# Mitigation Ideas

## A Resource for Reducing Risk to Natural Hazards

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# Introduction

The purpose of this document is to provide a resource that communities can use to identify and evaluate a range of potential mitigation actions for reducing risk to natural hazards and disasters.

The focus of this document is mitigation, which is action 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.

Ideas for mitigation actions are presented for the following natural hazards:

- Drought
- Earthquake
- Erosion
- Extreme temperatures
- Flood
- Hail
- Landslide
- Lightning
- Sea level rise
- Severe wind
- Severe winter weather
- Storm surge
- Subsidence
- Tornado
- Tsunami
- Wildfire

*Examples of mitigation actions are planning and zoning, floodplain protection, property acquisition and relocation, or public outreach projects.*

*Examples of preparedness actions are installing disaster warning systems, purchasing radio communications equipment, or conducting emergency response training.*

Actions that may mitigate multiple hazards are presented in the last section, entitled "Multiple Hazards."

The suggested mitigation actions are summarized into four types: (1) Local Planning and Regulations, (2) Structure and Infrastructure Projects, (3) Natural Systems Protection, and (4) Education and Awareness Programs. Examples of activities that can be used to accomplish each mitigation goal are identified, as well as the relevant FEMA publications or resources, if applicable.

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 that 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.

# Drought

A drought is a period of unusually constant dry weather that persists long enough to cause deficiencies in water supply (surface or underground). Droughts are slow-onset hazards, but, over time, they can severely affect crops, municipal water supplies, recreational resources, and wildlife. If drought conditions extend over a number of years, the direct and indirect economic impacts can be significant. High temperatures, high winds, and low humidity can worsen drought conditions and also make areas more susceptible to wildfire. In addition, human actions and demands for water resources can accelerate drought-related impacts.

# Local Planning and Regulations

## D-1 Assess Vulnerability to Drought Risk

**To better understand and assess local vulnerability to drought, consider actions such as:**

- Gathering and analyzing water and climate data to gain a better understanding of local climate and drought history.
- Identifying factors that affect the severity of a drought.
- Identifying available water supplies.
- Determining how the community and its water sources have been impacted by droughts in the past.

## D-2 Monitor Drought Conditions

**Monitoring drought conditions can provide early warning for policymakers and planners to make decisions through actions including:**

- Identifying local drought indicators, such as precipitation, temperature, surface water levels, soil moisture, etc.
- Establishing a regular schedule to monitor and report conditions on at least a monthly basis.

## D-3 Monitor Water Supply

**Monitoring the water supply and its functions can save water in the long run through actions such as:**

- Regularly checking for leaks to minimize water supply losses.
- Improving water supply monitoring.

## D-4 Plan for Drought

**Plan for future drought events in your area through actions such as:**

- Developing a drought emergency plan.
- Developing criteria or triggers for drought-related actions.
- Developing a drought communication plan and early warning system to facilitate timely communication of relevant information to officials, decision makers, emergency managers, and the general public.
- Developing agreements for secondary water sources that may be used during drought conditions.
- Establishing an irrigation time/scheduling program or process so that all agricultural land gets the required amount of water. Through incremental timing, each area is irrigated at different times so that all water is not consumed at the same time. Spacing usage may also help with recharge of groundwater.

### D-5 Require Water Conservation During Drought Conditions

**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 fire fighting.

### D-6 Prevent Overgrazing

**Prevent overgrazing, which has been linked to drought vulnerability, through actions such as:**

- Establishing a grazing policy or permitting program to prevent overgrazing.
- Reducing the number of animals and improving range management.

## Structure and Infrastructure Projects

### D-7 Retrofit Water Supply Systems

**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.

## Natural Systems Protection

### D-8 Enhance Landscaping and Design Measures

**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.

# Education and Awareness Programs

## D-9 Educate Residents on Water Saving Techniques

**Encourage citizens to take water-saving measures, such as the following:**

- Installing low-flow water saving showerheads and toilets.
- Turning water flow off while brushing teeth or during other cleaning activities.
- Adjusting sprinklers to water the lawn and not the sidewalk or street.
- Running the dishwasher and washing machine only when they are full.
- Checking for leaks in plumping or dripping faucets.
- Installing rain-capturing devices for irrigation.
- Encouraging the installation of graywater systems in homes to encourage water reuse.

## D-10 Educate Farmers on Soil and Water Conservation Practices

**Encourage farmers to implement soil and water conservation practices that foster soil health and improve soil quality to help increase resiliency and mitigate the impacts of droughts. Potential conservation practices include the following:**

- Rotating crops by growing a series of different types of crops on the same fields every season to reduce soil erosion.
- Practicing contour farming by farming along elevation contour lines to slow water runoff during rainstorms and prevent soil erosion, allowing the water time to absorb into the soil.
- Using terracing on hilly or mountainous terrain to decrease soil erosion and surface runoff.
- Planting "cover crops," such as oats, wheat, and buckwheat, to prevent soil erosion.
- Using zero and reduced tillage to minimize soil disturbance and leave crop residue on the ground to prevent soil erosion.
- Constructing windbreaks to prevent evaporation from reclaiming salt-affected soil.
- Collecting rainwater and using natural runoff to water plants.

## D-11 Purchase Crop Insurance

*FEMA Resources/Publications*
*FEMA 20, P-85, 361, 453*

**Preserve economic stability during a drought by encouraging agricultural interests to obtain crop insurance to cover potential losses due to drought.**

*Other drought-related mitigation actions may also apply to other hazards. See the sections entitled "Extreme Temperatures" and "Multiple Hazards" for other possible ideas.*

# Earthquake

An earthquake is a sudden release of energy that creates a movement in the earth's crust. Most earthquake-related property damage and deaths are caused by the failure and collapse of structures due to ground shaking. The level of damage depends upon the extent and duration of the shaking. Other damaging earthquake effects include landslides, the down-slope movement of soil and rock (in mountain regions and along hillsides), and liquefaction.

# Local Planning and Regulations

## EQ-1 Adopt and Enforce Building Codes

*FEMA Resources/Publications*
*FEMA 83, 224, 232, 254, 266, 313, 349, P-749, P-750*

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

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

## EQ-2 Incorporate Earthquake Mitigation into Local Planning

*FEMA Resources/Publications*
*FEMA 83, 224, 254, 266, 313, 349*

**Earthquake risk can be reduced through local planning, codes, and ordinances, including:**

- Creating a seismic safety committee to provide policy recommendations, evaluate and recommend changes in seismic safety standards, and give an annual assessment of local and statewide implementation of seismic safety improvements.
- Developing and distributing guidelines or passing ordinances that require developers and building owners to locate lifelines, buildings, critical facilities, and hazardous materials out of areas subject to significant seismic hazards.
- Incorporating structural and non-structural seismic strengthening actions into ongoing building plans and activities in the capital improvement plan to ensure that facilities remain operational for years to come.
- Supporting financial incentives, such as low interest loans or tax breaks, for home and business owners who seismically retrofit their structures.

## EQ-3 Map and Assess Community Vulnerability to Seismic Hazards

*FEMA Resources/Publications*
*FEMA 83, 154, 366, ROVER*

**To better understand and assess local vulnerability to earthquakes, consider actions such as:**

- Developing an inventory of public and commercial buildings that may be particularly vulnerable to earthquake damage, including pre-1940s homes and homes with cripple wall foundations.
- Collecting geologic information on seismic sources, soil conditions, and related potential hazards.
- Creating an earthquake scenario to estimate potential loss of life and injuries, the types of potential damage, and existing vulnerabilities within a community to develop earthquake mitigation priorities.
- Using Hazus to quantitatively estimate potential losses from an earthquake.
- Maintaining a database to track community vulnerability to earthquake risk.
- Using GIS to map hazard areas, at-risk structures, and associated hazards (e.g., liquefaction and landslides) to assess high-risk areas.

## EQ-4 Conduct Inspections of Building Safety

*FEMA Resources/Publications*
*FEMA 154, 155, 202, 221, 224, 225, 226, 233, 306, 307, 395, ROVER*

**Inspections can be used to assess earthquake risk, such as:**

- Establishing a school survey procedure and guidance document to inventory structural and non-structural hazards in and around school buildings.
- Using rapid visual screening to quickly inspect a building and identify disaster damage or potential seismic structural and non-structural weaknesses to prioritize retrofit efforts, inventory high-risk structures and critical facilities, or assess post-disaster risk to determine if buildings are safe to re-occupy.
- Consulting industry standard publications such as American Society of Civil Engineers (ASCE) 31 - *Seismic Evaluation of Existing Buildings*, ASCE 41 - *Seismic Rehabilitation of Existing Buildings*, and Applied Technology Council (ATC) 20 - *Procedures for Postearthquake Safety Evaluation of Buildings*.

## EQ-5 Protect Critical Facilities and Infrastructure

**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.

## EQ-6 Implement Structural Mitigation Techniques

*FEMA Resources/Publications*
*FEMA 307, 320, 345, 356, 361, 395, 396, 412, 453, 547, P-774*

**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.

## EQ-7 Increase Earthquake Risk Awareness

*FEMA Resources/Publications*
*FEMA E-74, 474, 526, 527, 528, 529, 530, P-811; EMI IS-22*

**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.

## EQ-8 Conduct Outreach to Builders, Architects, Engineers, and Inspectors

*FEMA Resources/Publications*
*FEMA 232, 313, 389, P-420, 454*

**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.
- Training building department staff and officials on Form ATC-20 for post-earthquake building evaluation. The ATC-20 report and addendum, prepared by the Applied Technology Council, provide procedures and guidelines for making on-the-spot evaluations and decisions regarding continued use and occupancy of earthquake-damaged buildings.

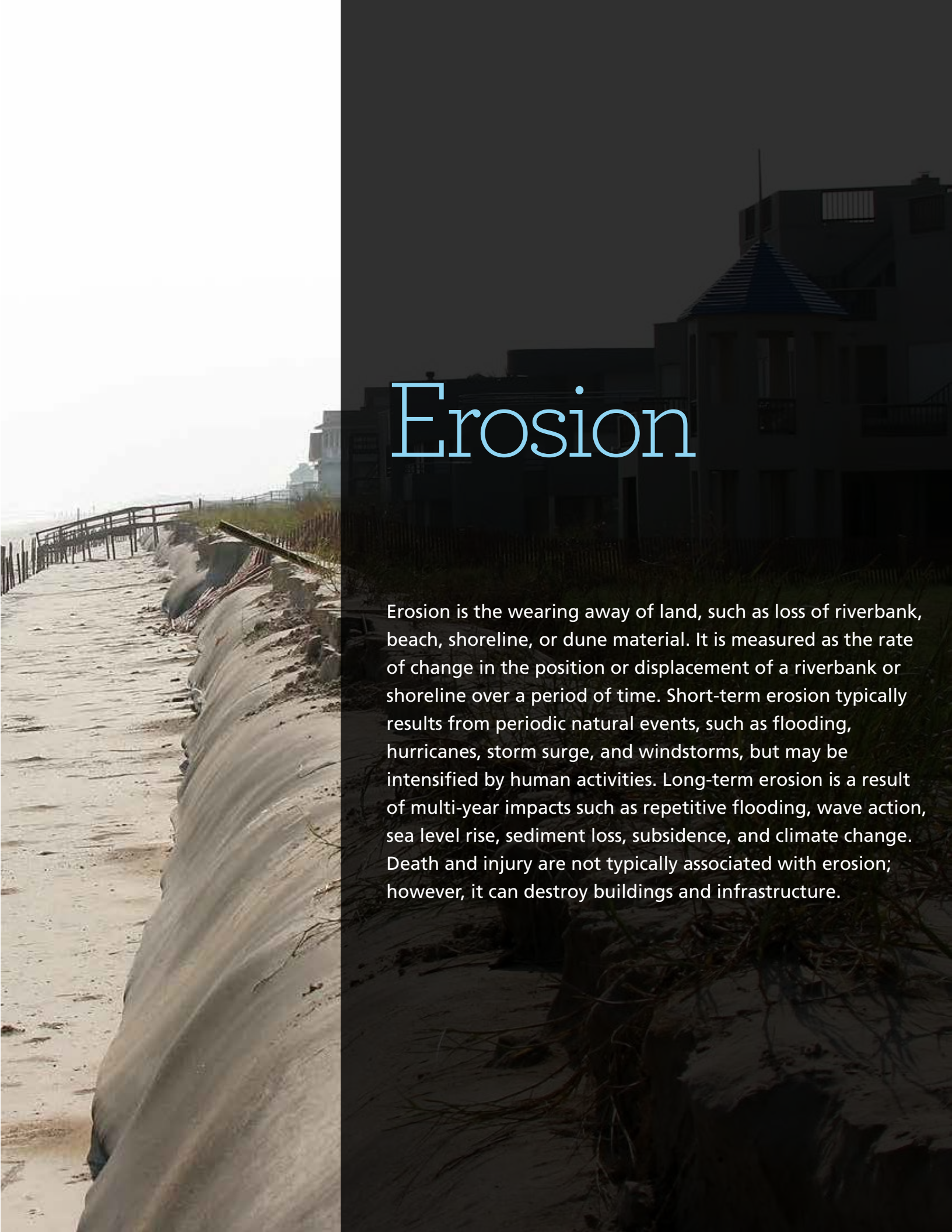
## EQ-9 Provide Information on Structural and Non-Structural Retrofitting

*FEMA Resources/Publications*
*FEMA E-74, 412, 413, 414, 530, 547*

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

- Educating homeowners about structural and non-structural 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 non-structural mitigation options as well as model ordinances and procedures that have been used by other jurisdictions to reduce earthquake risk.

*Other earthquake-related mitigation actions may also apply to other hazards. See the section entitled "Multiple Hazards" for other possible ideas.*



# Erosion

Erosion is the wearing away of land, such as loss of riverbank, beach, shoreline, or dune material. It is measured as the rate of change in the position or displacement of a riverbank or shoreline over a period of time. Short-term erosion typically results from periodic natural events, such as flooding, hurricanes, storm surge, and windstorms, but may be intensified by human activities. Long-term erosion is a result of multi-year impacts such as repetitive flooding, wave action, sea level rise, sediment loss, subsidence, and climate change. Death and injury are not typically associated with erosion; however, it can destroy buildings and infrastructure.

# Local Planning and Regulations

## ER-1 Map and Assess Vulnerability to Erosion

**Erosion risk can be better assessed and monitored with mapping techniques, including the following:**

- Using GIS to identify and map erosion hazard areas.
- Developing and maintaining a database to track community vulnerability to erosion.
- Using GIS to identify concentrations of at-risk structures.
- Improving mapping of hazard areas to educate residents about unexpected risks.

## ER-2 Manage Development in Erosion Hazard Areas

**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.

## ER-3 Promote or Require Site and Building Design Standards to Minimize Erosion Risk

**Development can be designed to minimize damage due to erosion using the following techniques:**

- Constructing open foundation systems on buildings to minimize scour.
- Constructing deep foundations in erosion hazard areas.
- Clustering buildings during building and site design.
- Designing and orienting infrastructure to deter erosion and accretion.

# Structure and Infrastructure Projects

## ER-4 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.**

*FEMA Resources/Publications*

*FEMA P-55*

## ER-5 Stabilize Erosion Hazard Areas

**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.

## ER-6 Increase Awareness of Erosion Hazards

**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.

*Other erosion-related mitigation actions may also apply to other hazards. See the sections entitled "Subsidence," "Landslide," and "Multiple Hazards" for other possible ideas.*

# Extreme Temperatures

Extreme heat and extreme cold constitute different conditions in different parts of the country. Extreme cold can range from near freezing temperatures in the southern United States to temperatures well below zero in the northern states. Similarly, extreme heat is typically recognized as the condition where temperatures consistently stay ten degrees or more above a region's average high temperature for an extended period. Fatalities can result from extreme temperatures, as they can push the human body beyond its limits (hyperthermia and hypothermia).

## Local Planning and Regulations

### ET-1 Reduce Urban Heat Island Effect

**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.

## Education and Awareness Programs

### ET-2 Increase Awareness of Extreme Temperature Risk and Safety

**The impacts of extreme temperatures on public health can be lessened if citizens know how to prepare and protect themselves. Ideas for increasing awareness include the following:**

- Educating citizens regarding the dangers of extreme heat and cold and the steps they can take to protect themselves when extreme temperatures occur.

### ET-3 Assist Vulnerable Populations

**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.

### ET-4 Educate Property Owners About Freezing Pipes

**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.

*Other extreme temperature-related mitigation actions may also apply to other hazards. See the sections entitled "Severe Winter Weather," "Drought," and "Multiple Hazards" for other possible ideas.*

# Flood

A flood is the partial or complete inundation of normally dry land. The various types of flooding include riverine flooding, coastal flooding, and shallow flooding. Common impacts of flooding include damage to personal property, buildings, and infrastructure; bridge and road closures; service disruptions; and injuries or even fatalities.

# Local Planning and Regulations

## F-1 Incorporate Flood Mitigation in Local Planning

*FEMA Resources/Publications*
*FEMA 100, 268, 473*

**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.
- Developing a floodplain management plan and updating it regularly.
- 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.

## F-2 Form Partnerships to Support Floodplain Management

**Partnerships between local, state, and regional entities help expand resources and improve coordination. Consider the following actions:**

- Developing a stormwater committee that meets regularly to discuss issues and recommend projects.
- Forming a regional watershed council to help bring together resources for comprehensive analysis, planning, decision-making, and cooperation.
- Establishing watershed-based planning initiatives to address the flood hazard with neighboring jurisdictions.
- Forming a citizen plan implementation steering committee to monitor progress on local mitigation actions. Include a mix of representatives from neighborhoods, local businesses, and local government.

## F-3 Limit or Restrict Development in Floodplain Areas

*FEMA Resources/Publications*
*FEMA 100, 268, 473*

**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.

## F-4 Adopt and Enforce Building Codes and Development Standards

*FEMA Resources/Publications*
*FEMA 100, 268, P-762*

**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.

## F-5 Improve Stormwater Management Planning

**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 run-off through a stormwater ordinance.
- Linking flood hazard mitigation objectives with EPA Stormwater Phase II initiatives.
- Developing engineering guidelines for drainage from new development.
- Requiring a drainage study with new development.
- Encouraging the use of Low Impact Development techniques

## F-6 Adopt Polices to Reduce Stormwater Runoff

**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.

## F-7 Improve Flood Risk Assessment

*FEMA Resources/Publications*
*FEMA 416, 467-1, B-797*

**Heighten awareness of flood risk with the following:**

- Incorporating the procedures for tracking high water marks following a flood into emergency response plans.
- Conducting cumulative impact analyses for multiple development projects within the same watershed.
- Conducting a verification study of FEMA's repetitive loss inventory and developing an associated tracking database.
- Regularly calculating and documenting the amount of flood-prone property preserved as open space.
- Requiring a thorough watershed analysis for all proposed dam or reservoir projects.
- Developing a dam failure study and emergency action plan.
- Using GIS to map areas that are at risk of flooding.
- Obtaining depth grid data and using it to illustrate flood risk to citizens.
- Incorporating digital floodplain and topographic data into GIS systems, in conjunction with Hazus, to assess risk.
- Developing and maintaining a database to track community exposure to flood risk.
- Revising and updating regulatory floodplain maps.

## F-8 Join or Improve Compliance with NFIP

*FEMA Resources/Publications*
*FEMA 100, 209, FIA-15A,*
*NFIP Technical Bulletins*

**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.

## F-9 Manage the Floodplain Beyond Minimum Requirements

*FEMA Resources/Publications*
*FEMA 100, 209, 213, 268, 480;*
*FIA-15A*

**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).

## F-10 Participate in the CRS

*FEMA Resources/Publications*
*FEMA 100, 209, 213, 268, 480;*
*FIA-15A*

**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 drainageways and retention basins.
- Taking action to minimize the effects of flooding on people, property, and building contents through measures including flood warning, emergency response, and evacuation planning.

## F-11 Establish Local Funding Mechanisms for Flood Mitigation

**Potential methods to develop local funding sources for flood mitigation include:**

- Using taxes to support a regulatory system.
- Using impact fees to help fund public projects to mitigate impacts of land development (e.g., increased runoff).
- Levying taxes to finance maintenance of drainage systems and capital improvements.

# Structure and Infrastructure Projects

## F-12 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.**

## F-13 Improve Stormwater Drainage System Capacity

**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.

## F-14 Conduct Regular Maintenance for Drainage Systems and Flood Control Structures

**Regular maintenance will help drainage systems and flood control structures continue to function properly. Potential activities include:**

- Performing regular drainage system maintenance, such as sediment and debris clearance, as well as detection and prevention of discharges into stormwater and sewer systems from home footing drains, downspouts, or sewer pumps.
- Implementing an inspection, maintenance, and enforcement program to help ensure continued structural integrity of dams and levees.
- Routinely cleaning debris from support bracing underneath low-lying bridges.
- Routinely cleaning and repairing stormwater drains.
- Regularly clearing sediment build-up on riverbanks near aerial lines.
- Inspecting bridges and identifying if any repairs or retrofits are needed to prevent scour.
- Incorporating ice jam prevention techniques as appropriate.

## F-15 Elevate or Retrofit Structures and Utilities

*FEMA Resources/Publications*
*FEMA 54, P-85, 114, P-259, 347, P-348, P-499*

**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 tankless water heaters in limited spaces.

## F-16 Floodproof Residential and Non-Residential Structures

*FEMA Resources/Publications*
*FEMA P-55, 114, P-259*

**Floodproofing techniques may protect certain structures from flood damage, including:**

- Wet floodproofing 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 floodproofing 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 floodproofing non-residential structures by strengthening walls, sealing openings, or using waterproof compounds or plastic sheeting on walls to keep water out.

## F-17 Protect Infrastructure

*FEMA Resources/Publications*

*FEMA P-259, 345, 543, B-797*

**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.
- Floodproofing wastewater treatment facilities located in flood hazard areas.
- Floodproofing 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 buildings.
- Using bioengineered bank stabilization techniques.

## F-18 Protect Critical Facilities

*FEMA Resources/Publications*

*FEMA P-259, 345, 543, B-797*

**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 back-up 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.

## F-19 Construct Flood Control Measures

**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 Systems Protection

## F-20 Protect and Restore Natural Flood Mitigation Features

*FEMA Resources/Publications*
*FEMA 100, 268*

**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.
- 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.

## F-21 Preserve Floodplains as Open Space

*FEMA Resources/Publications*

*FEMA 100, 268*

**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.

## F-22 Increase Awareness of Flood Risk and Safety

**Ideas for increasing flood risk awareness include the following:**

- Encouraging homeowners to purchase flood insurance.
- Annually distributing flood protection safety pamphlets or brochures to the owners of flood-prone property.
- Educating citizens about safety during flood conditions, including the dangers of driving on flooded roads.
- Using outreach programs to advise homeowners of risks to life, health, and safety.
- Offering GIS hazard mapping online for residents and design professionals.
- Establishing a Program for Public Information (PPI) with a PPI committee (as suggested by Activity 332 of the CRS Coordinator's Manual).

## F-23 Educate Property Owners about Flood Mitigation Techniques

*FEMA Resources/Publications*
*FEMA Building Code Tool Kit (FEMA CD)*

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

- Using outreach activities to facilitate technical assistance programs that address measures that citizens can take or facilitate funding for mitigation measures.
- Encouraging homeowners to install backflow valves to prevent reverse-flow flood damages.
- Encouraging residents in flood-prone areas to elevate homes.
- 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.
- Asking residents to help keep storm drains clear of debris during storms (not to rely solely on Public Works).

*Other flooding-related mitigation actions may also apply to other hazards. See the sections entitled "Storm Surge," "Erosion," and "Multiple Hazards" for other possible ideas.*

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# Hail

Hailstorms are a potentially damaging outgrowth of severe thunderstorms. Hailstorms frequently accompany thunderstorms, so their locations and spatial extents overlap. Hail can cause substantial damage to vehicles, roofs, landscaping, and other areas of the built environment. U.S. agriculture is typically the area most affected by hail storms, which cause severe crop damage even during minor events.

## Structure and Infrastructure Projects

### HA-1 Locate Safe Rooms to Minimize Damage

*FEMA Resources/Publications*
*FEMA 320, 453*

**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.**

### HA-2 Protect Buildings from Hail Damage

**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.
- Contacting the Insurance Institute for Business and Home Safety (IBHS) to learn more about the most appropriate type of roof covering for your geographic region.

## Education and Awareness Programs

### HA-3 Increase Hail Risk Awareness

**Conduct outreach activities to increase public awareness of hail dangers, including:**

- Mailing safety brochures with monthly water bills.
- Posting warning signage at local parks, county fairs, and other outdoor venues.
- Teaching school children about the dangers of hail and how to take safety precautions.

*Other hail-related mitigation actions may also apply to other hazards. See the section entitled "Multiple Hazards" for other possible ideas.*

# Landslide

The movement of a mass of rock, debris, or earth down a slope by force of gravity is considered a landslide. Landslides occur when the slope or soil stability changes from stable to unstable, which may be caused by earthquakes, storms, volcanic eruptions, erosion, fire, or additional human-induced activities. Slopes greater than 10 degrees are more likely to slide, as are slopes where the height from the top of the slope to its toe is greater than 40 feet. Slopes are also more likely to fail if vegetative cover is low and/or soil water content is high. Potential impacts include environmental disturbance, property and infrastructure damage, and injuries or fatalities.

# Local Planning and Regulations

## LS-1 Map and Assess Vulnerability to Landslides

**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).

## LS-2 Manage Development in Landslide Hazard Areas

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

- Creating a plan to implement reinforcement measures in high-risk areas.
- 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.

## LS-3 Prevent Impacts to Roadways

**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.

## LS-4 Remove Existing Buildings and Infrastructure from Landslide Hazard Areas

**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.**

*FEMA Resources/Publications*
*FEMA 182*

*Other landslide-related mitigation actions may also apply to other hazards. See the sections entitled "Erosion," "Subsidence," and "Multiple Hazards" for other possible ideas.*

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# Lightning

Lightning is a discharge of electrical energy that results from the buildup of positive and negative charges in a thunderstorm, which creates a “bolt” when the buildup of charges becomes strong enough. On average, 55 people are killed and hundreds are injured each year by lightning strikes in the United States. Lightning can strike communications equipment (e.g., radio or cell towers, antennae, satellite dishes, etc.) and hamper communication and emergency response. Lightning strikes can also cause significant damage to buildings, critical facilities, and infrastructure, largely by igniting a fire. Lightning can also ignite a wildfire.

## Structure and Infrastructure Projects

### L-1 Protect Critical Facilities and Equipment

**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 infrastructure and other critical facilities.
- Installing and maintaining surge protection on critical electronic equipment.

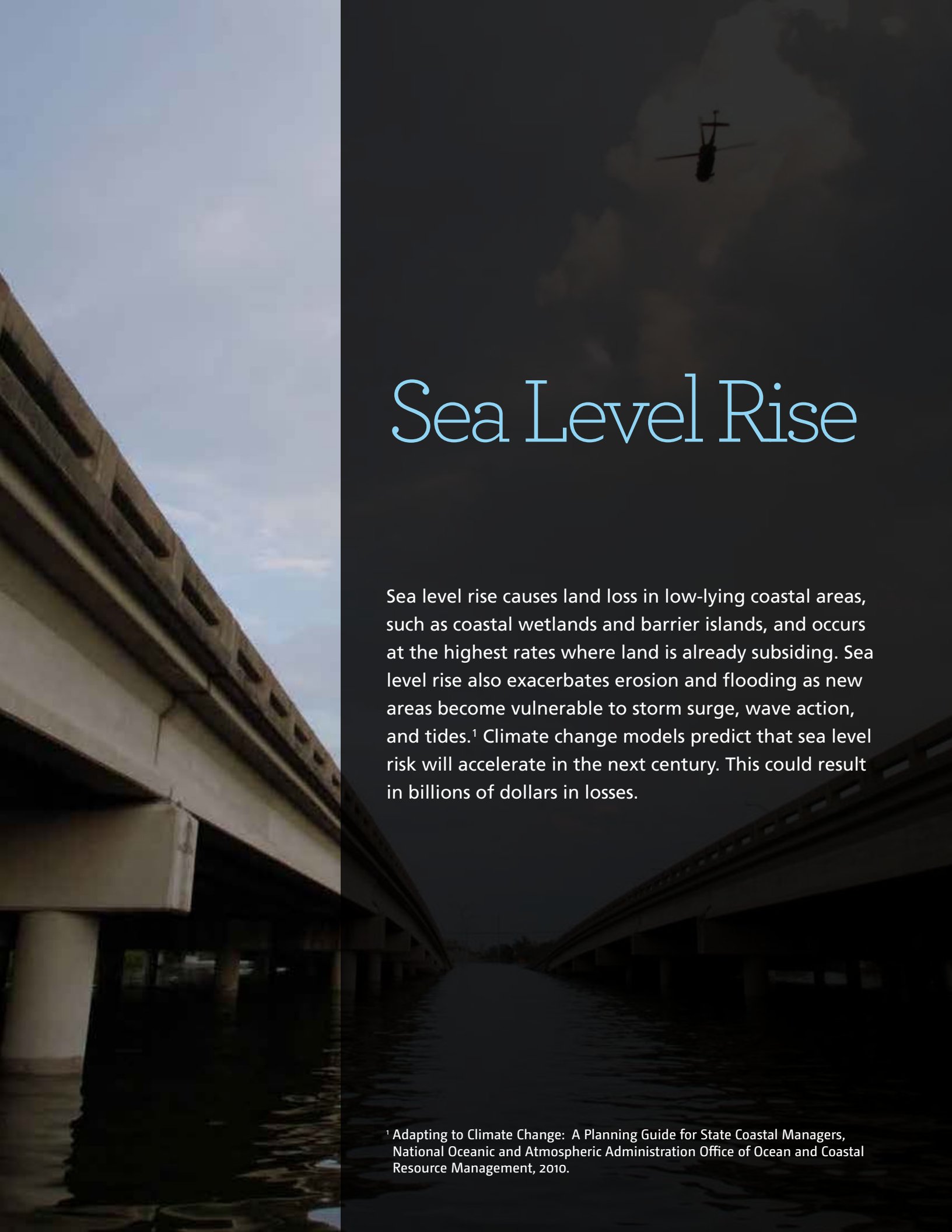
## Education and Awareness Programs

### L-2 Conduct Lightning Awareness Programs

**Use outreach programs to promote awareness of lightning dangers. This could include ideas such as:**

- Developing a lightning brochure for distribution by recreation equipment retailers or outfitters in mountainous areas.
- Mailing safety brochures with monthly water bills.
- Posting warning signage at local parks.
- Teaching school children about the dangers of lightning and how to take safety precautions.

*Other lightning-related mitigation actions may also apply to other hazards. See the section entitled "Multiple Hazards" for other possible ideas.*



# Sea Level Rise

Sea level rise causes land loss in low-lying coastal areas, such as coastal wetlands and barrier islands, and occurs at the highest rates where land is already subsiding. Sea level rise also exacerbates erosion and flooding as new areas become vulnerable to storm surge, wave action, and tides.[1] Climate change models predict that sea level risk will accelerate in the next century. This could result in billions of dollars in losses.

[1] Adapting to Climate Change: A Planning Guide for State Coastal Managers, National Oceanic and Atmospheric Administration Office of Ocean and Coastal Resource Management, 2010.

# Local Planning and Regulations

## SLR-1 Map and Assess Vulnerability to 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.
- 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).

## SLR-2 Manage Development in High-Risk Areas

**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.
- Promoting 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.
- Encouraging compact community design in low-risk areas.
- Establishing setbacks in high-risk areas that account for potential sea level rise.

## SRL-3 Prevent Infrastructure Expansion in High-Risk Areas

**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.

# Structure and Infrastructure Projects

## SRL-4 Protect Buildings and Infrastructure

**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.

# Natural Systems Protection

## SLR-5 Preserve High-Hazard Areas as Open Space

**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.

### SLR-6 Protect and Restore Natural Buffers

**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.
- 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.

## Education and Awareness Programs

### SLR-7 Increase Awareness of Sea Level Rise

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

- Encouraging homeowners to purchase flood insurance.
- Using outreach programs to facilitate technical assistance programs that address measures that citizens can take or facilitate funding for mitigation measures.
- Annually distributing flood protection safety pamphlets or brochures to the owners of property in high-risk areas.
- Educating citizens about safety during flood conditions, including the dangers of driving on flooded roads.
- Using outreach programs to advise homeowners of risks to life, health, and safety.
- Offering GIS hazard mapping online for residents and design professionals.
- Disclosing the location of possible sea level rise areas to potential buyers.

*Other sea level rise-related mitigation actions may also apply to other hazards. See the sections entitled "Flood," "Storm Surge," "Erosion," and "Multiple Hazards" for other possible ideas.*

*Climate change is likely to exacerbate the effects of other hazards as well. See the other sections for possible ideas.*

# Severe Wind

Severe wind can occur alone, such as during straight-line wind events and derechos, or it can accompany other natural hazards, including hurricanes and severe thunderstorms. Severe wind poses a threat to lives, property, and vital utilities primarily due to the effects of flying debris or downed trees and power lines. Severe wind will typically cause the greatest damage to structures of light construction, particularly manufactured homes.

## SW-1 Adopt and Enforce Building Codes

*FEMA Resources/Publications*
*FEMA P-85, P-804*

**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 or encouraging 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.

## SW-2 Promote or Require Site and Building Design Standards to Minimize Wind Damage

*FEMA Resources/Publications*
*FEMA P-499, 550*

**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).

## SW-3 Assess Vulnerability to Severe Wind

**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.

## SW-4 Protect Power Lines and Infrastructure

**The regular maintenance and upkeep of utilities can help prevent wind damage. Possible strategies are:**

- Establishing standards for all utilities regarding tree pruning around lines.
- Incorporating inspection and management of hazardous trees into the drainage system maintenance process.
- Preemptively testing power line holes to determine if they are rotting.
- Inspecting utility poles to ensure they meet specifications and are wind resistant.
- 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).
- Avoiding use of aerial extensions to water, sewer, and gas 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 loopfeeds.

## SW-5 Retrofit Residential Buildings

*FEMA Resources/Publications*
*FEMA 320, 361, 453, P-499, P-804*

**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.

## SW-6 Retrofit Public Buildings and Critical Facilities

*FEMA Resources/Publications*
*FEMA 361, P-499, 550*

**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.

## SW-7 Increase Severe Wind Risk Awareness

*FEMA Resources/Publications*
*FEMA P-431, P-804*

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

- Informing residents of shelter locations and evacuation routes.
- Educating homeowners on the benefits of wind retrofits such as shutters, hurricane clips, etc.
- Ensuring that school officials are aware of the best area of refuge in school buildings.
- Instructing property owners on how to properly install temporary window coverings before a storm.
- Educating design professionals to include wind mitigation during building design.

*Other severe wind-related mitigation actions may also apply to other hazards. See the sections entitled "Multiple Hazards" and "Tornadoes" for other possible ideas.*

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# Severe Winter Weather

Severe winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. Severe winter weather can down trees, cause widespread power outages, damage property, and cause fatalities and injuries.

# Local Planning and Regulations

## WW-1 Adopt and Enforce Building Codes

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

- Adopting the International Building Code (IBC) and International Residential Code (IRC).
- Ensuring the development and enforcement of building codes for roof snow loads.
- Discouraging flat roofs in areas that experience heavy snows.

# Structure and Infrastructure Projects

## WW-2 Protect Buildings and Infrastructure

**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.

## WW-3 Protect Power Lines

**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 loopfeeds.

## WW-4 Reduce Impacts to Roadways

**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:**

- Planning for and maintaining adequate road and debris clearing capabilities.
- 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.
- Installing roadway heating technology to prevent ice/snow buildup.

## WW-5 Conduct Winter Weather Risk Awareness Activities

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

- Informing the public about severe winter weather impacts.
- Producing and distributing family and traveler emergency preparedness information about severe winter weather hazards.
- Including safety strategies for severe weather in driver education classes and materials.
- Encouraging homeowners to install carbon monoxide monitors and alarms.
- Educating citizens that all fuel-burning equipment should be vented to the outside.

## WW-6 Assist Vulnerable Populations

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

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

*Other winter weather-related mitigation actions may also apply to other hazards. See the sections entitled "Extreme Temperatures" and "Multiple Hazards" for other possible ideas.*

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# Storm Surge

A storm surge is a large dome of water, often 50 to 100 miles wide, that rises anywhere from 4 to 5 feet in a Category 1 hurricane and up to more than 30 feet in a Category 5 storm. Storm surge arrives prior to a hurricane's landfall, and the greater the hurricane's intensity, the sooner the surge arrives. Storm surge can be devastating to coastal regions, causing flooding, severe beach erosion, and property damage along the immediate coast. Furthermore, water can rise very rapidly due to storm surge, posing a serious threat to people remaining in inundation areas.

# Local Planning and Regulations

## SS-1 Adopt Building Codes and Development Standards

**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 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.

## SS-2 Improve Land Use Planning and Regulations

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

- 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).
- Planning for future storm surge heights due to sea level rise.
- 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.

## SS-3 Minimize Risk to New Facilities and Infrastructure

*FEMA Resources/Publications*

*FEMA P-55, P-499, B-797*

**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).

### SS-4 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.

## Structure and Infrastructure Projects

### SS-5 Construct Structural Control Techniques

**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.

### SS-6 Protect Infrastructure and Critical Facilities

*FEMA Resources/Publications*

*FEMA P-55, P-499, B-797*

**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.

# Natural Systems Protection

## SS-7 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:**

- 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.
- Evaluating the appropriate use of sediment-trapping vegetation, sediment mounds, etc., for coastal hazards.
- 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.
- 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.

# Education and Awareness Programs

## SS-8 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.
- Educating the public about risks, preparedness measures, and evacuation procedures.

*Other storm surge-related mitigation actions may also apply to other hazards. See the sections entitled "Flood" and "Multiple Hazards" for other possible ideas.*

# Subsidence

Subsidence is the gradual settling or sudden sinking of the Earth's surface due to subsurface movement of earth materials. The level of subsidence ranges from a broad lowering to collapse of land surface. Most causes of subsidence are human-induced, such as groundwater pumpage, aquifer system compaction, drainage of organic soils, underground mining, hydrocompaction, natural compaction, sinkholes, and thawing permafrost. Areas located above or adjacent to karsts topography have a greater risk of experiencing subsidence. Sudden collapses of surface areas can damage and destroy buildings and infrastructure.

# Local Planning and Regulations

## SU-1 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.

## SU-2 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.

## SU-3 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.

## SU-4 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.

## Structure and Infrastructure Projects

### SU-5 Remove Existing Structures from Subsidence Hazard Areas

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

*FEMA Resources/Publications*
*FEMA 20, P-85, 361, 453*

## Education and Awareness Programs

### SU-6 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.

*Other subsidence-related mitigation actions may also apply to other hazards. See the sections entitled "Landslide," "Erosion," and "Multiple Hazards" for other possible ideas.*

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# Tornado

A tornado is a violently rotating column of air that has contact with the ground and is often visible as a funnel cloud. The destruction caused by tornadoes ranges from light to catastrophic depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light construction, including residential dwellings and particularly manufactured homes. Tornadoes are more likely to occur during the months of March through May and tend to form in the late afternoon and early evening.

# Local Planning and Regulations

## T-1 Encourage Construction of Safe Rooms

*FEMA Resources/Publications*
*FEMA 20, P-85, 320, 361, P-431, 453*

**Promote the construction and use of safe rooms by:**

- Requiring construction of safe rooms in new schools, daycares, and nursing homes.
- Encouraging the construction and use of safe rooms in homes and shelter areas of manufactured home parks, fairgrounds, shopping malls, or other vulnerable public structures.
- Encouraging builders and homeowners to locate tornado safe rooms inside or directly adjacent to houses to prevent injuries due to flying debris or hail.
- Developing a local grant program to assist homeowners who wish to construct a new safe room.
- Consulting guidance from 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.*

## T-2 Require Wind-Resistant Building Techniques

*FEMA Resources/Publications*
*FEMA P-804*

**Require or encourage 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 S*tandard for Residential Construction in High-Wind Regions.***

# Education and Awareness Programs

## T-3 Conduct Tornado Awareness Activities

*FEMA Resources/Publications*
*FEMA 182*

**Conduct outreach activities to increase awareness of tornado risk. Activities could include the following:**

- Educating citizens through media outlets.
- Conducting tornado drills in schools and public buildings.
- Teaching school children about the dangers of tornadoes and how to take safety precautions.
- Distributing tornado shelter location information.
- Supporting severe weather awareness week.
- Promoting use of National Oceanic and Atmospheric Administration (NOAA) weather radios.

*Other tornado wind-related mitigation actions may also apply to other hazards. See the sections entitled "Severe Wind" and "Multiple Hazards" for other possible ideas.*

# Tsunami

A tsunami is a series of great waves that are created by undersea disturbances, such as earthquakes or volcanic eruptions. As opposed to typical waves that crash at the shoreline, tsunamis bring a continuously flowing "wall of water" that has the potential to cause devastating damage in coastal areas immediately along the shore. Areas at greatest risk are less than 50 feet above sea level and within 1 mile of the shoreline. Most deaths that occur during a tsunami result from drowning. Associated risks include flooding, polluted water supplies, and damaged gas lines.

## TSU-1 Map and Assess Vulnerability to Tsunami

*FEMA Resources/Publications*
*FEMA P-646, 646-A*

**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.

## TSU-2 Manage Development in Tsunami Hazard Areas

*FEMA Resources/Publications*
*FEMA P-55*

**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.
- Encouraging new development that is configured to minimize tsunami losses by using site planning strategies that slow water currents, steer water forces, and block water forces.

## TSU-3 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.**

## Structure and Infrastructure Projects

### TSU-4 Build Tsunami Shelters

**Ensure the population is adequately protected from tsunami inundation by constructing tsunami shelters.**

### TSU-5 Protect Buildings and Infrastructure

*FEMA Resources/Publications*
*FEMA P-646, 646-A*

**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.

## Education and Awareness Programs

### TSU-6 Increase Public Awareness of Tsunami Hazard

*FEMA Resources/Publications*
*FEMA P-646, 646-A*

**Improve public awareness and better prepare citizens for evacuation during a tsunami by the following:**

- Educating citizens regarding the dangers of tsunami and inform them of emergency procedures and routes to use should a tsunami warning be issued.
- Conducting tsunami drills.
- 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 NOAA's TsunamiReady Community program.

*Other tsunami-related mitigation actions may also apply to other hazards. See the sections entitled "Flood," "Storm Surge," and "Multiple Hazards" for other possible ideas.*

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# Wildfire

A wildfire is any outdoor fire that is not controlled, supervised, or arranged. Wildfire probability depends on local weather conditions; outdoor activities such as camping, debris burning, and construction; and the degree of public cooperation with fire prevention measures. Wildfires can result in widespread damage to property and loss of life.

# Local Planning and Regulations

## WF-1 Map and Assess Vulnerability to Wildfire

*FEMA Resources/Publications*
*FEMA P-754*

**The first step in local planning is to identify wildfire hazard areas and assess overall community vulnerability. Potential actions include:**

- Using GIS mapping of wildfire hazard areas to facilitate analysis and planning decisions through comparison with zoning, development, infrastructure, etc.
- Developing and maintaining a database to track community vulnerability to wildfire.
- Creating a wildfire scenario to estimate potential loss of life and injuries, the types of potential damage, and existing vulnerabilities within a community to develop wildfire mitigation priorities.

## WF-2 Incorporate Wildfire Mitigation in the Comprehensive Plan

**Communities can review comprehensive plans to ensure wildfire mitigation has been addressed. The comprehensive plan may include the following:**

- Recognizing the existence of wildfire hazards and identifying areas of risk based on a wildfire vulnerability assessment.
- Describing policies and recommendation for addressing wildfire risk and discouraging expansion in the wildland-urban interface.
- Including considerations of wildfire hazards in land use, public safety, and other elements of the comprehensive plan.

## WF-3 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.
- Addressing density and quantity of development, as well emergency access, landscaping and water supply.
- Promoting 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.

### WF-4 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.

### WF-5 Require or Encourage Fire-Resistant Construction Techniques

*FEMA Resources/Publications*
*FEMA P-737, P-754*

**A local government can encourage fire-resistant construction or may choose to require it through local regulations. Examples include:**

- Encouraging the use of non-combustible materials (i.e., stone, brick, and stucco) for new construction in wildfire hazard areas.
- Using fire resistant roofing and building materials in remodels, upgrades, and new construction.
- Enclosing the foundations of homes and other buildings in wildfire-prone areas, rather than leaving them open and potentially exposing undersides to blown embers or other materials.
- Prohibiting wooden shingles/wood shake roofs on any new development in areas prone to wildfires.
- Encouraging the use of functional shutters on windows.

## Structure and Infrastructure Projects

### WF-6 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.

### WF-7 Create Defensible Space Around Structures and Infrastructure

**Local governments can implement defensible space programs to reduce risk to structures and infrastructure, including:**

- 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.

### WF-8 Conduct Maintenance to Reduce Risk

**Local governments can implement maintenance procedures to reduce wildfire risk, including:**

- Performing arson prevention cleanup activities in areas of abandoned or collapsed structures, accumulated trash or debris, and with a history of storing flammable materials where spills or dumping may have occurred.
- Preventing or alleviating wildfires by proper maintenance and separation of power lines as well as efficient response to fallen power lines.
- Routinely inspecting the functionality of fire hydrants.
- Requiring and maintaining safe access for fire apparatus to wildland-urban interface neighborhoods and properties.

## Natural Systems Protection

### WF-9 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:**

- Performing maintenance including fuel management techniques such as pruning and clearing dead vegetation, selective logging, cutting high grass, planting fire-resistant vegetation, and creating fuel/fire breaks (i.e., areas where the spread of wildfires will be slowed or stopped by the removal of fuels).
- 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.
- Linking wildfire safety with environmental protection strategies (i.e., improving forest ecology, wildlife habitat, etc.).
- Developing a vegetation management plan.

# Education and Awareness Programs

## WF-10 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).
- Sponsoring Firewise workshops for local officials, developers, civic groups, and neighborhood/homeowners' associations.
- Consulting Firewise guidance and encouraging or requiring best practices in your community.

## WF-11 Increase Wildfire Risk Awareness

**Education and outreach programs can target citizens, businesses, developers, landscapers, and insurers among others to increase awareness of wildfire risk and strategies for protecting homes and infrastructure. Consider actions such as:**

- Offering GIS hazard mapping online for residents, developers, and design professionals.
- Organizing a local fire department tour to show local elected officials and planners the most vulnerable areas of the community's wildland-urban interface and increase their understanding of risks.
- Working with insurance companies, utility providers, and others to include wildfire safety information in materials provided to area residents.
- Developing partnerships with neighborhood groups, homeowners' associations, and others to conduct outreach activities.
- Using local fire departments to conduct education programs in schools.
- Informing the public about proper evacuation procedures.
- Forming a citizen plan implementation steering committee to monitor progress of local mitigation actions. Include a mix of representatives from neighborhoods, local businesses, and local government.

## WF-12 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.

*Other wildfire-related mitigation actions may also apply to other hazards. See the section entitled "Multiple Hazards" for other possible ideas.*

# Multiple Hazards

The actions presented here are general actions that mitigate multiple hazards.

# Local Planning and Regulations

## MU-1 Assess Community Risk

*FEMA Resources/Publications*

*FEMA 366, 543*

**Understanding community vulnerability and level of risk is important to identify and prioritize mitigation alternatives. Improve risk assessment through the following:**

- Obtaining local data including tax parcels, building footprints, critical facility locations, and other information for use in risk analysis.
- Developing and maintaining a database to track community vulnerability (i.e., exposure in known hazard areas).
- Establishing a process to coordinate with state and Federal agencies to maintain up-to-date hazard data, maps, and assessments.
- Keeping aerial photography current, especially in rapidly developing areas.
- Identifying the most at-risk critical facilities and evaluating potential mitigation techniques.

## MU-2 Map Community Risk

**Maps are an important tool for communicating risk. Consider the following for developing GIS capabilities:**

- Developing a coordinated GIS Department. Find out who uses GIS, determine how it is used, and identify other potential uses.
- Incorporating a GIS system/management plan for tracking permitting, land use patterns, etc.
- Obtaining hazard data and using GIS to map risk for various hazards.

## MU-3 Prevent Development in Hazard Areas

*FEMA Resources/Publications*
*FEMA 476*

**Limit or prohibit development in high-hazard areas through the following types of actions:**

- Encouraging clustering of residential lots outside of hazard areas in subdivision design/review.
- Prohibiting or limiting public expenditures for capital improvements in known hazard areas.
- Organizing a managed retreat from very high-risk areas.
- Purchasing the "right of first refusal" for hazard-prone parcels targeted for public acquisition.
- 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.

## MU-4 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.
- Evaluating the use of performance/impact zoning to set risk-based standards for land development.
- 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).

## MU-5 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.

## MU-6 Integrate Mitigation into Local Planning

**Hazard mitigation can be integrated into local planning efforts through the following:**

- Incorporating risk assessment and hazard mitigation principles into comprehensive planning efforts.
- Incorporating a stand-alone element for hazard mitigation into the local comprehensive (land use) plan.
- Incorporating hazard mitigation into broader growth management (i.e., Smart Growth) initiatives.
- Incorporating a hazard risk assessment into the local development and subdivision review process.
- Adding hazard mitigation measures to existing adequate public facilities (APF) tests and programs.
- Ensuring natural hazards are considered in all land suitability analyses (LSA).
- Determining and enforcing acceptable land uses to alleviate the risk of damage by limiting exposure in such hazard areas.
- Developing a post-disaster reconstruction plan to facilitate decision making following a hazard event.
- Involving citizens in comprehensive planning activities that identify and mitigate hazards.

## MU-7 Strengthen Land Use Regulations

*FEMA Resources/Publications*
*FEMA 100, 268*

**Land use regulations can reduce hazard risk through the following:**

- 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.

## MU-8 Adopt and Enforce Building Codes

*FEMA Resources/Publications*
*FEMA 421,P-762*

**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.
- Providing advanced training to local building inspectors.
- 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.

## MU-9 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.

## MU-10 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.
- 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.
- Encouraging infill development through tax incentives, streamlined approval processes, etc.

## MU-11 Monitor Mitigation Plan Implementation

**Monitoring the implementation of the local mitigation plan can ensure that mitigation actions are being completed through:**

- Forming a plan implementation steering committee to monitor progress on local mitigation actions. Include a mix of representatives from neighborhoods, local businesses, and local government.
- Preparing a plan implementation monitoring schedule and outlining roles for those responsible for monitoring (i.e., local departments, agencies, and committees).
- Preparing and submitting an annual plan implementation progress report to the local elected body.

# Structure and Infrastructure Projects

## MU-12 Protect Structures

*FEMA Resources/Publications*

*FEMA* 577, P-798

**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.

### MU-13 Protect Infrastructure and Critical Facilities

*FEMA Resources/Publications*
*FEMA* 345, 476

**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 hook-ups for critical facilities

## Education and Awareness Programs

### MU-14 Increase Hazard Education and Risk Awareness

*FEMA Resources/Publications*
*EMI IS-22*

**Hazard education and awareness activities that address multiple hazards include:**

- Developing and implementing a multi-hazard public awareness program.
- Providing information on all types of hazards, preparedness and mitigation measures, and responses during hazard events.
- Establishing a "hazard awareness week" in coordination with the media to promote hazard awareness (seasonal).
- Establishing an interactive website for educating the public on hazard mitigation and preparedness measures.
- Annually hosting a public hazards workshop or exposition for all residents.
- Establishing hazard information centers.
- Creating a speakers bureau for disaster-related topics that focus on mitigation and preparedness measures.
- Enhancing hazard awareness of the private sector, particularly lenders, insurance agents, and realtors.
- Scheduling an annual "what's new in mitigation" briefing for the local governing body (possibly with SHMO, etc.).

## MU-15 Improve Household Disaster Preparedness

*FEMA Resources/Publications*
*EMI IS-22*

**Educate the public on how to prepare for hazards and disasters, including the following:**

- Encouraging property owners to purchase hazard insurance not as an alternative to mitigation, but rather to add financial protection if damage does occur.
- Encouraging residents to prepare by stocking up the necessary items and planning for how family members should respond during a disaster. Publicized information about household preparedness can be found at www.ready.gov.
- Providing hazard vulnerability checklists for homeowners to conduct their own inspections.
- Promoting the purchase and use of NOAA weather radios by residents.
- Encouraging citizens to secure loose items (i.e., patio furniture).
- Participating in Nation Weather Service StormReady Program.
- Purchasing and installing NOAA weather radios in schools, government buildings, parks, etc.
- Storing digital or hard copies of public records in low-risk, offsite locations.

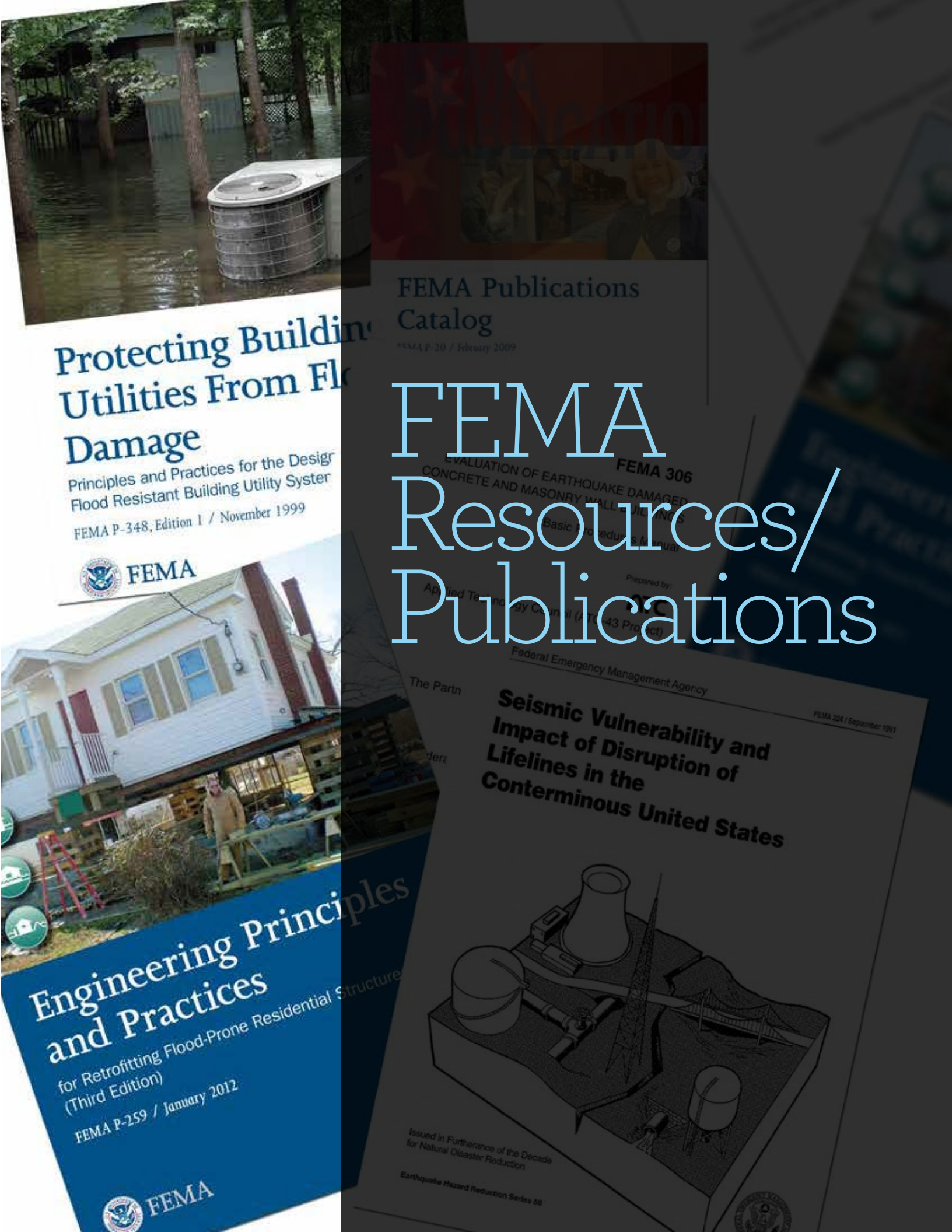
## MU-16 Promote Private Mitigation Efforts

*FEMA Resources/Publications*
*EMI IS-22*

**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.

# FEMA Resources/ Publications



1. **FEMA 20** FEMA Publications Catalog
   http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=2894
2. **FEMA 54** Elevated Residential Structures
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3. **FEMA P-55** Coastal Construction Manual: Principles and Practices of Planning, Siting, Designing, Constructing, and Maintaining Residential Buildings in Coastal Areas (4th ed.)
   http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=1671
4. **FEMA E-74** Reducing the Risks of Nonstructural Earthquake Damage: A Practical Guide. Fourth Edition
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5. **FEMA 83** Seismic Considerations for Communities at Risk
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8. **FEMA 114** Design Manual for Retrofitting Flood-prone Residential Structures
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11. **FEMA 182** Landslide Loss Reduction: A Guide for State and Local Government Planning
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12. **FEMA 202** Earthquake Resistant Construction of Electric Transmission and Telecommunication Facilities Serving the Federal Government
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13. **FEMA 209** Flood: Are You Protected From the Next Disaster
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http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=1645

23. **FEMA 266** Creating a Seismic Safety Advisory Board: A Guide to Earthquake Risk Management
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24. **FEMA 268** Protecting Floodplain Resources - A Guidebook for Communities
http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=1419

25. **FEMA 306** Evaluation of Earthquake Damaged Concrete and Masonry Wall Buildings: Basic Procedures Manual
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26. **FEMA 307** Evaluation of Earthquake Damaged Concrete and Masonry Wall Buildings: Technical Resources
http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=1652

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http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=1421

28. **FEMA 320 FEMA P-320 -** Taking Shelter From the Storm: Construction Plans and Specifications
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http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=1472

30. **FEMA 347** Above the Flood: Elevating your Flood-prone House
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31. **FEMA P-348** Protecting Building Utilities from Flood Damage
http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=1750

32. **FEMA 349** Action Plan for Performance Based Seismic Design
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33. **FEMA 356** Prestandard and Commentary for the Seismic Rehabilitation of Buildings
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35. **FEMA 366** HAZUS-MH Estimated Annualized Earthquake Losses for the United States
http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=3265

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37. **FEMA 395** Incremental Seismic Rehabilitation of School Buildings (K-12) : Providing Protection to People and Buildings
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http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=1850

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46. **FEMA 453** Safe Rooms and Shelters - Protecting People Against Terrorist Attacks
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http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=3723

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http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=4271

72. **FEMA P-798** Natural Hazards and Sustainability for Residential Buildings
http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=4347

73. **FEMA P-804** Wind Retrofit Guide for Residential Buildings
http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=4569

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http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=4958

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http://www.fema.gov/national-flood-insurance-program-2/nfip-technical-bulletins

76. **FEMA ROVER** Rapid Observation of Vulnerability and Estimation Risk (ROVER) Tool
http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=4616

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http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=2314

79. **HMA EHP at-a-Glance Guide:** Project Planning with Considerations for EHP Compliance
http://www.fema.gov/library/viewRecord.do?fromSearch=fromsearch&id=5904

80. **Building Code Tool Kit** (FEMA CD, available in December 2012)
http://www.fema.gov/earthquake

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