside of your immediate area who would be willing to host you and your pets in an emergency. If your area shelters accept pets, be sure to bring proof of current rabies vaccination, food, bowls, bedding, waste disposal bags, leashes, and any medication. Pets entering shelters should be crated.

2.5 EVACUATION PROCEDURES FOR A HURRICANE OR COASTAL STORM

Your emergency supplies and evacuation kit should already be in place before there is a storm. You should stay in a place away from flood inundation zones and able to withstand strong winds and rain.

STORM SHELTERING?

PLAN FOR YOUR PETS



Not all hurricane shelters accept pets.



Plan in advance to take the best care of your pets.

Information is available at

mass.gov/info-details/emergency-preparedness-for-pets-and-animals.

To learn more about shelters and pets,

visit the State of Massachusetts Animal Response Team's Disaster Animal Response Team webpage at smartma.org/disaster-animal-response-teams-dart.

weather.gov



If you are concerned about a forecast storm and the safety of staying in your home, you can use the Know Your Zone maps and storm surge inundation maps (Part 3.3) to help you decide whether to leave your home in advance of any given storm. Your level of risk may vary depending on your physical abilities and elevation of your structures (e.g., rainfall can fill a basement located outside of a storm surge area).

If you have been told to evacuate by local authorities, you should do so. Be aware that if areas other than your location have mandatory evacuation orders, you should shelter in place to avoid adding to road congestion to allow those people to leave.

If you plan to seek a hotel or motel as your shelter in Massachusetts or a neighboring state, make sure the location is open and space is available. Rooms tend to fill up quickly when a hurricane is posing a threat to a region. If you evacuate, you should already have prepared your house and made

Each year, more deaths occur due to flooding than from any other storm-related hazard.



plans for your pets.

If power is lost during a winter storm and the temperature in your home drops uncomfortably low, municipalities will establish local warming centers in places such as schools and libraries, for residents' daytime use. It is important to note that warming centers are not full emergency shelters and are not open overnight. The supplies you bring should reflect these differences. Check with your municipality for warming center locations.

Local shelters are available for your family to evacuate to. On Cape Cod, the Regional Emergency Planning Committee keeps a list of local shelters.⁵ To find shelters in other locations, visit the Red Cross⁶ or search for open shelters by texting SHELTER and your ZIP code to 43362. Keep in mind that shelters are very basic and are likely a “Plan B” if other options are not available to you, like staying with family, friends, or in a hotel. Be sure to check if pets are allowed prior to a storm and be aware that shelters have limited space. You should plan to provide your own bedding and other essentials such as personal hygiene items and medications. (See Table 2.2 for a checklist.)

⁵ www.capecod.gov/departments/regional-emergency-planning-committee/sheltering/regional-shelter-map/

⁶ www.redcross.org/local/massachusetts/get-help.html

2.6 STAYING SAFE DURING EVACUATION

During evacuation stay calm and be aware of your surroundings. For any emergency you may encounter, you should call 911. Below are more common situations you might see during a storm and measures you should take to stay safe.

2.6.1 Flooding

Floods can be caused by storm surge, rainfall, or astronomically high tides. Heavy rainfall can cause hazardous flash flooding. Every year, more deaths occur due to flooding than from any other storm-related hazard.⁷ The main reason is that people underestimate the force and power of water. Six inches of water can knock you over or cause your car to stall, and one foot of moving water can lift a car. Many deaths occur in automobiles as they are swept downstream. Whether you are driving or walking, if you come to a flooded road, “turn around, don’t drown.” If you are attempting to evacuate and become stuck or endangered, call 911 immediately.



Credit: Boston Harbor Now/Stone Living Lab

7 www.noaa.gov/jetstream/thunderstorms/flood

Other important safety precautions include:

- If you are in an area likely to flood, get to higher ground immediately.
- If you are caught in your house, go to the top floor or attic with your evacuation kit and hand tools to break through to the roof or get out a window in case you are trapped.
- Never attempt to cross swiftly-flowing water or waters of unknown depth by foot or in a car. Road beds may be washed out under floodwaters. Be especially cautious at night when it is harder to recognize flood dangers.
- Do not play in floodwaters and avoid walking through them unless absolutely necessary.

Protect yourself from illness by avoiding exposure to floodwaters. Floodwaters are full of contaminants including raw sewage, viruses, bacteria, diseases, debris from damaged houses and other property, road waste, and even carcasses. Any open wounds, including an insect bite or a shaving cut, can be enough for bacteria and viruses to enter the body. If you are exposed to floodwaters, thoroughly wash exposed skin and clothing.

2.6.2 Downed Power Lines

Downed power lines can carry an electric current strong enough to cause serious injury or death.⁸ If you see a downed power line or wire of any kind, move away from the line and anything touching it. You may not be able to tell if it is a live wire, so stay clear of all downed wires of any kind.

- If you see someone who is in direct or indirect contact with the downed line, do not touch the person. Call 911 instead.
- Avoid contact with water or objects that could come in contact with downed wires such as metal fences, sheds, vehicles, and tree limbs and branches.
- Do not attempt to use another object such as a broom or stick to move a downed power line or anything in contact with the line. Even nonconductive materials like wood or cloth, if slightly wet, can conduct electricity and then electrocute you.

⁸ www.eversource.com/residential/safety/electric-safety/downed-power-lines



Image courtesy of WHOI Sea Grant/CCCE

- The proper way to move away from a downed power line is to maintain contact with the ground, shuffling away with small steps with both feet on the ground. This will minimize the potential for a strong electric shock.
- Do not drive over downed lines or branches that may be concealing them in the road. When branches fall they can break power lines and make it hard to see the power lines in the road.
- If you are in your car and it is in contact with a downed line, stay in your car. Tell others to stay away from your vehicle. If you must leave your car because it's on fire, jump out of the vehicle with both feet together and avoid contact with the car and the ground at the same time. This way you avoid being the path of electricity from the car to the earth. Shuffle away from the car.

PART
3

Part 3: Protecting Your Home

Protecting your property and protecting your family go hand in hand, since your house may be able to provide shelter from most weather conditions. Taking steps now to strengthen your house can reduce the risk of damage to your home and possibly reduce insurance premiums. As you make upgrades to your home, consider your location, how and when your house was built, how it was maintained, and future hazard events. Visit the WHOI Sea Grant website (seagrant.whoi.edu) for a checklist to guide you in preparing your property for coastal storms.

When undertaking a home repair or improvement project, don't get bamboozled. Follow the important guidance provided by the Massachusetts Homeowner's Guide to Hiring a Home Improvement Contractor¹. Guidance includes getting written estimates and referrals from at least three licensed and insured contractors and having a formalized contract and payment schedule that ties the final payment to the completed project. Note that permits are likely to be required.

3.1 CREATING THE WIND- AND WATER-RESISTANT ENVELOPE

The envelope of a house consists of its roof, subfloor, exterior doors, windows, and the exterior walls. It is very important to seal the envelope of your house from wind and rain. When windows shatter during a storm, that envelope is broken, allowing much greater damage. Besides the incoming wind and torrential rain in your living room, there is shattered glass and debris from outside flying in. Even more importantly, it creates a problem with internal pressurization of your house (see Figure 3-1).

On a larger scale, a door or window breach can potentially double the uplift forces on your roof and can significantly increase the chances that your roof will lift off.² Several FEMA hurricane mitigation assessment reports, prepared by engineers, indicate that breaching of the building envelope and subsequent internal pressurization leads to progressive structural failure for many houses.

1 www.mass.gov/info-details/homeowners-guide-to-hiring-a-home-improvement-contractor

2 www.fema.gov/residential-coastal-construction

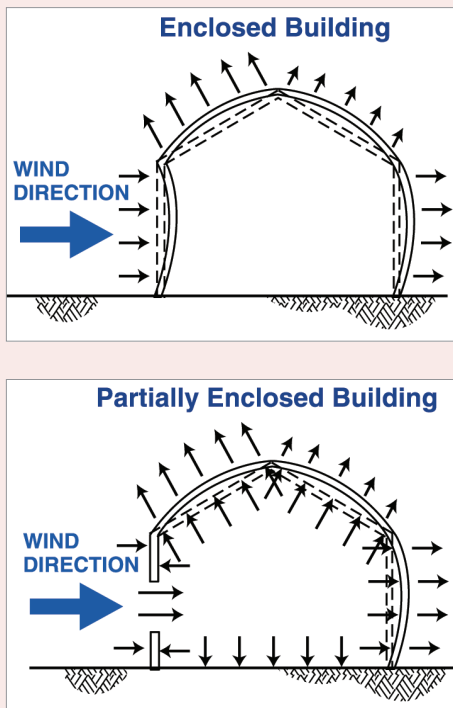


Figure 3-1. The diagram on the left shows a structure with the wind- and rain-resistant envelope intact. Pressure on the walls and roof comes from the outside only. In the diagram on the bottom, the structure's wind- and rain-resistant envelope has been breached due to a broken window. Now, pressure on the walls and roof comes from the outside and inside. The total amount of pressure on the roof and leeward wall increases significantly and can lead to the roof flying off and complete structural failure. Source: FEMA's *Residential Coastal Construction Manual* (2011).

3.1.1 Keep Your Roof On

Weaknesses in your roof are more vulnerable to wind damage from nor'easters and hurricanes. Once a weakness is exposed, adjacent areas may become more susceptible to damage as well. Thus, strengthening the roof is important; it should be considered for new construction and when a roof is replaced after its expected life.

Roof Framing/Truss Bracing

In general, there are three ways that roofs and roof systems fail in high winds:

1. Roof sheathing can be pulled off the roof framing by high-suction wind pressure.
2. Roof framing can fail at the roof-to-wall connection.
3. Gable end walls can collapse into the attic space or be pulled out from the exterior wall.

Sheathing

To prevent roof sheathing failure, there are exterior and interior methods to ensure the sheathing is adequately attached to the roof rafters or trusses:

- While replacing the roof covering, add nails (8d ring-shank nails are recommended) at a minimum spacing of 6 inches on center around the edge of the roof sheathing before re-applying the roof covering.
- From inside the attic, use closed-cell expansive foam to form a bond between the edge of the roof rafter or truss chords and the underside of the roof sheathing.

Roof-to-Wall Connections

Roof-to-wall connections can be implemented on existing homes in several ways:

- Roof sheathing can be removed while replacing the roof covering, and a connector can be attached from the exterior wall to each rafter or truss. The roof sheathing is then re-installed, and the roof covering is replaced.
- The soffit on the outside overhang can be removed; a new 2"x4" board installed on the exterior siding parallel to the roof; a new connector attached to the rafter or truss, and then installed on the new board; and the soffit re-installed.
- A section of drywall or interior wall and roof covering can be removed on the inside of the home; new connectors installed on the inside between the rafters or trusses; and then crown molding or other architectural treatment installed to cover the new connectors.

Gable End Support

It is possible to significantly strengthen your roof by providing lateral and diagonal bracing to the rafters or trusses. This is particularly important for houses with gable end roofs. This bracing can be done simply with 2"x4" boards purchased at a hardware store. Figure 3-2 is from the FEMA brochure, *Against the Wind*, which can be downloaded from FEMA's Building Science library.³

For lateral bracing, 2"x4" boards are attached to the trusses that run the length of the roof (Figure 3-3). The 2"x4" boards overlap over two trusses.

³ www.fema.gov/sites/default/files/documents/fema247_agstwnd.zip

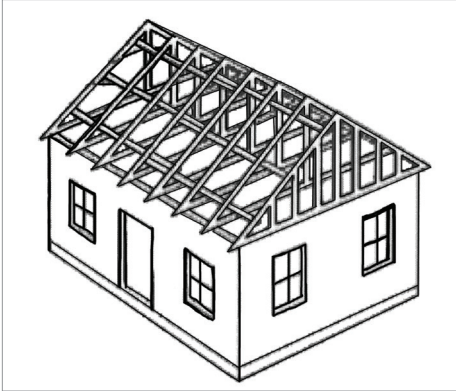


Figure 3-2. Trusses are built with a peak at the ridgeline of the house. The trusses at the end of the house form an A-shaped pattern know as a gable end. During a hurricane, the gable end is subject to great forces from the wind and could tip over, collapsing the other trusses in a domino fashion. Source: FEMA's Against the Wind brochure 247.



Figure 3-3. In this application of lateral bracing, the 2"x4"s are 18 inches from the ridge and connect to horizontal members that attach the opposing trusses. Not all roofs will have the horizontal members. The 2"x4"s are connected with two #14 3-inch screws (A) and overlap over two trusses (A and B). The end is connected to the gable end with an angle or L bracket (C). Image courtesy of Dennis Hwang.

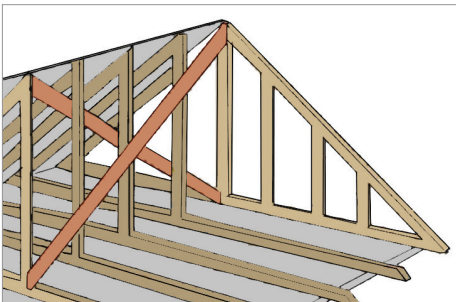


Figure 3-4. Diagonal braces form an X pattern from the top center of the gable end to the bottom center of the fourth truss and from the bottom center of the gable end to the top center of the fourth truss. The same screws as for lateral bracing are used. Source: FEMA's Against the Wind brochure 247.



Figure 3-5. Spray polyurethane foam is used to add strength between the rafters and the plywood sheathing. This method can be used to strengthen existing roofs and may negate the need to replace older roofs. It can also be used where fasteners are missing or at the corners of hip style roofs or the ends of gable end roofs, which are especially susceptible to wind forces. See FEMA publication numbers P-499 and P-804. Image courtesy of FEMA.

Braces should be 18 inches from the ridge in the center, and at the base, about 8 to 10 feet apart. You or a professional can do this work, although this can be difficult with long pieces of lumber in small attics. In homes built since the 1970s, this bracing should have been installed when the trusses were installed.

Another important type of bracing for your gable end involves making diagonal braces (Figure 3-4). Diagonal braces provide additional support against collapse of the gable end caused by high winds pushing (or pulling) on the gable end. Gable ends are more susceptible to high-wind damage because they are usually installed between the exterior wall of the house and the roof rafter or truss. There is a joint in the wood framing at that point, making the connection of the gable ends a weak link in the load path.

Hip-style roofs do not need as much bracing, as they are aerodynamically superior and they have the bracing built into the design of the structure. While gable end roofs have a flat end that is A-shaped, hip-style roofs have all four sides of the roof sloping towards the center of the roof.

Other Roof Improvements

There are small things you can do to strengthen your roof even if it is relatively new. For example, if you climb into your attic and see that nails that are supposed to attach the plywood sheathing to the truss have missed the truss, then you have found what could be a structural weakness. The joint can be strengthened with wood epoxy or spray polyurethane foam (Figure 3-5).

Another structural retrofit upgrade would be to install blocking between the roof rafters/ceiling/floor joists for at least two bays in from the gable or end wall. This blocking creates a load path for the lateral wind force to be transferred to the horizontal floor or roof system, using the shear strength in the floor or roof to resist the applied wind load. This is now required in new construction near an open field or on the water with few other structures or trees to deflect the wind.

FEMA provides guidance on these subjects in its Homebuilders Guide to Coastal Construction and Wind Retrofit Guide for Residential Buildings.⁴ An additional source of information regarding roofs and how to reduce risks from high winds can be found at the IBHS website (www.ibhs.org). The site includes information on re-nailing roof decks, maintaining steep-sloped roofs, re-roofing, and choosing a roofing material.

4 www.fema.gov/emergency-managers/risk-management/building-science/publications

A roof can rapidly fail in a storm event if there are gaps for wind and water to get underneath the shingles. If your roof is showing signs of deterioration, such as curling or missing shingles, it may be time to consider replacing it. One of the most common types of roofing you'll find in Massachusetts is asphalt shingles. These are often a versatile and cost-effective material choice and, when properly installed, can last for decades. You may also want to consider alternative materials, such as metal roofing, which may offer a longer lifespan or higher resistance to wind. Talking with your builder or architect about options that fit your roof structure, budget, and needs will be a great place to start.

Connecting the Foundation to the Roof: Continuous Load Path Connections

All houses have some continuous load path connection that ties your roof to your home's foundation and helps to keep the roof from blowing off during a severe wind event. Historically, the weakest part of this path has been the roof-to-wall connection. Thus, the hurricane tie was created (Figure 3-6). Hurricane ties are typically a couple of dollars each, depending on the type. The ties can be installed on each truss-rafter during new construction of houses, or during a retrofit.

Some coastal areas now require much stronger connections, such as straps, anchors, and hurricane ties, to protect against extreme winds from coastal storms. A properly selected hurricane tie is required for each rafter. In addition, the rafters at gable end eaves should be strapped down. Exterior beams supported by corner columns also require tie downs. For houses with post and beam roof construction, fasteners should be installed for roof rafter to roof beams, top of post to horizontal ridge beam, and post to beam connections located at the exterior wall (Figure 3-7).



Figure 3-6. This is an example of retrofitting an existing house originally built without hurricane clips. The popular H3 clip is used here; four nails attach the clip to the roof (truss-rafter) and four more nails attach to the wall or top plate below. For a retrofit, the clips are exposed on the outside of the house; therefore, both the clip and fasteners should be corrosion-resistant and painted to blend with the exterior of the house. With the correct clip and nails, you could perform the work or, if you prefer, hire a licensed contractor. Photo credit: WHOI Sea Grant.

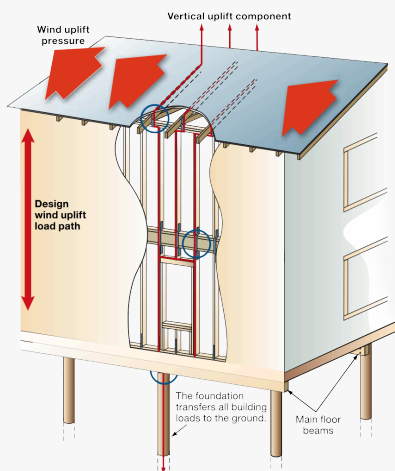


Figure 3-7a. Example of a continuous load path from roof to ground on a platform-and-pile-construction building. Load paths will vary depending on construction type and design, however vertical continuous load path connection ties should be used at various locations along the load path. Image adapted from 2005 FEMA 499 Technical Fact Sheet No. 10, Page 1.

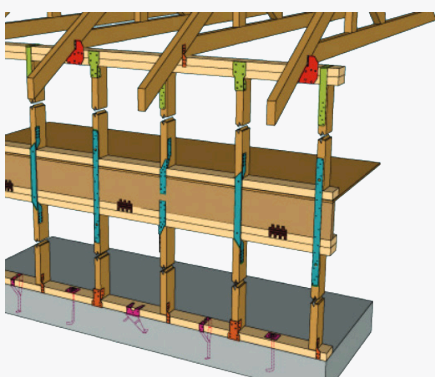


Figure 3-7b. Close-up of load path from roof to ground.

Roof to Wall Connection

- Roof member to top plate connections
- Top plate to stud connections

Upper Wall to Lower Wall Connection

- This connection is not required for a single story home.

Lower Wall to Foundation Connection

- Stud to sill plate connections
- Sill plate to foundation connections
- These connections are not required for uplift but may be required to transfer shear loads.

You should seek a licensed structural engineer or architect to select the proper connectors and hardware for your house. You can then do all or part of the installation yourself or hire a licensed contractor.

Strengthening the foundation to resist uplift will generally require the partial removal of interior finishes. The installation of uplift connections should be planned by a licensed structural engineer. It should occur only after the licensed engineer has inspected the home to understand materials and methods used to construct the home and have calculated the wind uplift requirements.

It is preferable to do both the roof-to-wall connection and the wall-to-foundation connection. However, if the wall-to-foundation connection is too difficult or expensive because of the way your house was built, installing only the roof-to-wall connection is better than doing nothing.

Remember, the weakest link for many homes is the roof-to-wall connection, and thus the hurricane tie will make that weakest link significantly stronger and improve the performance of the home during weaker wind events. Should Massachusetts experience a wind event of nearly 120 mph however, houses without a strong floor-to-foundation connection are still expected to fail. The International Code Council and Massachusetts Building Code⁵ anticipate that Massachusetts can experience wind events up to 150 mph.

Assess Potential Tree Damage

Your home's wind- and water-envelope can be compromised if a tree or branches break through. Cutting or trimming trees that overhang your house are additional measures that you can take in advance to protect your property during a coastal storm. Although trees provide a buffer to the full strength of the wind, there is a serious danger if there are large trees or limbs that are close enough to fall on the house. Few roofs are strong enough to withstand a falling 20-inch diameter, 40-foot tall tree.

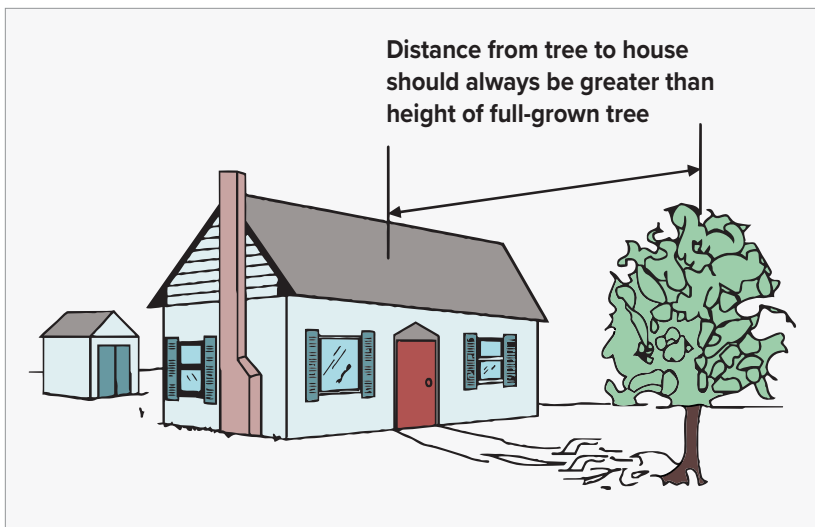


Figure 3-8. FEMA recommends that the distance between a tree and your house should always be greater than the height of the full-grown tree. This is to prevent trees from falling on the roof, either currently or in the future. Image courtesy of FEMA.

⁵ www.mass.gov/massachusetts-state-building-code-780-cmr

Tree limbs or branches falling onto your house will cause considerable damage. Figure 3-8 illustrates the distance from the tree to the house to ensure that falling limbs do not affect the roof. If it is not possible to remove a tree, you can at least cut off all branches that hang over the roof of the house. Generally, you should hire a certified arborist to perform this work and if you are located in the floodplain or near a wetland resource area, you'll need a permit from your local conservation commission.

Trees with shallow roots may also be susceptible to falling over when the soil is saturated or when the tree canopy is filled with blowing wind. This is a probable occurrence when the area is affected by severe rainfall (or snow/ice) along with heavy winds, which is usually the case with nor'easters and hurricanes.

Repairing Storm-related Roof Damage

Until the 21st century, most residential sloped roofs received a layer of asphalt-saturated felt building paper underneath the roofing material. Mimicking the attributes of house wraps, synthetic roof underlayments serve the same function as a secondary weather barrier with better resistance to tearing, moisture, and ultraviolet rays than traditional roofing felt.

Recent natural disasters and subsequent rebuilding efforts have highlighted the versatility of synthetics as roof underlayments by providing a real-life test environment. After several hurricanes ravaged southern coastal areas of the United States, many people were forced out of their damaged homes. At the same time, large numbers of homes required quick roof repair and “waterproofing” to minimize further damage due to water intrusion. With limited resources, contractors triaged homes, repairing the critical components and installing synthetic underlayments as temporary roofing. The underlayments performed better than FEMA's blue tarps and did not require removal and discarding when the new shingles were installed.^{4,6}

3.1.2 Secure Doors and Windows

Protection of your home's envelope from breaches during a windstorm is critically important, particularly to its vulnerable windows and doors.

If your home is located in a high-wind zone, it is important that window coverings not only withstand hurricane-force winds, but also withstand windborne-debris impacts. The usual standard for impact resistance is known as the “Large Missile Impact Test.” Essentially, it determines whether a given covering can withstand the impact of a 9 pound 2”x4” board fired at 30+ mph.



Figure 3-9. Coastal home protected with roll-down shutters on all windows and doors. The shutter is held in place by vertical guide tracks and can be deployed manually or with an integrated electric motor. Image courtesy of QMI, Inc.



Figure 3-10. Accordion shutter (shown in the open position) installed over a large window of a coastal home. Shutter has been installed to allow deployment from inside the home. Image courtesy of Roll-a-way.



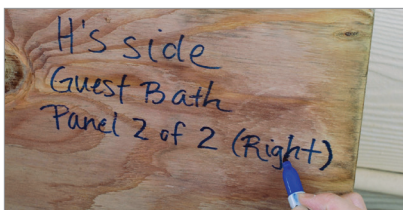
Figure 3-11. Colonial shutters that are suitable for storm protection are typically made of aluminum or fiberglass. During a storm, the panels are closed and secured along the vertical center of the window. During good weather, the panels open along hinges on the side of the window and rest flat against the wall in a decorative manner.



Figure 3-12. These 0.050 gauge aluminum storm panels offer cost effective storm protection. In this example, panels slip into a track above the window and secure onto a bottom track using wing nuts. Image courtesy of Roll-a-way.



Figure 3-13. Polyethylene basketweave fabric windscreen is deployed at edge of patio, enclosing the entire area. Image courtesy of Roll-a-way.



Figures 3-14 and 3-15. Not only is it necessary to install plywood opening covers correctly, it is also important to correctly label them and store them away from heat and humidity. Images courtesy of Dennis Hwang.

Coverings should be tested and approved to meet industry standards for hurricane impact and should carry a label indicating such approval. Check with the manufacturer. Use only licensed contractors and reputable dealers selling products tested by reputable testing vendors. For further information regarding opening protection, visit the IBHS website (www.ibhs.org), in particular the Fortified for Existing Homes Program.

Figures 3-9 through 3-15 generally describe several types of window and door opening protection systems. Within each category, numerous reputable manufacturers provide different products, each with individual features, benefits, and costs. You should consult with a competent contractor specializing in supplying and installing these systems.

Impact-resistant Windows and Glazed Doors

In order to withstand both wind pressures and impact from windborne debris, window and door manufacturers have developed products with both sturdier frames and laminated (impact-resistant) glazing. Such systems are available in a variety of styles, options, and costs.

While impact-resistant openings offer deployment-free protection, the glass can still be broken (but remains in the frame). Professional installation is highly recommended in order to ensure that proper attachment of the windows to the structure is achieved.

Table 3-1 lists the advantages and limitations of each type of covering discussed above. For most homes, a combination of different covering types is employed, based on the needs and budget of the homeowner.



Image courtesy of ChatGPT.

Impact-resistant Garage and Entry doors

One of the most important yet overlooked openings in a home that requires protection is its garage and entry doors. Most major suppliers of both types of doors offer products (with or without glazing options) that meet both wind- and impact-resistance requirements. Often, the replacement of a non-rated door with one of these newer types is more cost-effective than providing a covering for the older door.

TABLE 3-1. PROS AND CONS OF VARIOUS TYPES OF WINDOW PROTECTION

Type of Protection	Pros	Cons	Approx. Cost
Roll-down Shutters	Easiest to deploy; good overall protection, especially from wind-driven rain	Most expensive of permanent shutter systems; motorized versions need manual backup for power outages or an emergency power source	\$\$\$\$
Impact Resistant Glass	Always in place hurricane and security protection. Blocks noise and harmful UV radiation. Reduces solar heat gain to keep house cool and energy efficient. Opens view planes. Pass large missile tests.	Costs to buy and replace existing windows and frames can be high. While house contents are protected, there is potential for outer layer to crack, requiring replacement.	\$\$\$\$
Accordion Shutters	Easily deployed; simple manual operation; good overall protection	Possible aesthetic issues	\$\$\$
Colonial/Bahama Shutters	Easily deployed; good protection; provides shade	Blocks some light and view	\$\$\$
Storm Panels	Strong; removable; Relatively inexpensive permanent shutter system; good protection for the costs	Manual deployment required; requires adequate space for storage when not in use	\$
Laminates	Storm, security and UV protection; energy efficient; always on; allows light in; ideal for hard-to-reach windows	Other systems are stronger; need to lock laminate to frame; frame must be strong; window may need replacement after storm	\$
Plastic honeycomb	Strong system; lightweight; reasonable cost; won't warp or rot	Storage of panels; time to create and deploy. Availability	\$
Plywood	Materials readily available; easy to install on lower levels; inexpensive, 5/8" heavy but strong	1/2" not as strong as some other shutter systems; manual deployment is difficult on upper levels; must be properly stored	\$

Note: Be certain that purchased products (other than plywood) have been tested and approved to meet industry standards for hurricane impact and that they carry a label indicating such approval.

As with impact-resistant glazed windows and doors, a qualified professional installer should be used to install an impact-resistant garage or entry door. Doors that swing out are more storm resistant than in-swing doors because the door is closing against the door jamb, which provides resistance to the door being pushed in by high winds.

The garage door is a significant weakness in the building envelope due to its large area and the stress it is subject to from wind pressure. Garage door options include replacement with a stronger door, horizontal bracing, vertical bracing, or another type of garage door bracing kit.

For many garage doors, vertical bracing is a popular and reasonably priced option (Figure 3-16). When a storm is imminent, make sure to use the mechanical locks on the garage door, rather than relying only on the electric opener. Every little added connection helps strengthen the security of the building envelope.

Double entry doors should have slide bolts at the top header and bottom threshold of the inactive door, a deadbolt with at least 1-inch throw length between each door, and three hinges for each door. This requirement is similar to other guidelines for single entry doors, which call for at least three hinges and a bolt long enough that goes into the 2"x4" framing of the door. Whenever entry doors are fortified, at least two of them must be operable for access and exiting at any time.



Figure 3-16. Vertical braces such as these can be deployed during high-wind events to strengthen the garage door. The braces are secured from the header over the garage door to the fasteners installed in the concrete floor. Deployment and breakdown are about 10 minutes each. The windows have been covered with a laminate film. Image courtesy of Dennis Hwang.

3.1.3 Insulation

Insulation can help maintain interior temperature as well as reduce drafts. This can become incredibly important during nor'easters if power is lost. Insulation, along with doors and windows, will be rated with an R value. The higher this value, the more insulation it will provide. The effectiveness of insulation has increased in the past decades and years, so it may be worth considering upgrading. This can help during storm events and with typical energy bills. For more information on insulation and potential savings, visit the Mass Save website (www.masssave.com).

3.1.4 Snow Loads and Clearing Ice Dams

During nor'easters, your roof may experience significant loads from snow accumulation. You may need to clear this snow to protect the structural integrity of your roof and prevent collapse. Along with this, the refreezing of water at the edge of the roof or in gutters may create ice dams which can destroy shingles and create leaks. If you attempt to clear either type of hazard, be cautious if you are on the roof and beware of falling ice and snow if done from ground level.

3.1.5 Minimize Flood Damage

Protecting your property from flooding can involve a variety of actions, such as elevating the building and/or mechanical equipment, inspecting and maintaining them, and installing protective devices. Most of these actions, especially those that affect the structure of your building or utility systems, should be carried out by qualified maintenance staff or licensed contractors.

FEMA's National Flood Insurance Program (NFIP) website (www.floodsmart.gov) provides detailed information on flooding and flood risks. FEMA's Building Science website is an excellent source of information about coastal construction and protecting your property from flooding.⁶ Another source of information for reducing your flood risk is Reduce Flood Risk (www.reducefloodrisk.org). The website provides information and resources tailored to your risk and needs.

⁶ www.fema.gov/emergency-managers/risk-management/building-science/publications

Protecting Contents in Existing Basements

Many people in floodprone areas have basements that are particularly vulnerable to flood damage. If eliminating the basement (discussed below) is not an option, there are a number of measures you can take to protect the basement and its contents:

- Store belongings in plastic tubs and elevated onto shelves or platforms. Most insurance does not cover damage to items stored in the basement.
- Remove any belongings that can be damaged by mold.
- Store household hazardous materials on a shelf to prevent contamination of floodwater. Note: per OSHA guidance and for your own safety, these items should be stored no higher than eye-level.
- Apply mold- and mildew-resistant paint to interior basement walls.
- Install a sump pump which can remove much of the water from flooded basements.
- A water alarm can serve as a back up if your sump pump is overwhelmed and provide lead time before your belongings are damaged by floodwaters. Simple water alarms are inexpensive and similar to smoke alarms; they beep when exposed to water.

Flood Prevention

There are a number of steps you can take to protect your property, including improving the drainage around your home to direct water away from the foundation. It may be of great benefit to address the drainage issue with the professional advice of a licensed civil engineer. Remember that solving site-specific drainage issues cannot increase flooding on adjacent properties. Flood barriers including sandbags and deployable flood walls should be deployed as close to the foundation as possible to keep from diverting floodwaters onto neighboring properties.

Structural Elevation

The best way to reduce damage from floods for a structure that cannot be relocated is to elevate the living space of a structure above the predicted flood elevation for your site. Your local building department or contractor will know what the expected flood elevation is, per the latest regulations.

- **Increase Freeboard** - The building code requires new homes to have a minimum elevation (called freeboard) above the FEMA Base Flood

Elevation (BFE), which varies depending on location and flood zone. FEMA maps only use historical data, meaning they do not incorporate sea level rise or other changes in weather patterns. These factors are incorporated into the Massachusetts Coast Flood Risk Model (MC-FRM)⁷, which can be found, along with sea level rise and hurricane storm surge maps, on the Massachusetts Sea Level Rise and Coastal Flooding Viewer.⁸ On Cape Cod, this data is available through a map viewer from the Cape Cod Commission.⁹ Flood insurance discounts are available for higher freeboard levels. (See Part 5.2.)

- **Maximize the Flood Safety of Your Foundation** - Open foundations—piers, pilings, or columns—are the best way to prevent flood damage. If there is a risk of waves, having an open foundation is even more important. If a solid wall foundation makes the most sense for you and the flood zone you are in, consider increasing the number of flood vents in your foundation. Flood vents are openings in a solid wall foundation that allow water to freely enter and exit the enclosure, helping to equalize hydrostatic pressure and reduce the risk of cracking the foundation.

While elevating a structure is the best way to protect it from flooding, this often has negative aesthetic implications. Consider plantings or alternative designs created by registered design professionals to improve the aesthetic appearance of elevated homes, particularly in culturally-sensitive areas like historic districts.



For ideas on how to accomplish a successful pairing of aesthetics and flood safety, use the Cape Cod Commission's Flood Area Design Guidelines at www.capecodcommission.org/our-work/flood-area-design-guidelines.

7 <https://experience.arcgis.com/experience/23d861b79aed450eb8972013dd28579b/page/MA-Coast-Flood-Risk-Model>

8 www.mass.gov/info-details/massachusetts-sea-level-rise-and-coastal-flooding-viewer

9 www.capecodcommission.org/our-work/regulatory-tools-for-coastal-floodplain-resiliency

Elevate Appliances and Utilities

Items to elevate include your outside air conditioner compressor, inside furnace or air-conditioning unit, washer and dryer (choose front-loaders if on platform), water heater, freezer, and electrical outlets and switches, especially if located in a basement. An appliance can be elevated by placing it on a sturdy, flood-resistant platform or a strong shelf, which is securely attached to a structural support that can withstand flooding. If wood is used, it should be solid, pressure-treated lumber. Be sure to elevate the equipment well above the base flood; some owners remove all equipment in the basement and re-install it on the next higher floor or in an attic. Utilities including ducts should also be elevated; some limited equipment may be constructed of waterproof materials and designed to prevent the entrance or accumulation of water and to resist hydrostatic and hydrodynamic loads and stresses. More information can be found in the Massachusetts State Building Code.

If the electrical code allows, move the main breaker (or fuse box) and the electrical outlets and switches above the flood protection level for your home.

For information on potential funding sources for home elevations, see Part 4.5, Hazard Mitigation Grant Program.

Wet Floodproofing

Wet floodproofing means modifying the uninhabited portions of the house, such as a crawlspace or basement, so that floodwaters can get in but won't cause significant damage. Remember that wet floodproofing does nothing to alleviate the threat from fast-moving floodwaters (or waves), which are often a major cause of damage.

Wet floodproofing encompasses a variety of measures, not all of which may be permissible if your property is in or adjacent to certain coastal resource areas (e.g., dunes). Be sure to check with your insurance agent before retrofitting if part of your reasoning is to reduce annual insurance premiums. Wet floodproofing best practices include:

- **Use Flood-Resistant Materials** - Materials have differing abilities to resist flood damage. Flood resistance classifications have been developed for flooring, wall and ceiling materials, and the adhesives used to install them. These classifications are published by FEMA and are listed in NFIP Technical Bulletin 2: Flood Damage-Resistant

Materials Requirements¹⁰. Examples that can be attractive and flood resistant include clay tile, stone, or brick with waterproof mortar; solid vinyl flooring with chemical-set adhesives; stained concrete; terrazzo; decay-resistant or pressure-treated woods; and rigid, closed-cell foam insulation. There is also mold-and mildew-resistant paint.

- **Install Flood Vents** - In crawlspaces with a floor at or above grade, flood vents can be installed to allow the free movement of water into and out of the space. For new construction, basements and below-grade crawlspaces are prohibited in flood zones, and flood vents are required in all above-grade but below-BFE enclosures. Flood vents allow for pressure to equalize on both sides of the foundation wall, improving the structural stability.
- **Create Flushable, Drainable Walls** - In wet floodproofing, floodwater should be able to flow into and drain out of walls and other cavities to prevent damage from water pressure and keep the wall cavity from trapping contaminants. After flooding, there should be a way to drain, clean and dry these spaces easily to remove silt and contaminants and prevent the growth of harmful fungi and bacteria. Consider removable wide baseboards or wainscoting. Remember that any area below Base Flood Elevation built to code should not have any finishings and may not be covered by insurance.
- **Protect Appliances** - Relocate low appliances to a location high enough to be safe from flood damage, such as a higher floor or addition/bump-out. If this is not feasible, consider a waterproof barrier around appliances where shallow-depth flooding occurs often. There may be restrictions for the barrier approach, and it cannot be used to meet building code requirements.
- **Fill Your Below-Base Flood Elevation Basement or Crawlspace**
A licensed engineer can show you how to “give up” your basement



Figure 3-17. Image of flood vents courtesy of Cape Cod Commission

10 www.fema.gov/sites/default/files/2020-07/fema_tb_2_rev1.pdf

by filling and capping the area, and installing flood openings in the remaining crawlspace. The cost of this can possibly reduce your flood insurance premiums dramatically, making the investment pay for itself over a few years (verify with your insurance agent). Equipment that is currently in the basement would have to be relocated to a higher floor.

- **Sewage Backflow Prevention** - Even when a home is allowed to flood, sewage backflow prevention is important to avoid the serious health hazards and more expensive cleanup procedures associated with that type of contamination. A backflow valve should be installed.

Keep these points in mind when you wet floodproof:

- Activities that involve work on the electrical system, gas, or air-conditioning compressor usually require the services of a licensed contractor. Check with your local permit official to find out about requirements in your area.
- Raising the electrical system above flood levels will protect it from water damage, but it won't make it safe to have service turned on while water is in the building.
- Since wet floodproofing does not keep the structure dry, cleanup is still very important. Even if you successfully stop sewage backup through your plumbing, there is a good chance water coming in from outside has some chemical and biological contaminants. Disinfection, cleansing, and thorough drying are essential to remove contamination and to prevent growth of hazardous molds and decay.
- Wet floodproofing activities may not reduce your flood premiums, so the motivation for this activity should center on reducing the damage caused by flooding. Again, if you are seeking to reduce your annual insurance premiums, check with your agent before investing mitigation time and dollars. And remember, during a flood event, you may still be required to evacuate by local emergency management officials.

Dry Floodproofing

Dry floodproofing is typically not used in residential structures. It is not as reliable for flood protection as elevation or wet floodproofing. It can, however, be used to seal the building so that floodwaters cannot enter in cases where elevation is not an option and the residential structure is not

required to meet building code (Figure 3-18). This approach is primarily for slab on grade buildings with concrete or solid masonry walls (not for wood frame structures). It is not effective in conditions with high water velocities, waves, or rapidly rising water. FEMA guidance on use of dry floodproofing, Floodproofing for Non-Residential Buildings, can be found in the FEMA online library.¹¹



Figure 3-18. Image of dry floodproofing courtesy of ResilientWoodsHole

Resources for more information on retrofitting existing homes and new construction:

- The Insurance Institute for Business and Home Safety (IBHS) website includes numerous articles, reports, and videos that are extremely informative and explain preventative measures that reduce losses from all natural hazards, including hurricanes.¹²
- FEMA's division of Building Science provides guidance on how to protect structures from coastal storms. FEMA released two publications on retrofitting existing homes called Homeowners Guide to Retrofitting (for flooding) and Wind Retrofit Guide for Residential Buildings. Additionally, the Coastal Construction Manual and Homebuilder's Guide and Coastal Construction Technical Fact Sheet Series provide detailed guidance on building in coastal areas. All FEMA government publications are available for free and most can be downloaded from FEMA's Building Science Resource Library.¹³

3.1.6 Building Beyond Code Requirements

Building beyond code requirements can minimize damage and result in a home that is more wind and flood resistant. For many homeowners, even minor damage of 15% or less can be an extreme hardship. After Hurricane Sandy (2012) devastated portions of New York and New Jersey, a FEMA Mitigation Assessment Team (MAT) conducted an assessment of both wind and flood building performance. Damages to buildings and other structures were produced by wind speeds that were lower than the International Code

¹¹ www.fema.gov/emergency-managers/risk-management/building-science/publications

¹² <https://ibhs.org/guidance/homedisastertguides/>

¹³ www.fema.gov/emergency-managers/risk-management/building-science/publications

Council recommends using for design standards. The wind damage was due to lack of understanding of basic wind-resistant design and construction practices, insufficient codes and standards at the time of construction, insufficient or lack of design guides and/or test methods at the time of construction, and improper or non-compliant building modifications or lack of maintenance by the property owners.

In addition to unanticipated wind damage, flooding during Hurricane Sandy was more widespread than Flood Insurance Rate Maps (FIRMS) created by FEMA had predicted. 53% of the areas flooded by Hurricane Sandy in New York City had water levels that exceeded the mapped base flood elevation, or predicted height of flooding on the FEMA Flood Maps.

Overall, the damages observed by the MAT were consistent with typical flood damage patterns, where damage to properly designed and constructed elevated homes was generally minor. Performance of residential building foundations with regard to coastal and near-coastal hazards depended primarily on the residence having adequate elevation, proper construction, and proper foundation selection. If any of these criteria were not satisfied, performance suffered.¹⁴

3.2 CONSIDER ELECTRICAL AND POWER ISSUES

By following key safety precautions when dealing with electricity during and after storms and other disasters, you can help prevent death, injuries, and property damage. Homeowners should know where their electrical panels are and be comfortable turning off breakers in an emergency. Submerged outlets or electrical cords may energize the water and pose the risk of electrical shock. Do not enter any water that may have an electrical current.

All homes should use outlets equipped with ground fault circuit interrupters (GFCIs) near water sources such as sinks and bathrooms. GFCIs are inexpensive electrical devices that are designed to protect people from severe or fatal electric shocks. If you don't have them, consider having them installed by a licensed electrician.

Wet Electrical Equipment: Do not use electrical appliances that are wet. A qualified service repair dealer should recondition electrical equipment that has been wet. For more information, the National Electrical

¹⁴ Mitigation Assessment Team Report: Hurricane Sandy in New Jersey and New York—Building Performance Observations, Recommendations, and Technical Guidance (FEMA P-942). Federal Emergency Management Agency, November 2013.

Manufacturers Association (NEMA) has produced a brochure, *Guidelines for Handling Water Damaged Electrical Equipment*¹⁵, for use by suppliers, installers, inspectors, and users of electrical products to provide advice on the safe handling of electrical equipment that has been exposed to water. It outlines whether items will require complete replacement or can be reconditioned by a trained professional.

3.2.1 Generators

When considering alternate power sources, think about what appliances or equipment are critical during a power outage, which may occur in any season. If your family cannot get by without heating/cooling, medical equipment, or other critical appliances, then you may want to consider a generator. Generators can be permanently installed or portable (for a lower cost). Permanent generators are installed outside your home and programmed to turn on when power is lost. Portable generators should be moved outside when in use as they will emit carbon monoxide, which is odorless and lethal. A qualified, licensed electrician should install any generator that is wired into the house to ensure that it meets local electrical codes.

Other generator-related tips:

- Test your generator regularly and well in advance of a storm to ensure that it operates properly.
- Make sure extension cords used with generators are rated for the load, free of cuts and worn insulation, and have three-pronged plugs.
- Be mindful of the number of appliances drawing on the generator, so as not to overload it.
- Reduce demand from generators by charging devices and turning your refrigerator and freezer to the coldest setting before a storm.
- Some generators can be noisier than others. You may want to take this into consideration when selecting a generator.
- Make sure you have ample fuel for the expected duration of the power outage. Be cautious when filling a portable generator with gas, as it is highly flammable.
- For homes located in a floodplain, generators should be anchored to an elevated platform above expected flood levels.

¹⁵ www.nema.org/docs/default-source/secure-document-library/nema-gd-1-2016-evaluating-water-damaged-electrical-equipment-guide.pdf



Figure 3-19. Image of portable power station courtesy of WHOI Sea Grant

3.2.2 Battery Power Stations and Storage

There are many types and sizes of power stations and battery storage available. Some are capable of charging phones, while others can power your whole home. The effectiveness of the battery backup will be highly dependent on the loads put on the system and the size of the battery. Smaller power stations are relatively inexpensive and will recharge a cell phone for emergencies. Be sure to charge all batteries prior to storm impacts.

Some electric vehicles now come with the ability to power your home, and can keep your lights and refrigerator on, potentially for days, during a power outage. However, these high-capacity batteries require a professional to connect your car to your home's electrical panel. Care should be taken when using a vehicle as an energy source; ensure that you'll have enough battery charge in the vehicle to evacuate, if needed.

3.3 COASTAL EROSION CONTROL

Controlling erosion at your waterfront property can help protect your home from storm impacts and the gradual shifting of shorelines. There are many ways to limit erosion, from enhancing natural characteristics to building coastal engineering structures. For many locations, these solutions only present temporary reprieves from erosion and alternative approaches will need to be considered in time. It is important to note that many of the solutions below can be expensive and may have adverse impacts on the

surrounding shoreline and ecosystem. Any erosion control system implemented should be carefully designed and maintained. Due to the complexity of shorelines and potential for adverse impacts, you will likely need to file a Notice of Intent and receive a permit from your local Conservation Commission. For a more comprehensive list of stabilization methods, see the Sea Grant publication *Spectrum of Erosion Control Methodology* at seagrant.whoi.edu.

Stabilization methods are often used in conjunction with one another to limit erosion. These methods include:

- **Vegetation** - Planting native vegetation can help to slow wave energy, absorb excess runoff, and stabilize sediments through root systems.
- **Nourishment** - Adding compatible sediment to a coastline can help to keep erosion away from homes and structures by increasing the erosional buffer. Often seen as ‘sacrificial’, nourishment that is eroded can help to maintain natural systems, rather than deprive beaches and dunes of sediment.
- **Soft engineering** - These strategies often include fiber rolls and coir envelopes, sandbags made from coconut husk fiber. They are intended to protect erodible sediments from waves with natural, biodegradable materials that are meant to have minimal impact to the surrounding environment should they fail.
- **Coastal engineering structures** - A coastal engineering structure, often referred to as a CES, is a hard infrastructure project typically in the form of a revetment, seawall, jetty, or breakwater. These structures can be effective at controlling erosion, but often have significant adverse impacts to the environment.

3.4 RELOCATION

For homes that are repeatedly flooded or experience chronic erosion, the best option may be to relocate the house. Relocation could take place within the same parcel or offsite. This removes the structure from the hazardous location and creates more open space that will help to absorb and slow flood waters and waves for neighboring structures. While relocation is an effective solution to flooding and erosion, it is costly and can come with a series of additional challenges. See the Hazard Mitigation Grant Program section (Part 4.5) for more information.

PART
4

Part 4: Post-Storm Response and Recovery

Responding to and recovering from a storm is tough, and the process can be confusing. In addition to dealing with personal issues, homeowners may need to engage with professionals across many fields who are following official procedures to assist with all aspects of recovery. Understanding what to expect from disaster response and recovery can help homeowners find their way through it.

4.1 RETURNING TO A STORM-DAMAGED HOME

If you evacuated your home, you may be worried about what you will find when officials have deemed it's safe to return. Be cautious when you return and follow important safety precautions if you find that your home has been damaged.¹ Throughout this section it is important to keep the following in mind:

- **Document everything:** Take photos/videos of damage from various angles before cleaning or repairs, and keep all receipts for repairs and temporary living expenses for insurance purposes.
- **Contact insurer & lender:** File claims immediately and speak with your mortgage lender about forbearance or payment relief options. (See Part 5 for more information on insurance.)
- **Rebuild & prepare:** Plan for rebuilding and consider upgrades to make your home more resilient.

4.1.1 Hazards Outside the Home

Before entering your home to begin assessing damage, you need to make sure the outside of your home and utilities are safe. Some critical first steps are below.

- **Smell for gas.** If you smell natural gas or propane, or hear a hissing noise, leave immediately and call 911. (Once inside, you will want to smell for gas throughout the house.)
- **If there are power lines down on your property,** assume they are live and call your utility provider. Do not touch downed power lines.

¹ www.fema.gov/fact-sheet/tips-returning-home-safely-after-disaster

- Check for obvious signs of structural damage such as foundation cracks or holes in the roof. It may be too dangerous to enter the home until an inspector checks it out.
- If safe to do so, perform urgent repairs like tarping or boarding windows to prevent mold and further structural harm.

Keep in mind:

- You may need to remove snow or downed trees before you can access the property.
- If power and internet are restored to your neighborhood but not your home, notify your utility companies that there is an issue on your property.
- Rodents, snakes, insects and other animals may have taken up residence outside or in your home.
- Looters can take advantage of the disruption caused by a storm and may have accessed your home.

4.1.2 Hazards Inside the Home

Be cautious entering a home after a storm. Not all damage will be obvious from the external assessment of your home, and can still present a hazard to your safety.

If damage is extensive, your home may not be suitable for occupancy. If professional help is needed, get several estimates for repairs and hire reputable, licensed contractors. Depending on the type of disaster experienced, and the time of year, the following list of post-disaster recovery actions need to be considered. This list is not exhaustive, nor all-applicable:

- If your home was flooded or had high humidity due to the disaster, one of the most significant hazards is mold growth.² Exposure to mold may increase health risks for survivors with asthma, allergies or other breathing conditions. You should limit your exposure to mold, typically with non-ventilating goggles, rubber gloves and boots, and an N-95 (or greater) respirator appropriate for mold removal. If you are allergic or have a respiratory condition, you should strongly consider completely avoiding exposure.

² www.epa.gov/mold/mold-cleanup



Image courtesy of University of Hawai'i at Manoa.

- If the house was flooded, air it out by using fans with open doors and windows in warm weather or run dehumidifiers in any season. Be aware that water can be trapped in walls, floors, and ceilings, making them unsafe.
- Remove and discard anything that has been wet for more than 24-48 hours. Mold may be hidden in places such as the back side of drywall, wallpaper, paneling, insulation, the underside of carpets and pads, etc. Hard surfaces should be scrubbed with bleach and water and dried completely. Do not paint or caulk moldy surfaces, as it will likely peel and mold will not necessarily go away under these treatments.
- Throw out all food, beverages and medicine exposed to flood waters and mud, including canned goods and containers with food or liquid that have been sealed shut.
- Throw away refrigerated food if the temperature exceeded 40 degrees.
- Be aware that pipes may have frozen in cold weather and may only leak when they thaw.
- Check for any chemicals that may have spilled.
- Check with local post-disaster response officials for additional potential issues specific to your location and storm.

How Does a Disaster or Emergency Declaration Affect Me?

You may receive a time-sensitive request from state, county, or local officials to provide information on damage to your property. This will assist the state in assessing the extent of the damage, enabling the governor to request federal funds to repair public infrastructure and/or provide recovery assistance to individuals.³ These disaster declarations may also activate federal funding that individuals can access through their town to elevate or acquire their homes.

4.2 ASSISTANCE DURING RESPONSE AND RECOVERY

If a disaster has been declared for your area, federal and state funding will be activated for some relief efforts. If eligible, you could receive money for living expenses, repairs, or rebuilding, but the amount of money available

KEEP IN TOUCH WITH FEMA TO MAKE SURE ASSISTANCE ISN'T DELAYED

If you haven't heard from us after applying for assistance, you may need to update your contact information. If you changed your address or phone number, even temporarily, be sure to let us know. **HERE'S HOW:**



Visit **DISASTERASSISTANCE.GOV** to update and track your application.



Make changes in person at a **DISASTER RECOVERY CENTER**. Find one near you at fema.gov/DRC.



Give us a call at **800-621-3362** (711 or Video Relay Service available) or **800-462-7585** (TTY).

You can also check your local post office for your FEMA letter. They may be holding your mail until all delivery services are available.

³ www.fema.gov/disaster/how-declared

through disaster assistance is likely to be minimal — on the order of a few thousand dollars. The amount of federal funding you receive will depend on insurance coverage and the disaster-caused damages you experienced; federal disaster assistance legally cannot duplicate benefits provided by your insurance coverage and are likely to be substantially lower than funding provided by an insurance claim payment. Either way, it is a good idea to register with FEMA and begin the FEMA assistance application process while going through the insurance claims process to save time. **You must register within 60 days of the disaster declaration date.**

If you plan to apply for post-disaster assistance, see the federal government's disaster assistance fact sheet⁴ and checklist⁵.

4.2.1 FEMA Individual Assistance

FEMA Individual Assistance is administered directly to homeowners and renters and is not dependent on community participation in any program. It is typically the second avenue of financial assistance after an insurance policy, but it can also act as the first step and gateway to other federal assistance programs. It pays for a variety of services in addition to housing. The following can be provided through the Individuals and Households Program⁶:

Temporary housing: Financial assistance may be available to homeowners or renters to temporarily rent a place to live. If no rental properties are available, a government housing unit may be provided, but only as a last resort.

Lodging expenses reimbursement: If not covered by insurance or any other program, reimbursement of hotel expenses for homeowners or renters may be available for short periods of time due to inaccessibility or utility outages.

Repair: Financial assistance may be available to homeowners to repair disaster-caused damage to their primary residence that is not covered by insurance. The goal is to make the damaged home safe, sanitary, or fit to occupy only, not to return to a pre-disaster condition. Insurance coverage will provide more financial assistance.

⁴ www.disasterassistance.gov/information/fact-sheets

⁵ www.disasterassistance.gov/get-assistance/application-checklist

⁶ www.fema.gov/assistance/individual/program

Replacement: Financial assistance may be available to homeowners to replace their home destroyed in the disaster if the loss is not covered by insurance. The goal is to help the homeowner with the cost of replacing their destroyed home.

Permanent or semi-permanent housing construction: Direct assistance or money for the construction of a home may be available. This type of help occurs only in insular areas or other locations specified by FEMA, where no other type of housing assistance is possible.

To apply online (through www.disasterassistance.gov), you'll need the following to complete your registration:

- Social Security number (SSN)
- Annual household income
- Contact information (phone number, mailing address, and damaged home address)
- Insurance information (coverage, insurance company name, etc.)
- Bank account information (If you are eligible to receive financial assistance, the money can be deposited into your account.)

4.2.2 Small Business Association (SBA) Loans

Home and Property Disaster Loans are available to individuals after they have already pursued insurance claims and FEMA's Individual Assistance. If you register for disaster assistance and are referred to the SBA, it is important to complete the loan application. You aren't required to accept a loan if offered one, but FEMA uses loan eligibility to determine if you may qualify for other types of federal assistance.

You do not need to be a business owner to apply for an SBA loan; you can be a homeowner, renter, or member of a common interest development (e.g., homeowner associations or condominiums). Loans can pay for



DID YOU KNOW?

Homeowners and renters can apply for Small Business Association (SBA) loans for disaster recovery!

repairs, personal property, relocation assistance, and sometimes mortgage refinancing⁷. In some cases, SBA can refinance all or part of a previous mortgage when the applicant does not have credit available elsewhere and has suffered substantial disaster damage not covered by insurance.

Homeowners can apply to replace or repair their primary residence. This loan cannot be used to upgrade homes or make additions unless required by local building code. If you make improvements that mitigate the risk of future damage from a similar disaster, you may be eligible for up to a 20% loan amount increase.

**For additional information, please contact the
SBA disaster assistance customer service center.**

Call: 1-800-659-2955 (TTY: 1-800-877-8339)

Email: disastercustomerservice@sba.gov

4.2.3 Federal Assistance

There are many public and private entities that provide assistance in the post-storm environment, but some of the major federal programs accessible to large numbers of people are outlined below.

FEMA's Hazard Mitigation Grant Program (HMGP): Funded by FEMA, this program is administered by the Massachusetts Emergency Management Agency (MEMA) after a disaster declaration. Hazard mitigation is implemented before the next disaster in order to reduce the risk from hazards. However, communities can receive recovery funding if their state has or agrees to develop a state-wide Hazard Mitigation Plan. Sometimes these projects benefit individuals, especially when local governments buy properties located in the floodplain and assist homeowners in relocating to non-hazardous areas or assist individuals with elevating or wind-retrofitting buildings. Please note that the municipality must apply for these funds on behalf of individual homeowners. More information on this program is available on the FEMA website.⁸

⁷ www.fema.gov/grants/mitigation

⁸ www.fema.gov/grants/mitigation/learn/hazard-mitigation

FEMA's Flood Mitigation Assistance (FMA): Assistance is only available to communities that participate in the National Flood Insurance Program. The supported projects are similar to HMGP projects, such as relocation, building elevation, and flood control. More information on this program is available on the FEMA website.⁹

Housing and Urban Development 203(K) Loans: The Department of Housing and Urban Development provides Section 203(k) loans, which allow homebuyers and homeowners to finance the cost of rehabilitation and to purchase or refinance through a single mortgage. 203(k) loans can be used for flood safety improvements. Eligible activities include many approaches to improving flood protection, such as elevating the structure or utilities, relocation of the home to a non-flood-prone site, installation of overhead sewers and/or backflow prevention, and more. More information on the 203(k) loans is available on the HUD website.¹⁰

USDA NRCS Emergency Watershed Protection Buyout Program: The Emergency Watershed Protection Program from the U.S. Department of Agriculture's Natural Resource Conservation Service can be used in special circumstances for buyouts of flood-prone properties. The program only applies in certain flood zones and the property must be located in an area that received an eligible federal disaster declaration. This program is not widely used or activated but when it is, a substantial amount of money becomes available and is less competitive than other programs. For more information on this program is available on the USDA website.¹¹

4.3 REBUILDING AFTER A STORM

When returning after a storm, be prepared to receive visits from more than one inspector, as you file insurance claims or prepare to repair and rebuild. These inspectors may represent insurance companies or the National Flood Insurance Program, or federal, state, or local government agencies. Representatives of volunteer agencies may also contact you to offer their services.

9 www.fema.gov/grants/mitigation/learn/flood-mitigation-assistance

10 www.hud.gov/program_offices/housing/sfh/203k

11 www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/

It is also important to be aware of scammers who may be posing as insurance inspectors, government or representatives. Inspectors from any governmental agency will show photo ID badges. If you are not shown photo identification, do not allow the inspection. If you suspect someone is posing as an inspector, call your local law enforcement agency.

4.3.1 Before an Inspection

The following list compiles advice from FEMA regarding what to have ready before an insurance agent or adjuster arrives:

- An adult 18 or older, who lived in the residence before the disaster must be present for the inspection, with photo identification
- Proof of ownership/occupancy of the damaged residence, such as a property tax bill, mortgage payment bill or receipt, or utility service bill
- Insurance documents and policy numbers
- Detailed descriptions of the damage to the home and its contents (particularly if the damage was caused by wind or water)
- A brief description of what caused the damage (e.g., wind, flooding, debris)
- Photographs of the damage (very important before you begin any repairs)
- List of persons living in the residence at the time of disaster
- Best contact information for reaching you. (Consider that you may not be able to stay in your house or receive mail at your address, and your phone may not have service.)



4.3.2 Before the Rebuilding Process Begins

If there is damage, first contact your insurance agency to file a claim and check with your insurance company and municipality for permits before making any permanent repairs. You may need permits from building, conservation, health, or other departments before proceeding.

Ask for a substantial damage determination from your local building official. If the cost to rebuild is 50% or more of your structure's market value, it may qualify as substantially damaged. A substantial damage determination can enable access to additional funding from an existing National Flood Insurance Program policy but will require that the structure be brought up to code.

Learn about requirements for new construction and substantial improvements. The building must be brought into compliance with the state building code and any local regulations. This may include elevating the building, relocating the building to an area outside of the high-risk flood zone, or demolishing the building and rebuilding in compliance.

Document everything! Document interactions with FEMA, insurance, and contractors; make copies of all forms and correspondence; save receipts and track all recovery expenses for claims and reimbursement.



PART
5

Part 5: Protecting Your Property with Insurance

The previous chapter of this Handbook provided strategies to protect your home from storm damage. Proactively reducing risk is the best way to minimize storm impacts, however, damage can still occur. When this happens, insurance can provide resources to aid recovery.

Different types of insurance policies will apply depending on your situation. Renters can get coverage for contents, whereas homeowners should get coverage for both contents and the structure. There are also additional policies for flood and sometimes for wind damage.

5.1 GENERAL INSURANCE INFORMATION

It is very important that consumers make time before a disaster strikes to be certain that insurance concerns have been addressed. Consider the following before you are faced with a disaster:

5.1.1 Pre-Disaster Activities

- Inventory your personal property including model numbers, serial numbers, and purchase information. A home inventory will help you estimate the value and replacement cost of your possessions in order to ensure that you have sufficient coverage under your homeowner's or renter's insurance policy.
- Back up your inventory by videoing or photographing each room in your house and storing this visual record outside your home such as on a cloud-based storage. It can be helpful to take photos of your property after a disaster to document your losses.



DID YOU KNOW?

If you have a policy through the National Flood Insurance Program, you may be eligible for up to \$30,000 to help with the cost of bringing a damaged house up to code after a disaster.

- Review your insurance policies to see if you have adequate coverage. If you're unsure, talk to your agent or company.
- Keep in mind, after a disaster, you may have to bring your home up to current building codes rather than just restoring it "the way it was." Ask your agent if your policy will pay for the additional expense of bringing your home up to code. If you have a flood insurance policy with the National Flood Insurance Program (NFIP) and your home is substantially damaged by a flood, you might be able to get up to an additional \$30,000 to help with Increased Cost of Compliance.¹
- Keep insurance policies, your household inventory and other important papers together in a safe and secure place and back them up in cloud-based storage. Be sure to have copies accessible in case you have to evacuate. Having easy access to this information can help facilitate the claims process after a storm.

5.1.2 Protect Your Home from Damage

Part 3 of this Handbook reviews many ways to protect a structure from damage. Some of these can also reduce homeowners and flood insurance costs; talk to an agent about your specific policy. Protecting property from possible damage before a disaster can have a major impact on insurers' willingness to continue insuring the property.

5.1.3 Communicate with Your Homeowners Insurance Agent

Check with your agent and policy declarations pages for information about what is covered and possible discounts and incentives. Consider:

- Homeowners coverage is typically provided in terms of replacement cost or the cost to rebuild your house, but it may be Actual Cash Value (ACV). ACV means you will only get the value including depreciation, not the cost to rebuild.
- Does the homeowners policy have an inflation guard that increases each year as the cost to rebuild goes up? Construction costs have steadily increased and may increase even more after a natural disaster.
- Additions or improvements to your house made since your initial policy purchase may not be covered, so it is important to have a periodic appraisal so that your coverage is adequate.
- Understand your homeowners policy. Many wind policies cover only

¹ www.fema.gov/floodplain-management/financial-help/increased-cost-compliance

hurricanes and not lesser events such as a tropical storm. Some wind policies may also have a different deductible for a hurricane event.

- Verify whether you have coverage for (1) your main structure, (2) detached structures, (3) the contents in your house, and (4) expenses for loss of use (like hotel stays). Only the first item is required by mortgage lenders, so you may not have sufficient coverage for the remaining items.

5.2 FLOOD INSURANCE

Floods are a common natural disaster that can be extremely costly. Even if your property has never flooded, this does not mean that it never will. Across the nation, about 75% of all presidentially-declared disasters involve flooding.² Anywhere it rains it can flood. Flood insurance is an important consideration for all Massachusetts residents.

Standard homeowners' insurance policies do not provide protection against flooding. A separate policy is required to cover flood damage and can take 30 days to become active. It is a hard lesson that has been learned by some in Massachusetts, and it is an unfortunate reality that many people don't find out until it's too late.

A separate flood insurance policy can be obtained from several private companies in Massachusetts, as well as from the National Flood Insurance Program (NFIP).³ The NFIP provides up to \$250,000 in structural coverage for homeowners and \$100,000 in contents coverage to homeowners or renters. NFIP insurance is available for insurable property in any flood zone in a municipality participating in the NFIP (most communities in MA).⁴ Limited exceptions apply including properties with certain types of insurance rates and whether a property is located in the Coastal Barrier Resources System. (Check with your municipality to see if your property falls into one of these areas.) Most local insurance agents can issue NFIP policies. FEMA's flood insurance website (www.floodsmart.gov) provides additional information on flood risk, damage costs, and more.

Homes and businesses in high-risk flood areas that have mortgages from federally regulated or insured lenders are required to have flood insurance. While flood insurance is not federally required if you live in a moderate- to

² www.weather.gov/safety/flood-hazards

³ www.fema.gov/national-flood-insurance-program

⁴ www.fema.gov/flood-insurance/work-with-nfip/community-status-book

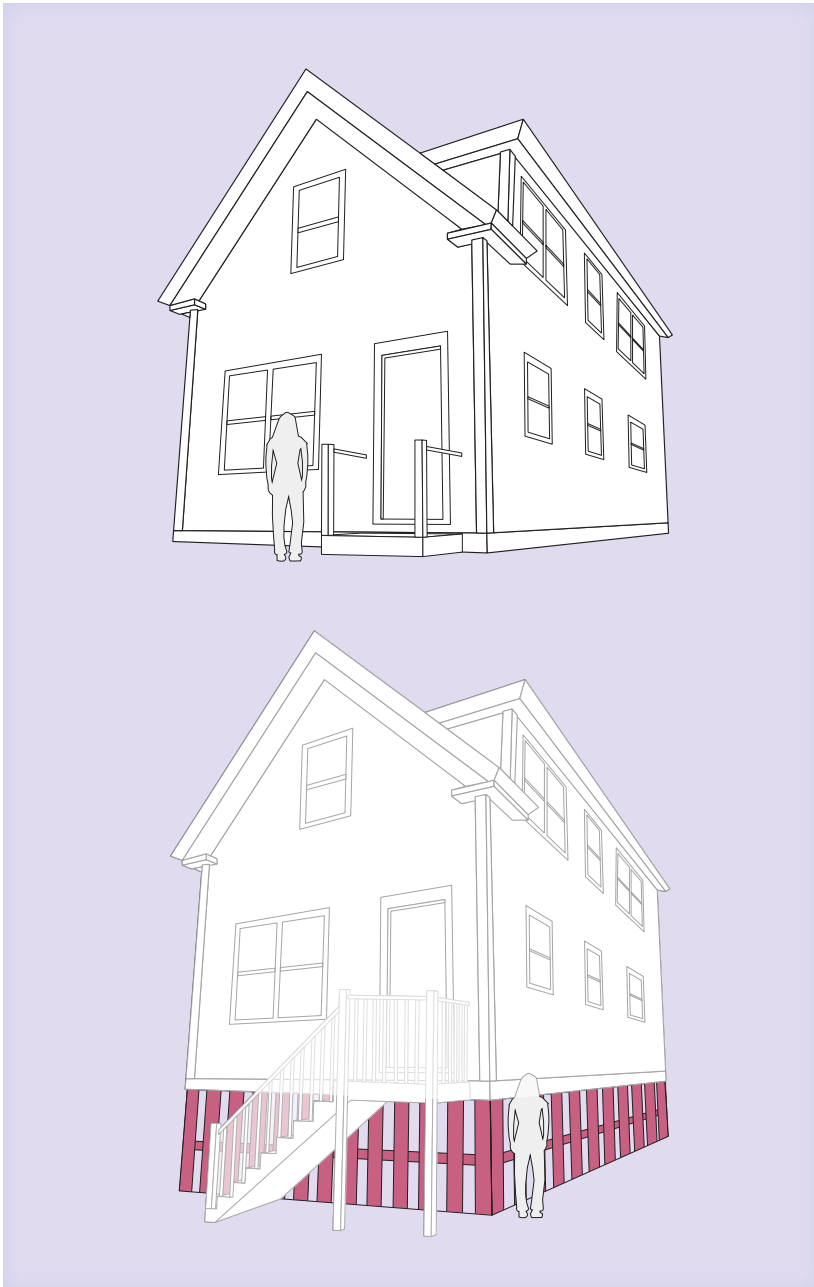


Figure 5-1. In this example, adding a small amount of height has very little effect on the look of a home, but results in a substantial flood insurance savings. Image modified from Cape Cod Commission. More information available at www.mass.gov/info-details/using-freeboard-to-elevate-structures-above-predicted-floodwaters.

low-risk flood area, the NFIP reports that 40% of flood insurance claims come from these areas.⁵

In areas with the greatest risk of flooding, called Special Flood Hazard Areas (SFHAs), a building has a 26% chance of being flooded during a 30-year mortgage.⁶ Homeowners, business owners, and renters inside or outside of any flood zone can all buy federal flood insurance as long as their community participates in the NFIP, and private flood insurance may be available as well. NFIP rates are set and do not differ from company to company or agent to agent. These rates depend on several factors, including the age and type of construction of your home and your home's level of risk.

To lower flood insurance costs in high-risk areas, a property owner can pursue structural changes like elevation and additional freeboard (covered in Part 4) to make a home safer from flooding. A non-structural option for ensuring the best price is to obtain an Elevation Certificate to accurately rate flood risk. If flood insurance costs are not affordable, consider reducing the amount of coverage rather than eliminating coverage or opt for a higher deductible. For more information, contact the floodplain specialist at WHOI Sea Grant / Barnstable County's Cape Cod Cooperative Extension

If your municipality participates in the NFIP's Community Rating System (CRS), you may qualify for a flood insurance premium discount. Participating communities in Massachusetts have earned a 5-20% discount for residents and businesses. To find out if your town participates, visit the CRS website.⁷

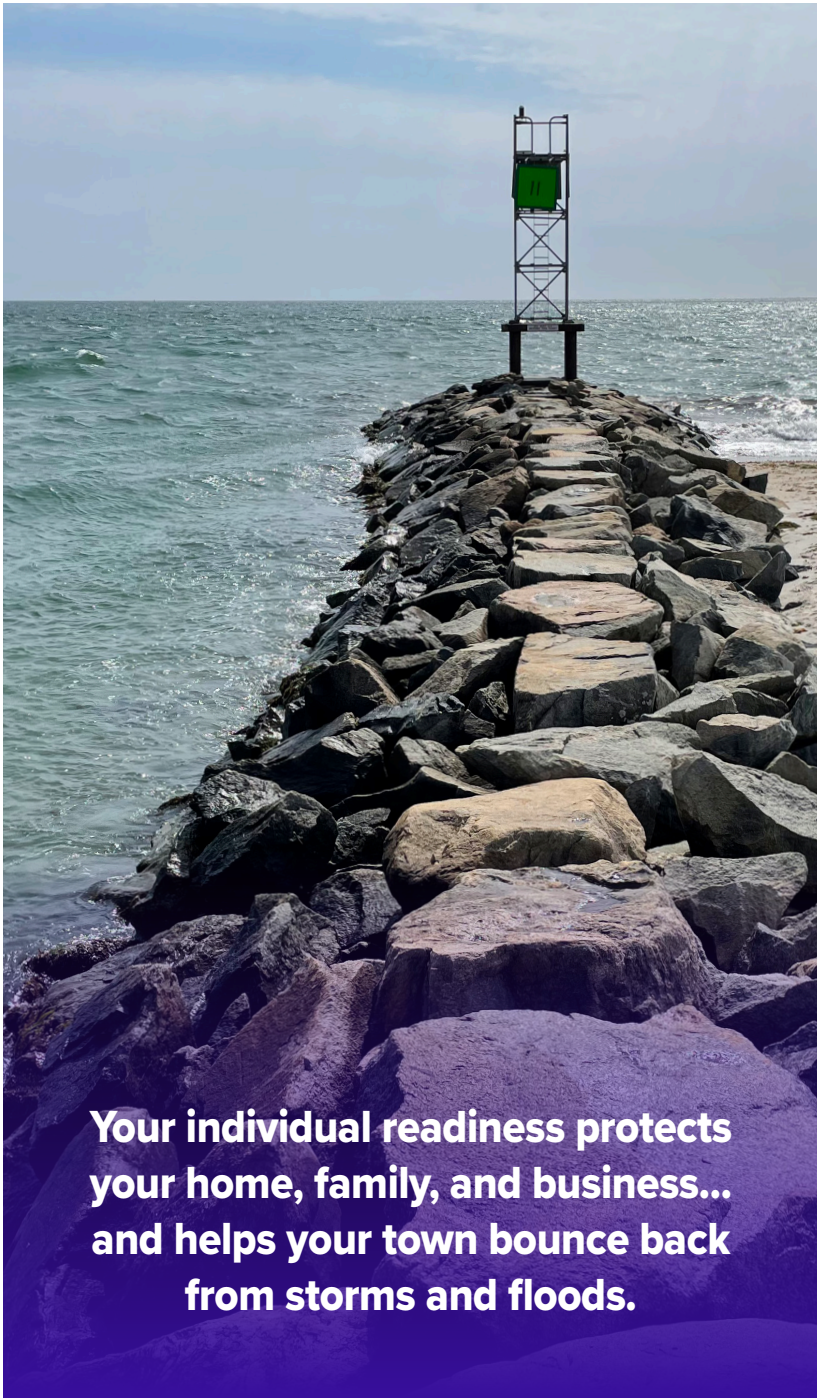
5.3 WIND INSURANCE

In some coastal areas, it can be difficult to obtain homeowners insurance because of high exposure to wind and flood risk from coastal storms. If a property owner can get coverage, flood is almost always excluded and wind may be excluded as well. In order to bridge the availability gap in the private market for wind coverage, Massachusetts has created a FAIR plan, also known as an "insurer of last resort" for those properties unable to obtain insurance through the voluntary market. For more information on the FAIR plan, visit www.mpiua.com.

⁵ www.fema.gov/blog/floods-can-happen-anywhere-be-prepared-flood-insurance

⁶ www.fema.gov/pdf/floodplain/nfip_sg_unit_3.pdf

⁷ <https://crsresources.org/100-2/#crs-community-list>









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Measach Users Handbook for Coastal Hazard Assessment, September 2026

M A S S A C H U S E T T S

HOMEOWNER'S HANDBOOK

— TO PREPARE FOR —
COASTAL HAZARDS



4TH EDITION, SEPTEMBER 2026