Mitigation Ideas
for Natural Hazards

Region 1, Boston, MA
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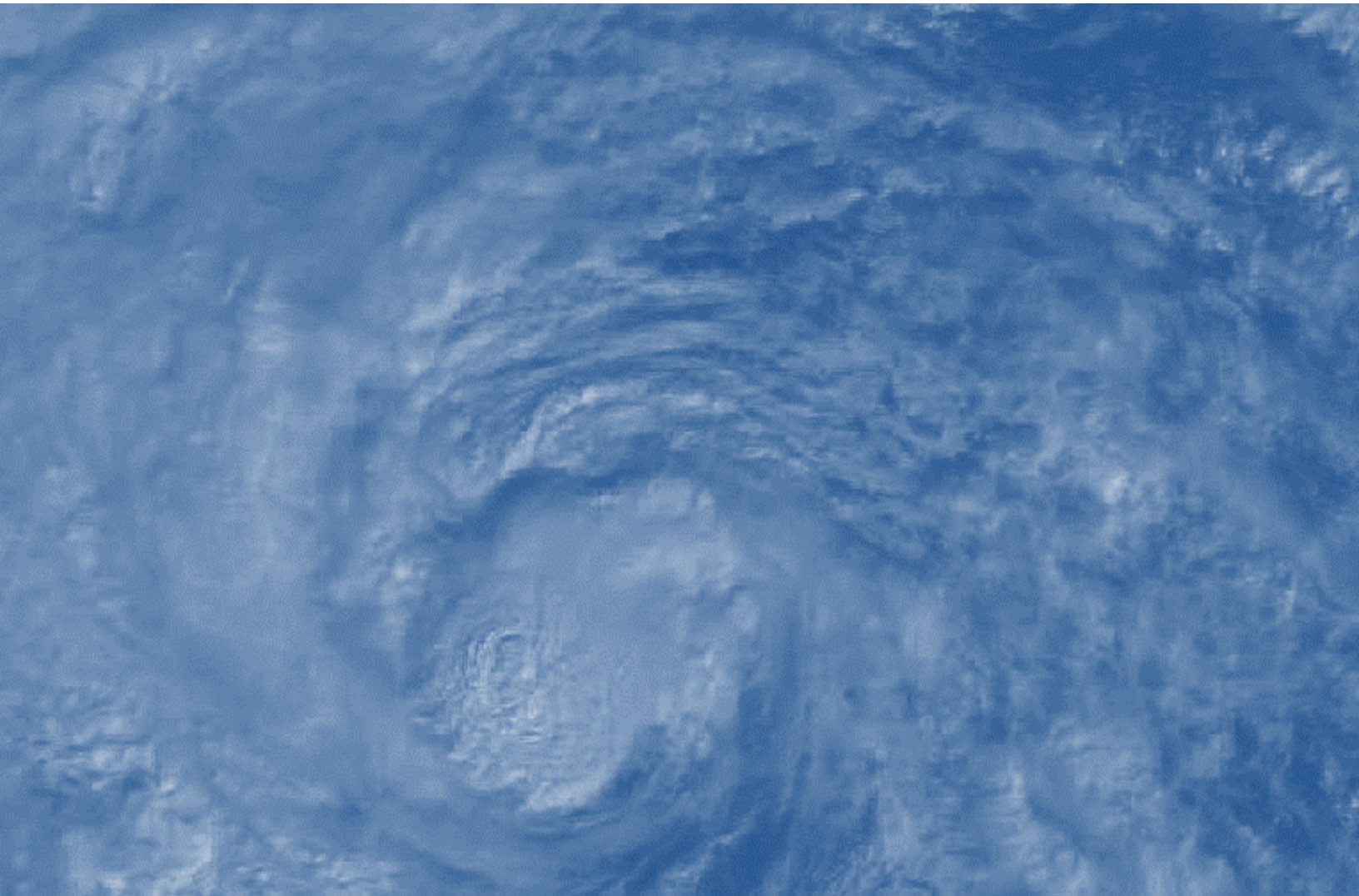
FEMA



Introduction

This document is intended for communities to use as a resource in identifying and evaluating potential mitigation actions for natural hazards and resulting disasters.

Mitigation is the focus, which are those actions taken to reduce or eliminate long-term risk to hazards. Mitigation is different from preparedness, which is action taken to improve emergency response or operational preparedness.

This document is intended to be a starting point for gathering ideas and should not be used as the only source for identifying actions. Communities should seek innovative and different ideas for reducing risk to meet their unique needs.

The actions listed are not necessarily eligible for Federal assistance programs. Users should review specific program guidance and contact their State Hazard Mitigation Officer (SHMO) or regional FEMA office for more information.

Cover photo:
Modified Advanced Scatterometer (ASCAT) image of winds around Hurricane Sandy, October 29, 2012. (Metop-A satellite)

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What is Mitigation?

Hazard Mitigation refers to any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazardous conditions.

The Ocean Side Inn in Scituate, MA was elevated in 2010 to protect against significant damages. FEMA Photo

The following list of possible hazard mitigation measures for communities is compiled from experience and discussion within the states of FEMA Region 1: Maine, Vermont, New Hampshire, Massachusetts, Connecticut, and Rhode Island. The list of hazard types and ideas starts generally with coverage of natural hazards such as flood or earthquake.

As extensive as this list is, it does not preclude other ideas for activities to save lives and prevent or reduce damages in the future. Many of the ideas are developed in other FEMA publications, including www.fema.gov, as well as in publications of other federal and state agencies.

Mitigation Action Requirements for Plan Approval

Source: Local Mitigation Plan Review Guide, October 1, 2011, page 24, Element C4.

a. The plan **must** include a mitigation strategy that 1) analyzes actions and/or projects that the jurisdiction considered to reduce the impacts of hazards identified in the risk assessment, and 2) identifies the actions and/or projects that the jurisdiction intends to implement.

Mitigation actions and projects *means a hazard mitigation action, activity or process (for example, adopting a building code) or it can be a physical project (for example, elevating structures or retrofitting critical infrastructure) designed to reduce or eliminate the long term risks from hazards.* This sub-element can be met with either actions or projects, or a combination of actions and projects.

The mitigation plan may include non-mitigation actions, such as actions that are emergency response or operational preparedness in nature. These will not be accepted as hazard mitigation actions, but neither will FEMA require these to be removed from the plan prior to approval.

A comprehensive range consists of different hazard mitigation alternatives that address the vulnerabilities to the hazards that the jurisdiction(s) determine are most important.

b. Each jurisdiction participating in the plan must have mitigation actions specific to that jurisdiction that are based on the community's risk and vulnerabilities, as well as community priorities.

c. The action plan **must** reduce risk to existing buildings and infrastructure as well as limit any risk to new development and redevelopment. **With emphasis on new and existing building and infrastructure** means that the action plan includes a consideration of actions that address the built environment.

A Sampling of Actions

Mitigation

- Planning
- Zoning
- Floodplain protection
- Property acquisition
- Relocation
- Public outreach projects

Preparedness (distinct from mitigation)

- Installing disaster warning systems
- Purchasing radio communications equipment
- Emergency response training

Mitigation for Multiple Natural Hazards

Shelf Cloud NOAA/NSSL Photo

Prevent Development in Hazard Areas. Limit or prohibit development in high-hazard areas through the following types of actions:

- Purchasing land and title in the name of a local governing body to remove structures and enforce permanent restrictions on development.
- Acquiring and using easements (e.g., conservation) to prevent development in known hazard areas.
- Using conservation easements to protect environmentally significant portions of parcels from development.
- Acquiring hazardous areas for conservation or restoring as functional public parks.
- Acquiring safe sites for public facilities (e.g., schools, police/fire stations, etc.).
- Prohibiting new facilities for persons with special needs/mobility concerns in hazard areas.
- Prohibiting animal shelters in known hazard areas.

Adopt Development Regulations in Hazard Areas. Regulate development in hazard areas. Examples include:

- Using subdivision and development regulations to regulate development in hazard-prone areas.
- Requiring setbacks from delineated hazard areas (e.g., shorelines, wetlands, steep slopes, etc.).
- Requiring conditional/special use permits for the development of known hazard areas.
- Offering expanded development rights to developers/businesses for performing mitigation retrofits.
- Incorporating restrictive covenants on properties located in known hazard areas.
- Designating high-risk zones as special assessment districts (to fund necessary hazard mitigation projects).

Limit Density in Hazard Areas. Limit the density of development in the hazard areas through the following techniques:

- Increasing minimum lot size for development in known hazard areas.
- Designating “agricultural use districts” in the zoning ordinance to limit densities in known hazard areas.
- Ensuring the zoning ordinance encourages higher densities only outside of known hazards areas.

- Requiring clustering for planned unit developments (PUD) in the zoning ordinance to reduce densities in known hazard areas.
- Establishing a local transfer of development rights (TDR) program for risk in known hazard areas.
- Establishing a process to use floating zones to reduce densities in damaged areas following a disaster event.

Strengthen Land Use Regulations. Land use regulations can reduce hazard risk through the following:

FEMA Photo

- Using bonus/incentive zoning to encourage mitigation measures for private land development.
- Using conditional use zoning to require or exact mitigation measures for private land development.
- Establishing a process to use overlay zones to require mitigation techniques in high-hazard districts.
- Adopting a post-disaster recovery ordinance based on a plan to regulate repair activity, generally depending on property location.
- Adopting environmental review standards.
- Incorporating proper species selection, planting, and maintenance practices into landscape ordinances.

Adopt and Enforce Building Codes. Building codes and inspections help ensure buildings can adequately withstand damage during hazard events. Effective actions include:

- Adopting the International Building Code (IBC) and International Residential Code (IRC).
- Increasing the local Building Code Effectiveness Grading Schedule (BCEGS) classification through higher building code standards and enforcement practices.
- Incorporating higher standards for hazard resistance in local application of the building code.
- Considering orientation of new development during design (e.g., subdivisions, buildings, infrastructure, etc.)
- Requiring standard tie-downs of propane tanks.
- Requiring tie-downs for all manufactured housing.
- Establishing moratorium procedures to guide the suspension of post-disaster reconstruction permits.

- Revising fire codes to limit hotel room occupancy to ensure timely evacuation of high-use and multi-floor structures.
- Establishing "value-added" incentives for hazard-resistant construction practices beyond code requirements.

Create Local Funding Mechanisms for Hazard Mitigation. Local funding resources can be developed through the following measures:

- Establishing a local reserve fund for public mitigation measures.
- Using impact fees to help fund public hazard mitigation projects related to land development (i.e., increased runoff).
- Requiring a development impact tax on new construction to mitigate the impacts of that development.
- Recruiting local financial institutions to participate in "good neighbor" lending for private mitigation practices.
- Providing local match to Federal funds that can fund private mitigation practices.

Incentivize Hazard Mitigation. Incentives and disincentives can be used to promote hazard mitigation through the following measures:

- Using special tax assessments to discourage builders from constructing in hazardous areas.
- Using insurance incentives and disincentives (i.e., incentives for best practices).
- Providing tax incentives for development of low-risk hazard parcels and to encourage infill development.
- Waiving permitting fees for home construction projects related to mitigation.
- Using tax abatements, public subsidies, and other incentives to encourage private mitigation practices.
- Reducing or deferring the tax burden for undeveloped hazard areas facing development pressure.

NOAA New Photo

Protect Structures. Damage to structures can be prevented through the following actions:

- Acquiring or relocating structures located in hazard areas.
- Moving vulnerable structures to a less hazardous location.
- Relocating or retrofitting public buildings located in high-hazard areas.
- Relocating or retrofitting endangered public housing units in high hazard areas.
- Retrofitting fire and police stations to become hazard resistant.
- Identifying and strengthening facilities to function as public shelters.

Protect Infrastructure and Critical Facilities. Infrastructure and critical facilities can be protected from damage by the following:

- Incorporating hazard mitigation principles into all aspects of public-funded building.
- Incorporating mitigation retrofits for public facilities into the annual capital improvements program.
- Engineering or retrofitting roads and bridges to withstand hazards.
- Relocating or undergrounding electrical infrastructure.
- Designing and building water tanks or wells for use in times of water outage.
- Installing quick-connect emergency generator hookups for critical facilities

Promote Private Mitigation Efforts. Encourage private mitigation efforts that address multiple hazards through the following:

- Using outreach programs to:
  1) Advise homeowners of risks to life, health, and safety;
  2) Facilitate technical assistance programs that address measures that citizens can take; or
  3) Facilitate funding for mitigation measures.
- Establishing, maintaining, and publicizing a library section on hazard mitigation techniques for local residents.
- Identifying and recruiting civic groups and volunteer agencies for community mitigation projects.
- Establishing a network for a business-to-business mitigation mentoring program.
- Offering hazard susceptibility audits of local small businesses.
- Completing a "demonstration model" showing use of hazard mitigation techniques for public display.
- Establishing a technical assistance program for residents to access data or resources for mitigation purposes.
- Educating the public on tradeoffs associated with multi-hazard design.

Mitigation Measures for Individual Hazards

Drought

FEMA Photo

Require mandatory water conservation measures during drought emergencies, including:

- Developing an ordinance to restrict the use of public water resources for non-essential usage, such as landscaping, washing cars, filling swimming pools, etc.
- Adopting ordinances to prioritize or control water use, particularly for emergency situations like firefighting.

Improve water supply and delivery systems to save water through actions such as:

- Designing water delivery systems to accommodate drought events.
- Developing new or upgrading existing water delivery systems to eliminate breaks and leaks.

Encourage drought tolerant landscape design through measures such as:

- Incorporating drought tolerant or xeriscape practices into landscape ordinances to reduce dependence on irrigation.
- Providing incentives for xeriscaping.
- Using permeable driveways and surfaces to reduce runoff and promote groundwater recharge.

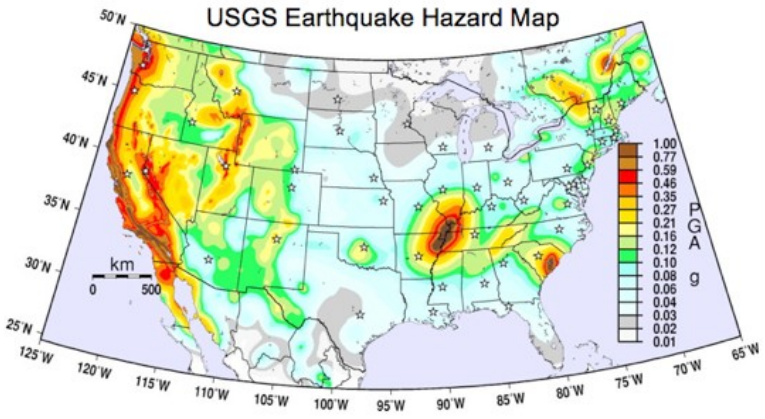
Earthquake

Building codes reduce earthquake damage to structures. Consider actions such as:

- Adopting and/or enforcing updated building code provisions to reduce earthquake damage risk.
- Adopting and/or enforcing the International Building Code (IBC) and International Residential Code (IRC).

Reduce potential damage to critical facilities and infrastructure from future seismic events through actions such as:

- Conducting seismic retrofitting for critical public facilities most at risk to earthquakes.
- Requiring bracing of generators, elevators, and other vital equipment in hospitals.
- Identifying and hardening critical lifeline systems (i.e., critical public services such as utilities and roads) to meet "Seismic Design Guidelines and Standards for Lifelines" or equivalent standards such as American Lifelines Alliance (ALA) guidance. This may distinguish a manageable earthquake from a social and economic catastrophe.
- Reviewing construction plans for all bridges to determine their susceptibility to collapse and retrofitting problem bridges.
- Using flexible piping when extending water, sewer, or natural gas service.
- Installing shutoff valves and emergency connector hoses where water mains cross fault lines.



Use structural mitigation measures to reduce damage from future seismic events, such as:

- Strengthening and retrofitting non-reinforced masonry buildings and non-ductile concrete facilities that are particularly vulnerable to ground shaking.
- Retrofitting building veneers to prevent failure.
- Building a safe room to provide protection during an earthquake.
- Installing window film to prevent injuries from shattered glass.
- Anchoring rooftop-mounted equipment (i.e., HVAC units, satellite dishes, etc.).

- Constructing masonry chimneys greater than 6 feet above a roof with continuous reinforced steel bracing.

There are many ways to increase awareness of earthquake risk, including:

- Working with insurance industry representatives to increase public awareness of the importance of earthquake insurance. Residential structural improvements can be factored into the process of obtaining insurance coverage or reduced deductibles.
- Developing an outreach program about earthquake risk and mitigation activities in homes, schools, and businesses.
- Educating homeowners on safety techniques to follow during and after an earthquake.
- Offering GIS hazard mapping online for residents and design professionals.

Building susceptibility to earthquake damage can be improved if design professionals are made aware of proper design and building requirements. Outreach activities include:

- Conducting information sessions or other forms of outreach on seismic code provisions for new and existing buildings to enhance code use and enforcement by local architects, engineers, contractors, and code enforcement personnel.

Property owners can retrofit existing structures to reduce damage from seismic events. Potential actions include the following:

- Educating homeowners about structural and nonstructural retrofitting of vulnerable homes and encouraging retrofit.
- Developing a technical assistance information program for homeowners. Teaching them how to seismically strengthen their houses can be an effective mitigation activity. The program can include providing local government building departments with copies of existing strengthening and repair information for distribution.
- Developing an outreach program to encourage homeowners to secure furnishings, storage cabinets, and utilities to prevent injuries and damage. Examples include anchoring tall bookcases and file cabinets, installing latches on drawers and cabinet doors, restraining desktop computers and appliances, using flexible connections on gas and water lines, mounting framed pictures and mirrors securely, and anchoring and bracing propane tanks and gas cylinders.
- Establishing a library of technical documents on structural and nonstructural mitigation options as well as model ordinances and procedures that have been used by other jurisdictions to reduce earthquake risk.

Erosion

Erosion damage can be mitigated by regulating how development occurs in hazard areas, such as the following:

- Adopting sediment and erosion control regulations.
- Adopting zoning and erosion overlay districts.
- Developing an erosion protection program for high hazard areas.
- Employing erosion control easements.
- Prohibiting development in high-hazard areas.
- Developing and implementing an erosion management plan.
- Requiring mandatory erosion surcharges on homes.
- Locating utilities and critical facilities outside of areas susceptible to erosion to decrease the risk of service disruption.

Structure and Infrastructure Projects:

- Remove existing buildings and infrastructure from erosion hazard areas. To prevent damage to buildings and infrastructure from erosion, consider acquiring and demolishing or relocating at-risk buildings and infrastructure and enforcing permanent restrictions on development after land and structure acquisition.

To stabilize slopes susceptible to erosion, consider options such as:

- Preventing erosion with proper bank stabilization, sloping or grading techniques, planting vegetation on slopes, terracing hillsides, or installing riprap boulders or geotextile fabric.
- Stabilizing cliffs with terracing or plantings of grasses or other plants to hold soil together.
- Prohibiting removal of natural vegetation from dunes and slopes.
- Planting mature trees in the coastal riparian zone to assist in dissipation of the wind force in the breaking wave zone.
- Using a hybrid of hard/soft engineering techniques (i.e., combine low-profile rock, rubble, oyster reefs, or wood structures with vegetative planting or other soft stabilization techniques).
- Implementing marine riparian habitat reinstatement or revegetation.
- Using a rock splash pad to direct runoff and minimize the potential for erosion.
- Using bioengineered bank stabilization techniques.

Consider ways to help citizens become more aware of specific erosion risks in your area, such as:

- Notifying property owners located in high-risk areas.
- Disclosing the location of high-risk areas to buyers.

- Developing a brochure describing risk and potential mitigation techniques.
- Offering GIS hazard mapping online for residents and design professionals.

Extreme Temperatures

As urban areas develop and buildings and roads replace open land and vegetation, urban regions become warmer than their rural surroundings, forming an "island" of heat. Several methods for reducing heat island effects include:

- Increasing tree plantings around buildings to shade parking lots and along public rights-of-way.
- Encouraging installation of green roofs, which provide shade and remove heat from the roof surface and surrounding air.
- Using cool roofing products that reflect sunlight and heat away from a building.

Measures should be taken to ensure vulnerable populations are adequately protected from the impacts of extreme temperatures, such as:

- Organizing outreach to vulnerable populations, including establishing and promoting accessible heating or cooling centers in the community.
- Requiring minimum temperatures in housing/landlord codes.
- Encouraging utility companies to offer special arrangements for paying heating bills, if not already required by state law.
- Creating a database to track those individuals at high risk of death, such as the elderly, homeless, etc.

Extreme cold may cause water pipes to freeze and burst, which can cause flooding inside a building. Ideas for educating property owners include the following:

- Educating homeowners and builders on how to protect their pipes, including locating water pipes on the inside of building insulation or keeping them out of attics, crawl spaces, and vulnerable outside walls.
- Informing homeowners that letting a faucet drip during extreme cold weather can prevent the buildup of excessive pressure in the pipeline and avoid bursting.

Flood

Comprehensive planning and floodplain management can mitigate flooding by influencing development. Strategies include:

- Determining and enforcing acceptable land uses to alleviate the risk of damage by limiting exposure in flood hazard areas. Floodplain and coastal zone management can be included in comprehensive planning.
- Mitigating hazards during infrastructure planning. For example, decisions to extend roads or utilities to an area may increase exposure to flood hazards.
- Adopting a post-disaster recovery ordinance based on a plan to regulate repair activity, generally depending on property location.
- Passing and enforcing an ordinance that regulates dumping in streams and ditches.
- Establishing a "green infrastructure" program to link, manage, and expand existing parks, preserves, greenways, etc.
- Obtaining easements for planned and regulated public use of privately-owned land for temporary water retention and drainage.

Flooding in Shapleigh, Maine during May 2006 FEMA Photo

Flooding can be mitigated by limiting or restricting how development occurs in floodplain areas through actions such as:

- Prohibiting or limiting floodplain development through regulatory and/or incentive-based measures.
- Limiting the density of developments in the floodplain.
- Requiring that floodplains be kept as open space.
- Limiting the percentage of allowable impervious surface within developed parcels.
- Developing a stream buffer ordinance to protect water resources and limit flood impacts.
- Prohibiting any fill in floodplain areas.

The use of building codes and development standards can ensure structures are able to withstand flooding. Potential actions include:

- Adopting the International Building Code (IBC) and International Residential Code (IRC).
- Adopting ASCE 24-05 Flood Resistant Design and Construction. ASCE 24 is a referenced standard in the IBC that specifies minimum requirements and expected performance for the design and construction of buildings and structures in the flood hazard areas to make them more resistant to flood loads and flood damage.
- Adding or increasing "freeboard" requirements (feet above base flood elevation) in the flood damage ordinance.
- Prohibiting all first floor enclosures below base flood elevation for all structures in flood hazard areas.
- Considering orientation of new development during design (e.g., subdivisions, buildings, infrastructure, etc.).
- Setting the design flood elevation at or above the historical high water mark if it is above the mapped base flood elevation.
- Using subdivision design standards to require elevation data collection during platting and to have buildable space on lots above the base flood elevation.
- Requiring standard tie-downs of propane tanks.

Rainwater and snowmelt can cause flooding and erosion in developed areas. Stormwater management practices to prevent this include:

- Completing a stormwater drainage study for known problem areas.
- Preparing and adopting a stormwater drainage plan and ordinance.
- Preparing and adopting a community-wide stormwater management master plan.
- Regulating development in upland areas in order to reduce stormwater runoff through a stormwater ordinance.
- Developing engineering guidelines for drainage from new development.
- Requiring a drainage study with new development.

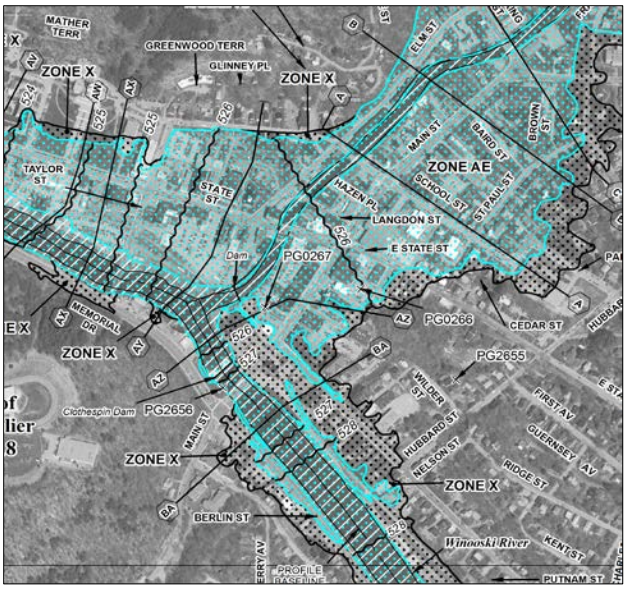
In addition to stormwater management, techniques to reduce rain runoff can prevent flooding and erosion, such as:

- Designing a "natural runoff" or "zero discharge" policy for stormwater in subdivision design.
- Requiring more trees be preserved and planted in landscape designs to reduce the amount of stormwater runoff.
- Requiring developers to plan for on-site sediment retention.
- Requiring developers to construct on-site retention basins for excessive stormwater and as a firefighting water source.

- Encouraging the use of porous pavement, vegetative buffers, and islands in large parking areas.
- Conforming pavement to land contours so as not to provide easier avenues for stormwater.
- Encouraging the use of permeable driveways and surfaces to reduce runoff and increase groundwater recharge.
- Adopting erosion and sedimentation control regulations for construction and farming.

The National Flood Insurance Program (NFIP) enables property owners in participating communities to purchase insurance protection against flood losses. Actions to achieve eligibility and maintain compliance include:

- Participating in NFIP.
- Adopting ordinances that meet minimum Federal and state requirements to comply with NFIP.
- Conducting NFIP community workshops to provide information and incentives for property owners to acquire flood insurance.
- Designating a local floodplain manager and/or CRS coordinator who achieves CFM certification.
- Completing and maintaining FEMA elevation certificates for pre-FIRM and/or post-FIRM buildings.
- Requiring and maintaining FEMA elevation certificates for all new and improved buildings located in floodplains.



Flood Insurance Rate Map (FIRM) superimposed on satellite imagery.

In addition to participation in NFIP, implementing good floodplain management techniques that exceed minimum requirements can help minimize flood losses. Examples include:

- Incorporating the ASFPM's "No Adverse Impact" policy into local floodplain management programs.
- Revising the floodplain ordinance to incorporate cumulative substantial damage requirements.
- Adopting a "no-rise" in base flood elevation clause for the flood damage prevention ordinance.
- Extending the freeboard requirement past the mapped floodplain to include an equivalent land elevation.
- Including requirements in the local floodplain ordinance for homeowners to sign non-conversion agreements for areas below base flood elevation.

- Establishing and publicizing a user friendly, publicly accessible repository for inquirers to obtain Flood Insurance Rate Maps.
- Developing an educational flyer targeting NFIP policyholders on increased cost of compliance during post-flood damage assessments.
- Annually notifying the owners of repetitive loss properties of Flood Mitigation Assistance funding.
- Offering incentives for building above the required freeboard minimum (code plus).

The Community Rating System (CRS) rewards communities that exceed the minimum NFIP requirements. Depending upon the level of participation, flood insurance premium rates are discounted for policyholders. Potential activities that are eligible to receive credit include:

- Advising the public about the local flood hazard, flood insurance, and flood protection measures.
- Enacting and enforcing regulations that exceed NFIP minimum standards so that more flood protection is provided for new development.
- Implementing damage reduction measures for existing buildings such as acquisition, relocation, retrofitting, and maintenance of drainage-ways and retention basins.

Damaged Homes were acquired after a 1998 flood on the New Haven River in Bristol, VT. FEMA Photo

Remove Existing Structures from Flood Hazard Areas

- Communities may remove structures from flood-prone areas to minimize future flood losses by acquiring and demolishing or relocating structures from voluntary property owners and preserving lands subject to repetitive flooding.

Rainwater and snowmelt can cause flooding and erosion in developed areas. Structural stormwater management projects that prevent this include:

- Installing, re-routing, or increasing the capacity of a storm drainage system.
- Increasing drainage or absorption capacities with detention and retention basins, relief drains, spillways, drain widening/dredging or rerouting, logjam and debris removal, extra culverts, bridge modification, dike setbacks, flood gates and pumps, or channel redirection.
- Increasing capacity of stormwater detention and retention basins.
- Increasing dimensions of drainage culverts in flood prone areas.

- Using stream restoration to ensure adequate drainage and diversion of stormwater.
- Requiring developers to construct on-site retention basins for excessive stormwater and as a firefighting water source.
- Providing grassy swales along roadsides.

Drainage Systems & Flood Control Structures:

- Implementing an inspection and enforcement program to help ensure continued structural integrity of dams and levees.
- Incorporating ice jam prevention techniques as appropriate.

Structures and utilities can be elevated to reduce flood damage, including:

- Elevating structures so that the lowest floor, including the basement, is raised above the base flood elevation.
- Raising utilities or other mechanical devices above expected flood levels.
- Elevating and anchoring manufactured homes or, preferably, keeping manufactured homes out of the floodplain.
- Relocating utilities and water heaters above base flood elevation and using tank-less water heaters in limited spaces.

Flood proofing techniques may protect certain structures from flood damage, including:

- Wet flood proofing in a basement, which may be preferable to attempting to keep water out completely because it allows for controlled flooding to balance exterior and interior wall forces and discourages structural collapse.
- Encouraging wet flood proofing of areas above base flood elevation.
- Using water resistant paints or other materials to allow for easy cleanup after floodwater exposure in accessory structures or in a garage area below an elevated residential structure.
- Dry flood proofing non-residential structures by strengthening walls, sealing openings, or using waterproof compounds or plastic sheeting on walls to keep water out.

Techniques to protect critical facilities from flood events include:

- Requiring that all critical facilities including emergency operations centers (EOC), police stations, and fire department facilities be located outside of flood-prone areas.
- Requiring all critical facilities to meet requirements of Executive Order 11988 and be built 1 foot above the 500-year flood elevation.
- Installing/upgrading stormwater pumping stations.
- Raising electrical components of sewage lift stations above base flood elevation.
- Raising manhole openings using concrete pillars.
- Installing watertight covers or inflow guards on sewer manholes.
- Installing flood telemetry systems in sewage lift stations.

- Installing backup generators for pumping and lift stations in sanitary sewer systems along with other measures (e.g., alarms, meters, remote controls, and switchgear upgrades).
- Building earthen dikes around flood-threatened critical facilities.
- Using bioengineered bank stabilization techniques.

Road flood damage in Essex, VT during May 2013
FEMA Photo

Mitigation techniques can be implemented to help minimize losses to infrastructure from flood events, such as:

- Elevating roads and bridges above the base flood elevation to maintain dry access. In situations where flood waters tend to wash roads out, construction, reconstruction, or repair can include not only attention to drainage, but also stabilization or armoring of vulnerable shoulders or embankments.
- Raising low-lying bridges.
- Flood proofing wastewater treatment facilities located in flood hazard areas.
- Flood proofing water treatment facilities located in flood hazard areas.
- Depending on its infrastructure capabilities, using check valves, sump pumps, and backflow prevention devices in homes and other buildings.
- Using bioengineered bank stabilization techniques.

Small flood control structures can be built to prevent flood damage. Examples include:

- Using minor structural projects that are smaller and more localized (e.g., floodwalls or small berms) in areas that cannot be mitigated through non-structural activities or where structural activities are not feasible due to low densities.
- Using revetments (hardened materials placed atop existing riverbanks or slopes) to protect against floods.
- Using bioengineered bank stabilization techniques.

Natural resources provide floodplain protection, riparian buffers, and other ecosystem services that mitigate flooding. It is important to preserve such functionality with the following:

- Protecting and enhancing landforms that serve as natural mitigation features (i.e., riverbanks, wetlands, dunes, etc.).
- Using vegetative management, such as vegetative buffers, around streams and water sources.

Beach grass plantings on dune areas. USFWS Photos

- Protecting and preserving wetlands to help prevent flooding in other areas.
- Establishing and managing riparian buffers along rivers and streams.
- Retaining natural vegetative beds in stormwater channels.
- Retaining thick vegetative cover on public lands flanking rivers.

Preserving natural areas and vegetation benefits natural resources while also mitigating potential flood losses. Techniques include:

- Developing an open space acquisition, reuse, and preservation plan targeting hazard areas.
- Developing a land banking program for the preservation of the natural and beneficial functions of flood hazard areas.
- Using transfer of development rights to allow a developer to increase densities on another parcel that is not at risk in return for keeping floodplain areas vacant.
- Compensating an owner for partial rights, such as easement or development rights, to prevent a property from being developed.

Ideas for increasing flood risk awareness include the following:

- Encouraging homeowners to purchase flood insurance by the distribution of NFIP information publications.
- Establishing a Program for Public Information (PPI) with a PPI committee (as suggested by Activity 332 of the CRS Coordinator's Manual).

Educate property owners regarding options for mitigating their properties from flooding through outreach activities such as:

- Educating the public about securing debris, propane tanks, yard items, or stored objects that may otherwise be swept away, damaged, or pose a hazard if picked up and washed away by floodwaters.
- Educating homeowners about installing backflow valves to prevent reverse-flow flood damages.
- Using outreach activities to facilitate technical assistance programs that address measures that citizens can take or facilitate funding for mitigation measures.

NOTE: Public education publications related to flood hazard mitigation may be available from FEMA.

Hail

NOAA Photo

Locate tornado safe rooms inside or directly adjacent to houses to prevent hail-induced injuries that may occur when taking shelter during a severe thunderstorm.

NOAA/NSSL Photo

For new construction as well as retrofitting existing buildings, techniques to minimize hail damage include:

- Including measures such as structural bracing, shutters, laminated glass in window panes, and hail-resistant roof coverings or flashing in building design to minimize damage.
- Improving roof sheathing to prevent hail penetration.
- Installing hail resistant roofing and siding.

Landslide

Improve data and mapping on specific landslide risks in the community by:

- Studying areas where riparian landslides may occur.
- Completing an inventory of locations where critical facilities, other buildings, and infrastructure are vulnerable to landslides.
- Using GIS to identify and map landslide hazard areas.
- Developing and maintaining a database to track community vulnerability to landslides.

- Assessing vegetation in wildfire-prone areas to prevent landslides after fires (e.g., encourage plants with strong root systems).

FEMA Photo

Landslide risk can be mitigated by regulating development in landslide hazard areas through actions such as:

- Defining steep slope/high-risk areas in land use and comprehensive plans and creating guidelines or restricting new development in those areas.
- Creating or increasing setback limits on parcels near high-risk areas.
- Locating utilities outside of landslide areas to decrease the risk of service disruption.
- Restricting or limiting industrial activity that would strip slopes of essential top soil.
- Incorporating economic development Activity restrictions in high-risk areas.

To prevent roadway damage and traffic disruptions from landslides, consider options such as:

- Implementing monitoring mechanisms/procedures (i.e., visual inspection or electronic monitoring systems).
- Applying soil stabilization measures, such as planting soil-stabilizing vegetation on steep, publicly-owned slopes.
- Using debris-flow measures that may reduce damage in sloping areas, such as stabilization, energy dissipation, and flow control measures.
- Establishing setback requirements and using large setbacks when building roads near slopes of marginal stability.
- Installing catch-fall nets for rocks at steep slopes near roadways.

To help mitigate landslide hazards, communities can acquire and demolish or relocate at-risk buildings and infrastructure and enforce permanent restrictions on development after land and structure acquisition.

Lightning

NWS Photo

Protect critical facilities and infrastructure from lighting damage with the following measures:

- Installing lightning protection devices and methods, such as lightning rods and grounding, on communications infra-structure and other critical facilities.
- Installing and maintaining surge protection on critical electronic equipment.

Sea Level Rise

To better understand and assess local vulnerability to sea level rise, consider actions such as:

- Modeling various "what-if" scenarios to estimate potential vulnerabilities in order to develop sea level rise mitigation priorities.

Boston Harbor skyline FEMA Photo

- Using GIS to map hazard areas, at risk structures, and associated hazards (e.g., flood and storm surge) to assess high-risk areas.
- Developing an inventory of public buildings and infrastructure that may be particularly vulnerable to sea level rise.
- Adding future conditions hydrology and areas that may be inundated by sea level rise to Digital Flood Insurance Rate Maps (DFIRM).

Local governments can mitigate future losses resulting from sea level rise by regulating development in potential hazard areas through land use planning, including:

- Using zoning, subdivision regulations, and/or a special sea level rise overlay district to designate high-risk areas and specify the conditions for the use and development of specific areas.
- Conservation and management of open space, wetlands, and/or sea level rise boundary zones to separate developed areas from high-hazard areas.
- Prohibiting the redevelopment of areas destroyed by storms or chronic erosion in order to prevent future losses.
- Establishing setbacks in high-risk areas that account for potential sea level rise.

Future development can be protected from damage resulting from sea level rise through the following:

- Setting guidelines for annexation and service extensions in high-risk areas.
- Locating utilities and critical facilities outside of areas susceptible to sea level rise to decrease the risk of service disruption.
- Requiring all critical facilities to be built 1 foot above the 500-year flood elevation (considering wave action) or the predicted sea level rise level, whichever is higher.

Existing structures, infrastructure, and critical facilities can be protected from sea level rise through the following:

- Acquiring and demolishing or relocating structures located in high-risk areas.
- Retrofitting structures to elevate them above potential sea level rise levels.
- Retrofitting critical facilities to be 1 foot above the 500-year flood elevation (considering wave action) or the predicted sea level rise level, whichever is higher.
- Replacing exterior building components with more hazard-resistant materials.

Elevated homes on Connecticut coastline FEMA Photo

Preserve open space to benefit natural resources and to reduce risk to structures from potential sea level rise. Techniques include:

- Developing an open space acquisition, reuse, and preservation plan targeting hazard areas.
- Developing a land banking program for the preservation and management of the natural and beneficial functions of flood hazard areas.

- Adopting rolling easements along the shoreline to promote natural migration of shorelines.
- Using transfer of development rights to allow a developer to increase densities on another parcel that is not at risk in return for keeping floodplain areas vacant.
- Compensating an owner for partial rights, such as easement or development rights, to prevent a property from being developed.

Damaged house on barrier beach following Hurricane Sandy
Westerly, RI - November 2012 FEMA Photo

Natural resources provide floodplain protection, riparian buffers, and other ecosystem services that mitigate sea level rise. It is important to preserve such functionality with the following:

- Examining the appropriate use of beach nourishment, sand scraping, dune-gap plugs, etc., for coastal hazards.
- Implementing dune restoration, plantings (e.g., sea oats), and use of natural materials.
- Examining the appropriate use of sediment-trapping vegetation, sediment mounds, etc., for coastal hazards.
- Planting sediment-trapping vegetation to buffer the coast against coastal storms by collecting sediment in protective features such as dunes or barrier islands.
- *Performing sand scraping—using bulldozers to deposit the top foot of sand above the high-tide line—to reinforce the beach without adding new sand.
  [*This action may require an Environmental Impact Review prior to initiation.]
- Using sediment mounds to act as artificial dunes or plugs for natural dune gaps in order to slow the inland progress of storm-related wind and water.

Improve public awareness of risks due to sea level rise through outreach activities such as:

- Encouraging homeowners to purchase flood insurance by making NFIP publications available to the public. These publications can be obtained from FEMA at no cost.
- Using outreach programs to facilitate technical assistance programs that address measures that citizens can take or facilitate funding for mitigation measures.
- Offering GIS hazard mapping online for residents and design professionals.
- Disclosing the location of possible sea level rise areas to potential buyers.

Sea level rise-related mitigation actions may also apply to other hazards. Climate change is likely to exacerbate the effects of a variety of hazards. See the sections entitled “Flood,” “Storm Surge,” “Erosion,” and “Mitigation for Multiple Natural Hazards” for additional ideas.

Severe Wind

Hurricane Isabel NASA Image

Adopt regulations governing residential construction to prevent wind damage. Examples of appropriate regulations are:

- Adopting the International Building Code (IBC) and International Residential Code (IRC).
- Adopting standards from International Code Council (ICC) 600 Standard for Residential Construction in High Wind Regions.
- Reviewing building codes and structural policies to ensure they are adequate to protect older structures from wind damage.
- Requiring wind engineering measures and construction techniques that may include structural bracing, straps and clips, anchor bolts, laminated or impact-resistant glass, reinforced pedestrian and garage doors, window shutters, waterproof adhesive sealing strips, or interlocking roof shingles.
- Requiring tie-downs with anchors and ground anchors appropriate for the soil type for manufactured homes.
- Prohibiting the use of carports and open coverings attached to manufactured homes.
- Requiring the use of special interlocking shingles designed to interlock and resist uplift forces in extreme wind conditions to reduce damage to a roof or other structures.
- Improving nailing patterns.
- Requiring building foundation design, braced elevated platforms, and protections against the lateral forces of winds and waves.
- Requiring new masonry chimneys greater than 6 feet above a roof to have continuous reinforced steel bracing.
- Requiring structures on temporary foundations to be securely anchored to permanent foundations.

Promote or Require Site and Building Design Standards to Minimize Wind Damage. Damage associated with severe wind events can be reduced or prevented if considered during building and site design. Examples include the following:

- Using natural environmental features as wind buffers in site design.
- Incorporating passive ventilation in the building design.

- Incorporating passive ventilation in the site design. Passive ventilation systems use a series of vents in exterior walls or at exterior windows to allow outdoor air to enter the home in a controlled way.
- Encouraging architectural designs that limit potential for wind-borne debris.
- Improving architectural design standards for optimal wind conveyance.
- Encouraging wind-resistant roof shapes (e.g., hip over gable).

In order to better understand and assess local vulnerability to severe wind, consider actions such as:

- Developing and maintaining a database to track community vulnerability to severe wind.
- Using GIS to map areas that are at risk to the wind hazard associated with different hurricane conditions (e.g., Category 1, 2, 3, etc.) and to identify concentrations of at-risk structures.
- Creating a severe wind scenario to estimate potential loss of life and injuries, the types of potential damage, and existing vulnerabilities within a community to develop severe wind mitigation priorities.
- Using HAZUS to quantitatively estimate potential losses from hurricane wind.

Protect Power Lines and Infrastructure

- Burying power lines to provide uninterrupted power after severe winds, considering both maintenance and repair issues.
- Upgrading overhead utility lines (e.g., adjust utility pole sizes, utility pole span widths, and/or line strength).
- Using designed failure mode for power line design to allow lines to fall or fail in small sections rather than as a complete system to enable faster restoration.
- Installing redundancies and loop-feeds.

Wind damage following Hurricane Irene in Narragansett, RI during August 2011. FEMA Photo

The following types of modifications or retrofits to existing residential buildings can reduce future wind damage:

- Improving the building envelope.
- Installing hurricane shutters or other protective measures.
- Retrofitting gable end walls to eliminate wall failures in high winds.
- Replacing existing non-ductile infrastructure with ductile infrastructure to reduce their exposure to hazardous events.
- Retrofitting buildings with load-path connectors to strengthen the structural frames.
- Installing safe rooms.
- Reinforcing garage doors.
- Inspecting and retrofitting roofs to adequate standards to provide wind resistance.

Public buildings and critical facilities can be retrofitted to reduce future wind damage with the following actions:

- Improving roof coverings (e.g., no pebbles, remove ballast roof systems).
- Anchoring roof-mounted heating, ventilation, and air conditioning units.
- Retrofitting buildings with load-path connectors to strengthen the structural frames.
- Retrofitting or constructing the emergency operations center to FEMA 361 standards.
- Avoiding placing flag poles or antennas near buildings.
- Upgrading and maintaining existing lightning protection systems to prevent roof cover damage.
- Requiring upgrading of reused buildings that will house critical facilities.
- Protecting traffic lights and other traffic controls from high winds.
- Converting traffic lights to mast arms.

Improve public awareness of severe wind through outreach activities such as:

- Educating homeowners on the benefits of wind retrofits such as shutters, hurricane clips, etc.
- Instructing property owners on how to properly install temporary window coverings before a storm.
- Educating design professionals to include wind mitigation during building design.

Severe wind-related mitigation actions may also apply to other hazards. See the sections entitled “Mitigation for Multiple Natural Hazards” and “Tornadoes” for additional ideas.

Severe Winter Weather

Major snowstorm during 2015 in Boston, MA FEMA Photo

Buildings and infrastructure can be protected from the impacts of winter storms with the following regulations:

- Ensuring the development and enforcement of building codes for roof snow loads.
- Adopting the International Building Code (IBC) and International Residential Code (IRC).

Buildings and infrastructure can be protected from the impacts of winter storms with the following techniques:

- Adding building insulation to walls and attics.
- As buildings are modified, using new technology to create or increase structural stability.
- Retrofitting public buildings to withstand snow loads and prevent roof collapse.

Power lines can be protected from the impacts of winter storms with the following techniques:

- Establishing standards for all utilities regarding tree pruning around lines.
- Burying overhead power lines.
- Using designed-failure mode for power line design to allow lines to fall or fail in small sections rather than as a complete system to enable faster restoration.
- Installing redundancies and loop-feeds.

Massachusetts ice storm damage, Worcester County, 2008
FEMA Photo

The leading cause of death during winter storms is from automobile or other transportation accidents, so it is important to consider ways to lessen roadway impacts. Potential strategies include:

- *Using snow fences or "living snow fences" (e.g., rows of trees or other vegetation) to limit blowing and drifting of snow over critical roadway segments. [*If not permanent, this is not mitigation. BUT permanent snow fences MAY require environmental reviews.]
- Installing roadway heating technology to prevent ice/snow buildup.

Public awareness of severe winter storms can be improved through the following efforts:

- Educating homeowners of the importance of installing carbon monoxide monitors and alarms.
- Educating citizens that all fuel-burning equipment should be vented to the outside.

Snow storm, Boston, MA 2008 FEMA Photo

Protect vulnerable populations from the impacts of severe winter storms through the following efforts:

- Step One: Identifying specific at-risk populations that may be exceptionally vulnerable in the event of long-term power outages.
- Step Two: Organizing outreach to vulnerable populations, including establishing and promoting accessible heating centers in the community.

Winter weather-related mitigation actions may also apply to other hazards.
See the sections entitled "Extreme Temperatures" and "Mitigation for Multiple Natural Hazards" for additional ideas.

Storm Surge

Building codes and development standards can be established to mitigate storm surge damage. Possible regulations include:

- Adopting the International Building Code (IBC) and International Residential Code (IRC).
- Adopting ASCE-24-05 Flood Resistant Design and Construction. ASCE 24, created by the American Society of Civil Engineers, is a referenced standard in the IBC that specifies minimum requirements and expected performance for the design and

Elevation project on an existing building
FEMA Photo

construction of buildings and structures in flood hazard areas to make them more resistant to flood loads and flood damage.

- Establishing design standards for buildings located in areas susceptible to storm surge.
- Implementing V-zone construction requirements for new development located in coastal A-zones.
- Adopting building requirements for higher elevation in inundation zones.
- Requiring open foundations (e.g., piles or piers) in coastal areas.
- Requiring deep foundations in order to avoid erosion and scour.

Land uses should be planned and regulated to minimize the impact of storm surge. Possible measures to implement include:

Aftermath of Hurricane Sandy storm surge on Misquamicut Beach, Westerly, RI, November 2012 FEMA Photo

- Developing and maintaining a beach management plan.
- Adopting shoreline setback regulations and establishing coastal setback lines.
- Adopting coastal zone management regulations.
- Eliminating all obstructions in areas along the coast subject to inundation by the 1-percent-annual-chance flood event with additional hazards associated with storm-induced waves (also known as the V-zone).
- Limiting or prohibiting development in areas along the coast subject to inundation by the 1-percent-annual-chance flood event with additional hazards associated with storm-induced waves (referred to as the V-zone on Flood Insurance Rate Maps).
- Adopting coastal A-zones, areas of special flood hazard that extend inland and are subject to breaking waves between 1.5 and 3 feet, and ensuring that they are mapped accurately.
- Adopting and enforcing coastal A-zones in A-zones.

Infrastructure and critical facilities can be protected from storm surge damage through the following:

- Locating future critical facilities outside of areas susceptible to storm surge.
- Requiring that all critical facilities meet requirements of Executive Order 11988 and be built 1 foot above the 500-year flood elevation (considering wave action).

Map and Assess Vulnerability to Storm Surge. Storm surge risk can be better assessed and monitored with mapping techniques, including the following:

- Using GIS to map areas that are at risk to inundation by storm surge.
- Developing and maintaining a database to track community vulnerability to storm surge.

Storm surge can move buildings off foundations. Westerly, RI 2012 FEMA Photo

Structural controls can be used to lessen the impact of storm surge. Examples include the following:

- Constructing groins to capture material along the shoreline in order to trap and retain sand.
- Installing geotextile sand tubes to trap sand or protect beachfront properties.
- Building a coastal berm to absorb waves and protect the shoreline from erosion.
- Building a storm berm to keep rock protection in place and provide a slow supply of sediment to the coastal system.

Infrastructure and critical facilities can be protected from damage by storm surge through the following:

- Reorienting near-shore roads so they are parallel (not perpendicular) to the beach to prevent the channelization of storm surge and wind inland.
- Constructing seawalls or other structures to protect critical facilities located on the shoreline.
- Relocating existing vulnerable critical facilities outside of high-risk areas.

Protect and Restore Natural Buffers. Natural resources provide floodplain protection, riparian buffers, and other ecosystem services that mitigate storm surge risk. It is important to preserve such functionality with the following:

- Implementing dune restoration, plantings (e.g., sea oats), and use of natural materials.

- Planting sediment-trapping vegetation to make the coast more resistant to coastal storms by collecting sediment in protective features such as dunes or barrier islands.
- *Performing sand scraping—using bulldozers to deposit the top foot of sand above the high-tide line—to reinforce the beach without adding new sand.
  [*Illegal is some states – or may require an Environmental Impact Report (EIR).]
- Using sediment mounts to act as artificial dunes or plugs for natural dune gaps in order to slow the inland progress of storm-related wind and water.

Provide Information on High-Risk Areas. Increase public awareness of storm surge risk through the following actions:

- Offering GIS hazard mapping online for residents and design professionals.
- More accurately mapping problem areas to educate residents about unanticipated risks. Upgrading maps provides a truer measure of risks to a community.
- Educating property owners in high-risk areas about mitigation options.

Storm surge related mitigation actions may also apply to other hazards. See the sections entitled "Flood" and "Mitigation for Multiple Natural Hazards" for additional ideas.

Subsidence

Map and Assess Vulnerability to Subsidence. Some areas with subsidence risk may not be fully identified in your community. Consider actions such as:

- Using GIS to map areas that are susceptible to subsidence.
- Identifying and mapping old mining areas or geologically unstable terrain so that development can be prevented or eliminated.
- Using ground-penetrating radar to detect lava tubes and map their location.
- Supporting mapping efforts to identify areas of existing permafrost.
- Improving accuracy of hazard area maps to educate residents about unanticipated risks. Upgrading maps provides a truer measure of risks to a community.

Manage Development in High-Risk Areas. Development regulations should consider areas with poor soil conditions, including the following:

- Prohibiting development in areas that have been identified as at-risk to subsidence.
- Restricting development in areas with soil that is considered poor or unsuitable for development.

Consider Subsidence in Building Design. If subsidence is considered during building design, future damage may be prevented. Potential actions include:

- Educating design professionals about where to locate information on subsidence rates and maps.
- Incorporating structural designs that can resist loading associated with subsidence.
- Adopting an ordinance promoting permafrost sensitive construction practices.
- Including potential subsidence in freeboard calculations for buildings in flood-prone areas.

Monitor Subsidence Risk Factors. Several risk factors can be monitored to help predict subsidence, such as the following:

- Monitoring areas at risk to subsidence by remaining aware of changes in groundwater levels.
- Monitoring areas where natural resources are removed from underground.
- Filling or buttressing subterranean open spaces, as with abandoned mines, to prevent or alleviate collapse.

Remove Existing Structures from Subsidence Hazard Areas.

- To prevent property loss, acquire and demolish or relocate buildings and infrastructure in high-risk areas.

Educate Residents about Subsidence. Increase residents' knowledge of subsidence through the following:

- Promoting community awareness of subsidence risks and impacts.
- Offering GIS hazard mapping online for residents and design professionals.

Subsidence-related mitigation actions may also apply to other hazards. See the sections entitled "Landslide," "Erosion," and "Mitigation for Multiple Natural Hazards" for additional ideas.

Tornado

Promote the construction and use of safe rooms by:

- Requiring construction of safe rooms in new schools, daycares, and nursing homes.
- Educating the public about the construction and use of safe rooms in homes and shelter areas of manufactured home parks, fairgrounds, shopping malls, or other vulnerable public structures.

NOAA/NSSA Photo

- Encouraging builders and homeowners to locate tornado safe rooms inside or directly adjacent to houses to prevent injuries due to flying debris or hail (by use of public information efforts).
- Developing a local grant program to assist homeowners who wish to construct a new safe room.

Information Source:
FEMA P-320 - Taking Shelter From the Storm: Building a Safe Room For Your Home or Small Business and International Code Council (ICC)-500 Standard for the Design and Construction of Storm Shelters.

Tornado damage to residences in Springfield, MA June 1, 2011
FEMA Photos

Require wind engineering measures and construction techniques that may include the following:

- Structural bracing
- Straps and clips
- Anchor bolts
- Laminated or impact-resistant glass
- Reinforced pedestrian and garage doors
- Window shutters
- Waterproof adhesive sealing strips
  Interlocking roof shingles
- Also, improve the selection of building materials so that wind-resistant materials are more readily available to the public. Consult guidance from ICC-600 Standard for Residential Construction in High-Wind Regions.

Tornado wind-related mitigation actions may also apply to other hazards. See the sections entitled “Severe Wind” and “Mitigation for Multiple Natural Hazards” for additional ideas.

Tsunami

Map and Assess Vulnerability to Tsunami. Tsunami risk can be better assessed and monitored with mapping techniques, including the following:

- Using GIS to map areas that are vulnerable to inundation by tsunamis.
- Developing and maintaining a database to track community vulnerability to tsunamis.
- Offering GIS hazard mapping online for residents and design professionals.
- Educating map users on the appropriate uses and limitations of maps.
- More accurately mapping problem areas to educate residents about unanticipated risks. Upgrading maps provides a truer measure of risks to a community.

Manage Development in Tsunami Hazard Areas. Planning and regulations can mitigate tsunami damage in many ways, such as:

- Adopting and enforcing building codes and design standards that contain requirements for tsunami-resistant design.
- Limiting new development in tsunami run-up areas.

Protect Against Fire Following Tsunami.

- Communities can encourage wildfire mitigation measures (i.e., tree breaks) in tsunami-prone areas to reduce impacts of fires that may occur after a tsunami hits the coastline.

Protect Buildings and Infrastructure. Ensure buildings and infrastructure are adequately protected from tsunami inundation with the following:

- Requiring coastal structures to be built to standards that allow for proper vertical evacuation and to be specially designed and constructed to resist both tsunami and earthquake loads.
- Locating new and relocating existing infrastructure and critical facilities outside of the tsunami hazard area.
- Elevating existing buildings above the inundation level.
- Relocating fire-prone infrastructure such as electrical lines or case tanks.

Increase Public Awareness of Tsunami Hazard.

- Designating tsunami inundation zones and marking evacuation routes.
- Developing maps showing possible tsunami inundation areas and steering developers away from high-risk areas.
- Participating in National Weather Service's TsunamiReady Program for communities.

Tsunami mitigation actions may also apply to other hazards. See the sections entitled "Flood," "Storm Surge" and "Mitigation for Multiple Natural Hazards" for additional ideas.

Wildfire

FEMA Photo

Reduce Risk through Land Use Planning. Local governments can mitigate future losses by regulating development in wildfire hazard areas through land use planning, including:

- Using zoning and/or a special wildfire overlay district to designate high-risk areas and specify the conditions for the use and development of specific areas.
- Regulating density and quantity of development, as well emergency access, landscaping and water supply.
- Conservation of open space or wildland-urban boundary zones to separate developed areas from high-hazard areas.
- Setting guidelines for annexation and service extensions in high-risk areas.

Develop a Wildland-Urban Interface Code. Communities can develop regulations for safer construction and incorporate mitigation considerations into the permitting process. Potential actions include:

- Developing specific design guidelines and development review procedures for new construction, replacement, relocation, and substantial improvement in wildfire hazard areas.
- Addressing fire mitigation through access, signage, fire hydrants, water availability, vegetation management, and special building construction standards.
- Involving fire protection agencies in determining guidelines and standards and in development and site plan review procedures.
- Establishing wildfire mitigation planning requirements for large scale developments or planned unit developments.

Retrofit At-Risk Structures with Ignition-Resistant Materials. Existing structures in wildfire hazard areas can be protected through the use of non-combustible materials and technologies, including:

- Installing roof coverings, sheathing, flashing, skylights, roof and attic vents, eaves, and gutters that conform to ignition-resistant construction standards.
- Installing wall components that conform to ignition-resistant construction standards.
- Protecting propane tanks or other external fuel sources.

- Purchasing and installing external, structure-specific water hydration systems (sprinklers); dedicated power sources; and dedicated cisterns if no water source (e.g., lake, river, or swimming pool) is available.

Create Defensible Space Around Structures and Infrastructure. Local governments can implement defensible space programs to reduce risk to structures and infrastructure, including:

Defensible space is crucial to protect structures. Wildfire in Addison, ME 2002
Maine Forest Service Photo

- Creating buffers around residential and non-residential structures through the removal or reduction of flammable vegetation, including vertical clearance of tree branches.
- Replacing flammable vegetation with less flammable species.
- Creating defensible zones around power lines, oil and gas lines, and other infrastructure systems.

Implement a Fuels Management Program. A fuels management program may be implemented to reduce hazardous vegetative fuels on public lands, near essential infrastructure, or on private lands by working with landowners. The program can include the following:

- Using prescribed burning to reduce fuel loads that threaten public safety and property.
- Identifying and clearing fuel loads created by downed trees.
- Cutting firebreaks into public wooded areas in the wildland-urban interface.
- Sponsoring local "slash and clean-up days" to reduce fuel loads along the wildland-urban interface.
- Developing a vegetation management plan.

Participate in Firewise Program. The Firewise program provides a series of steps that individual residents and their neighbors can take to keep their homes and neighborhoods safer from fire. Consider actions such as:

- Joining the "Firewise Communities/USA" recognition program sponsored by the National Wildlife Coordinating Group (firewise.org).
- Consulting Firewise guidance and requiring best practices in your community.

Educate Property Owners about Wildfire Mitigation Techniques. Educate property owners on actions that they can take to reduce risk to property, such as the following:

- Installing fire mitigation systems such as interior and exterior sprinkler systems.
- Performing safe disposal of yard and household waste rather than open burning.
- Removing dead or dry leaves, needles, twigs, and combustibles from roofs, decks, eaves, porches, and yards.
- Creating a defensible space or buffer zone cleared of combustible materials around property.
- Installing and maintaining smoke detectors and fire extinguishers on each floor of their homes or other buildings.
- Safely using and storing necessary flammable materials, including machine fuels. Approved safety cans should be used for storing gasoline, oily rags, and other flammable materials. Firewood should be stacked at least 100 feet away and uphill from homes.
- Keeping flammables, such as curtains, secured away from windows or using heavy fire-resistant drapes.

FEMA