WEATHERING THE STORM:

ARE WE READY FOR THE NEXT BIG FLOOD?

Floodwaters coming over the Conestee Dam, south of Greenville on the Reedy River.
Photo courtesy Dave Hargett.

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As part of the
Saluda-Reedy Watershed Consortium

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ARE WE PREPARED FOR THE NEXT BIG FLOOD?

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UPPER SAVANNAH COUNCIL OF GOVERNMENTS

SALUDA-REEDY WATERSHED CONSORTIUM

Appalachian Council of Governments

Prepared by the Appalachian and Upper Savannah Councils of Governments,
in cooperation with Upstate Forever and the Saluda-Reedy Watershed Consortium.

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INTRODUCTION

It seems that, every week or two, there's something in the news about floods. Whether it's statistics on the latest hundred year flood, dramatic photos of rivers running red with mud, or pleas for help from homeowners whose houses are filled with water, flooding has become an all-too-common feature of life in the Upstate.

Throughout our history, rivers and lakes have been key to the development of the Upstate. A hundred years ago, it was the ability of the Saluda and Reedy rivers to generate power that led the textile mills to locate along their banks. Today, these same rivers are the nexus of an economic revitalization that is driven by a desire to live near the water. However, the strength of this engine for growth is threatened by the very process of development that it generates. The shift from rural to urban land uses changes the way water moves across the landscape, increasing flood risks throughout the region.

Heavy rainfall in northwest Greenville on July 27, 2004 caused massive flooding on the Reedy River in downtown Greenville

Fortunately, it's not too late. Through foresight and good planning, communities can reduce both the severity of floods overall and the impacts of floods on our communities. While floods are a natural process that cannot (and should not) be eliminated entirely, there is much we can do to make our communities less flood prone. This report outlines some basic strategies for achieving this goal, and points to resources that communities can draw upon to weather the storm.

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IMPACTS OF DEVELOPMENT ON FLOODING PATTERNS

For as long as there have been rivers, the force of moving water has altered the floodplain landscape. Soil is eroded away in one location, only to be deposited in another. This process serves to absorb and dissipate the tremendous energy of flood waters – but it only works when the landscape as a whole is in a relatively natural state. An intact floodplain reduces the severity of floods by providing rising waters with a place to go. An intact upland reduces the frequency of floods by absorbing and detaining water before it gets to the floodplain in the first place. Such natural processes cost far less money than it would take to build facilities to correct flooding problems, water quality impacts, and all the other consequences of development.

Over the last two centuries, the Upstate landscape has been progressively altered by human development, affecting both the immediate floodplain and the broader upland landscape. Historically, people have been attracted to bodies of water as places for living, industry, commerce and recreation. Land development practices have drastically altered floodplains and waterways, and have resulted in changed patterns of runoff across the landscape as a whole. Everywhere they occur, these modifications have launched a chain of events that begins with increased runoff and – if continued unchecked – leads to severe damage to streams, decreased water quality, and regular flooding.

Combined with the pollutants typically carried by runoff, these changes in waterway form and function result in degraded systems no longer capable of providing good drainage, healthy habitat or natural pollutant processing. The result has been an increasing level of destruction wrought by the once-natural forces of flooding, forcing governments and residents to spend large sums to undo the damage done to property and structures by floods.

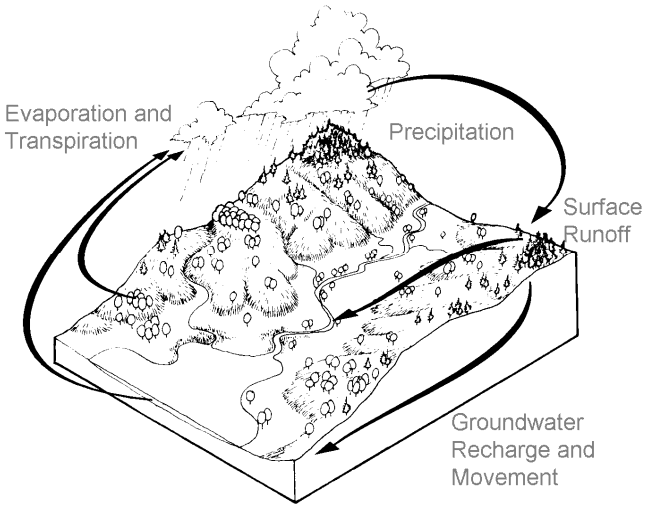
Disruption of the Hydrologic Cycle

The hydrologic cycle circulates water throughout the environment (see below). Floods and floodplains are a natural part of the cycle. This process maintains an overall balance between the amount of water in the air, on the surface and in the ground. Development can throw the hydrologic cycle out of balance, sending more water to an area than it can normally handle.

Development exacerbates flooding because it alters the way water is transported and stored in the environment. Impervious manmade surfaces (asphalt, concrete, rooftops) and compacted earth associated with development create a barrier to the percolation of rainfall into the soil. This disruption of the natural water cycle leads to a number of changes to the hydrologic cycle, including increased volume and velocity of runoff, decreased groundwater infiltration, and increased evaporation. Because these changes result in more water on the surface of the ground and less in the groundwater table, they have a number of impacts on river systems, including:

- Floodwaters that rise faster and higher than in a natural system
- Less water coming into rivers from groundwater recharge between rains

In short, development tends to make floods bigger and droughts drier. All else being equal, increased runoff from developed areas



The Natural Hydrologic Cycle

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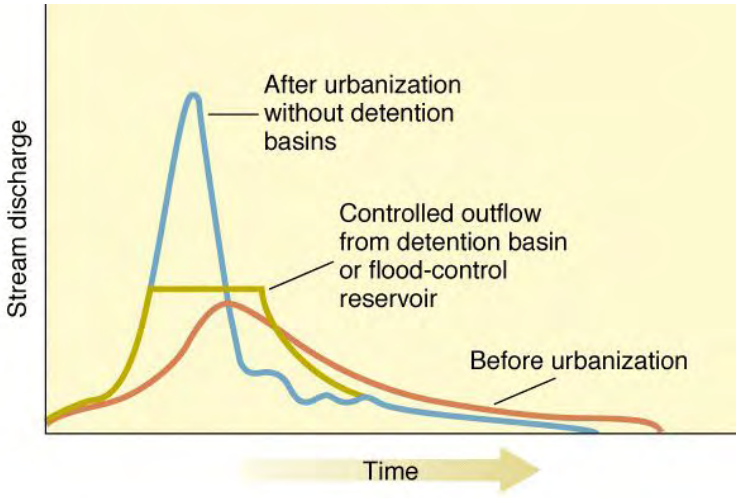

leads to what is known as a "flashy" river system: one in which floodwaters rise extremely rapidly, peak higher than normal, and recede just as quickly.

These alterations to the hydrologic cycle are progressive and often self-reinforcing. That is, once a certain threshold of impact has been exceeded, the system will require active intervention in order to return to normal function. Restoring natural water flows must be accompanied by reconstruction of the stream itself in order to recreate a healthy stream system that is able to absorb floodwaters.

Impacts on Stream Form and Function

Flooding is – to a point – a natural function of river systems, and rivers and floodplains are able to handle floods so long as they fall within the normal historic range of floods experienced by the system. However, when development alters the hydrologic cycle as described above, the system is hit with bigger and more frequent floods than it is able to handle. The cumulative impacts of flooding on stream form and function lead to degradation of water quality and habitat, in the area flooded and downstream.

As development of the upland landscape sends more water to rivers and streams, the resulting increase in volume and intensity of flow within the channel tends to cause increased erosion from stream banks. However, because runoff often carries large amounts of eroded sediment from construction sites and other upland locations, erosion of banks is in some cases matched or exceeded by deposition of sediment along the course of the river. Whatever the balance between erosion and deposition, though, the overall result is a river system that undergoes violent physical change every time it floods. The extreme energy of the system tends to cause stream channels to deepen and straighten, resulting in streams that lose their natural meanders and become progressively more like ditches.

Large areas of pavement disrupt natural drainage processes by causing stormwater to run off faster and in greater quantity than in an natural system.

In addition, as development occurs in the floodplain itself, the ability of the floodplain to handle floods of any magnitude becomes compromised. A natural floodplain is able to handle flooding because it allows flood waters to spread out, dissipating their energy and reducing their impact on stream form and function. Development in the floodplain displaces floodwaters, reducing the ability of the system to handle even a flood that falls within historic parameters. This only exacerbates the trends described

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above, leading ultimately to a river that has no real function or value other than the rapid conveyance of muddy water.

Less easily discerned than the changes to the stream's physical form is the damage to the ecological function of the stream. The large amount of sediment that is in motion during each flood itself tends to destroy aquatic habitat, alternately ripping out the stream's natural features with raging storm waters and smothering them beneath a layer of mud. In addition, bank erosion and frequent flooding degrade habitat along the stream bank, depriving wildlife of important shelter and feeding areas and travel corridors. A stream that floods more severely and more often than it did in its natural state eventually loses most of the features that make it useful and attractive to humans and to wildlife alike.

Restoring the Cycle

Stormwater management has long been part of the land use regulatory process, and has traditionally been accomplished using engineered systems designed to pipe drainage off-site as quickly and efficiently as possible. However, standard drainage "solutions" address neither the root cause of these symptoms – increased runoff due to the way we develop land – nor the resultant environmental effects. If we are to mitigate effectively the impacts of development on rivers, communities need to look at their waterways as an interconnected system and recognize the fundamental changes that development brings to the water cycle, stream form and function, aquatic ecology, and water quality.

There are a number of options that can be employed to reduce the impacts of development on water quantity and quality. Preventing such impacts in the first place is the most effective (and *cost* effective) approach and should always be emphasized. However, many communities are already experiencing flooding problems, and do not have the luxury of designing an ideal system from scratch. In this context, communities should consider a comprehensive strategy consisting of natural resource protection, prevention, appropriate site design, public education, and other strategies designed to restore a rough approximation of natural river function and allow for flooding as a natural part of the hydrologic cycle.

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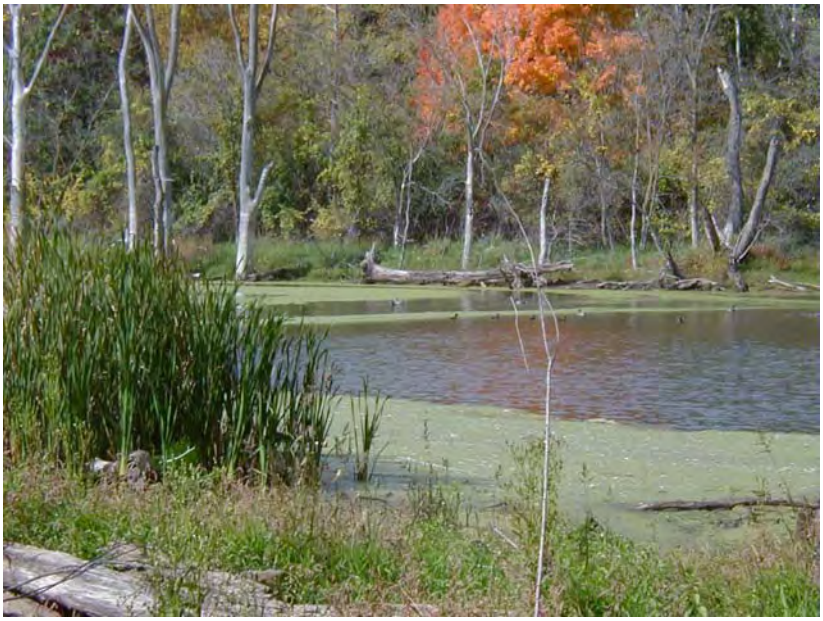
STRATEGIES FOR REDUCING FLOODING IMPACTS

States and communities throughout the U.S. take a number of approaches to reducing the severity and frequency of floods. Under the broad concept of "floodplain management," many communities coordinate the regulatory functions of various agencies to achieve multiple land use, environmental, and public safety goals. Ultimately, an effective program should go beyond the floodplain itself to include a comprehensive slate of corrective and preventive measures for reducing future flood damage. These mitigation measures typically include improved building codes and zoning and subdivision regulations, as well as drainage provisions and other special-purpose floodplain ordinances. The cumulative effect of these measures and ordinances is the creation of a developed landscape that is both better protected from the effects of flooding and that does not contribute to flooding problems downstream.

Each mitigation measure is appropriate in different situations. Structural flood control projects can be the most efficient way to protect an existing critical facility or a concentration of damage-prone buildings, but they are very costly and often simply shift flooding problems downstream. In areas currently undergoing development, prevention measures such as building codes that promote low-impact forms of development make more sense, as they are inexpensive ways to prevent the creation of flood problems in the first place. Of course, the best strategy is to get out ahead of the curve and protect critical flood-prone areas before development occurs by purchasing them for low-intensity public use. The variety of approaches to flood hazard mitigation can be organized into five basic strategies listed in order of preference:

1. **Natural resource protection** refers to the preservation or restoration of natural areas and of the natural functions of floodplains and wetlands in a given subwatershed before development substantially alters the natural hydrology and function of the area.
2. **Flooding prevention** means adjusting comprehensive plans, zoning maps, and building codes so as to reduce stormwater runoff, promote drainage, and ensure that development does not contribute to flood damage.



Wetlands are particularly valuable natural features, as they play a key role in mitigating the impacts of floods.

3. **Public education** involves working with property owners, potential property owners and visitors to inform them about how to identify and avoid flood-prone areas, protect people and property from flooding, and minimize their own contribution to stormwater problems.
4. **Property protection** refers to modifications to buildings or other facilities – ranging from flood-proofing to building elevation to acquisition and removal – to protect them from recurring flood damage.

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5. **Structural projects** are a last resort used to prevent floodwaters from reaching properties, and generally involve construction of facilities such as dams and levees that are intended to control water flows.

Natural resource protection

Preserving rivers, floodplains and wetland areas in a natural state is the cornerstone of any flood management program, as it is the most effective way to prevent future flooding problems. As explained earlier, an intact floodplain functions as a natural flood prevention "structure," absorbing and dissipating the energy of floods. Wetland areas in floodplains are especially valuable, as they are effective at removing nutrients and other pollutants from floodwaters as well.

Efforts to protect river corridors usually are implemented in one of two ways: either via regulation by environmental or code enforcement agencies, or via acquisition by parks and recreation authorities. A community can establish requirements for preservation of riparian buffers in development codes and ordinances, through easement agreements, or by acquiring the land for the buffer areas through a direct sale. By combining preservation with other desired low impact activities such as creation of new public parks and greenways, communities can often build enthusiastic support for natural resource protection programs.

Prevention

After protection of key natural flood mitigation areas, the next step is prevention of development impacts via good planning and sound municipal codes. While specific programs or functional organizations may vary considerably from community to community, a "comprehensive approach" to floodplain management is generally considered to include:

Constructed stormwater wetlands like this one at a golf course are an effective means of reducing flooding, and are becoming a common feature of municipal codes.

A comprehensive land use plan. This is a collection of policies and guidance on how the community is expected to grow, change, and look in the future. With respect to flood hazard areas, this plan should recognize existing and future flooding risks and establish a goal of reducing future flooding problems through the various mechanisms available to municipalities.

A zoning ordinance. Zoning is one of many tools available to help communities achieve the goals set forth in the plan. Zoning typically divides a community into districts and establishes use and development criteria within each district type. Development criteria specify such parameters as density, size, bulk, height, setbacks, and appearance of buildings. Some communities also use zoning to address floodplain protection, establishing a separate floodplain conservation zone with its own specifications regarding permitted uses. Other communities establish a floodplain protection "overlay" to the other zones, in which case the specifications for each zone that falls within the overlay are modified to achieve flood-related goals.

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Land development and/or subdivision ordinances. These regulations typically address lot size, shape, and setbacks; curbs, sidewalks, and gutters; open space; and public improvements such as street layout and dimensions, drainage and stormwater management, and installation of utilities. The built landscape takes its form largely from the standards set by these ordinances, and many of the elements contained therein have a major impact on the relative severity of flooding problems generated by new development. Regulations governing the amount of pavement that is created in the development process – street width, parking lot ratios, and the like – are particularly important, as are provisions that describe allowable techniques and required standards for managing stormwater. In addition, many land development ordinances are designed to avoid mapped flood hazard areas through the use of open space conservation and setbacks from bodies of water. Where floodplain impacts are unavoidable, ordinances may guide development to less hazard-prone areas through clustering of building pads on higher ground or by requiring non-fill methods of elevating buildings. Other flood mitigation related requirements include the preservation of open space (especially in wetland or floodplain areas), the establishment of erosion and sediment control standards, and the use of "best management practices" to control stormwater runoff, such as detention ponds that store rain water allowing for slow seepage into the groundwater table.

Subdivision ordinances often require wider streets and larger cul de sacs than are necessary, leading to increased stormwater runoff.

Building and other health and safety codes. These are applied after decisions regarding what and where to build have been made. The primary purpose of building and other health and safety codes is to provide minimum requirements to safeguard the public safety, health, and general welfare. They can govern how structures must be built in order to minimize the risk of flooding damage.

Public Education

While local governments often take the lead in public education programs, nonprofit community organizations can play a significant role as well. Public education efforts can include distributing floodplain map information, educating citizens about flood patterns, requiring real estate disclosure, and providing technical assistance during the development process. Educational programs should also provide "how to" guides on measures individual property owners can take to reduce flooding, such as restoring areas adjacent to lakes and streams to their natural state, using rain gardens and rain barrels to collect and reuse stormwater, and the like. A final component of public education entails building public awareness about what to do in the event of a flood so as to reduce the risk of injury and damage to property.

Property Protection

This category refers to efforts to retrofit a structure or land area after it has been constructed or developed and experienced flooding. Property protection measures are used to modify buildings so as to make them less vulnerable to flood damage rather than engaging in efforts to keep floodwaters away. While it is typically more economical to prevent flooding through natural resource protection or prevention

measures, in an already developed area with flooding problems, property protection measures can be the best solution for responding to repeated flooding. Many of the measures do not affect a building's appearance or use, making them particularly appropriate for historical sites and landmarks. These measures include:

- Constructing structure-specific drainage systems
- Floodproofing structures
- Installing sewer backup protection
- Elevating building foundations
- Grading or altering the slope
- Relocating structures to a higher location on the lot

Structural Projects

Structural flood control projects are a last option to prevent future flooding in a developed area in which all else has failed. These measures are called "structural" because they involve construction of man-made structures to control water flows. There are six common types of projects:

- Building reservoirs
- Constructing levees and floodwalls
- Modifying or hardening the river channel
- Enlarging culverts or bridge openings
- Building water diversions
- Expanding stormwater drainage systems

Hardened channels often create more problems than they solve.

Structural projects can be very expensive. They often disturb the land and disrupt natural water flows, destroying habitats. They require regular maintenance, and if maintenance is neglected, the consequences can be disastrous. Some kinds of structural projects – particularly those that constrict, channelize, or speed streamflow – simply shift flooding problems downstream. Structural projects should be undertaken only after a thorough study of the likely effects of the project basin-wide, and solutions that work with natural processes are preferable to those that replace them.

The Benefits of Mitigation Planning

It is unfortunately rather common for different departments or units of government within a given community to implement activities that are not coordinated or that may even conflict with one another. In addition, floodplain residents and property owners are not always aware of things that are being done to protect them from flooding, nor are they aware of things they can do to protect themselves, or how they can contribute to community efforts. Developing a flood hazard mitigation plan is one of the best ways to correct these shortcomings.

The objective of hazard mitigation planning is to produce a program of activities that will best tackle the community's flood problem and meet other community needs. A well-prepared plan will:

- Ensure that all activities with any relation to flooding are reviewed and modified so as to make them consistent with and supportive of each other
- Link floodplain management policies to upland-specific policies to as to reduce the conflicts between land development goals and flood prevention goals

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- Educate residents about flood hazards, flood loss reduction measures, and the natural and beneficial functions of floodplains
- Build public and political support for projects that prevent new flood problems, reduce flood losses and protect the natural and beneficial functions of floodplains
- Facilitate implementation of floodplain management activities through an action plan that has specific tasks, staff assignments and deadlines

Given how many disparate government activities and functions affect flooding, a comprehensive flood mitigation plan is the best way to ensure that local policies are not working at cross purposes with each other. A well-prepared plan will guide a community's flood, stormwater and related activities so that they are implemented more economically and in ways that minimize future costs.

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THE FLOOD: BEFORE, DURING, AND AFTER

Even with the best planning and mitigation, floods still happen. Emergency service measures protect people, property, public facilities, and the environment during and after a flood. Most counties and many cities have emergency management offices to coordinate warning, response, and recovery during a disaster. Measures include:

- Flood threat recognition
- Critical facilities protection
- Warning dissemination
- Health and safety maintenance
- Flood response
- Post-disaster recovery and mitigation
- Flood insurance

Flood Threat Recognition

The first step in responding to a flood is to know that one is coming. A flood threat recognition system provides early warning to emergency managers. A complete system measures rainfall, soil moisture, and stream flows upstream in order to calculate the time and height of the flood crest downstream. On many rivers, the flood threat recognition work is done by the National Weather Service (NWS). National Weather Service forecasts, advisories, and warnings for the Saluda-Reedy area are issued by the National Weather Service Forecast Office at the Greenville-Spartanburg International Airport. Information is disseminated through the NOAA Weather Radio, the Weather Forecast Office website (www.erh.noaa.gov/er/gsp.html) and local media.

For weather conditions posing an immediate danger, the Emergency Broadcast System is utilized. Flood data for the region is available from both the website of the Greenville-Spartanburg Forecast Office, as well as from the National Weather Service's Southeast River Forecast Center, located in Peachtree City, Georgia. The URL for its website is www.srh.noaa.gov. Communities on smaller streams that want specific flood threat data must develop their own systems. They may install rain and river gauges in key locations, and then gather data from them electronically or manually.

Warning Dissemination

Once the flood threat recognition system tells the emergency manager that a flood is coming, the next step is to notify the public and staff in other agencies and critical facilities that a flood is imminent. The earlier and the more accurate the warning, the greater the number of people who can take protective measures.

As noted above, a flood warning may be disseminated in a variety of ways, including via NOAA Weather Radio, sirens, radio, television, cable TV, mobile public address systems, telephone trees, and even door-to-door contact. Multiple or redundant systems are most effective. If people do not hear one warning, they may still get the message from another part of the system.

Flood Response

Once a flood threat is recognized, the first priority is to alert others through the flood warning system. The second priority is to respond with actions that can prevent or reduce damage or injury. Such actions (and the responding parties) include:

- Activating the emergency operations center (emergency manager)

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- Sandbagging areas vulnerable to flooding (public works or road department)
- Closing streets or bridges (police or sheriff's department)
- Shutting off power to threatened areas (utility company)
- Releasing children from school (school district)
- Ordering an evacuation (governor/mayor)
- Opening evacuation shelters (churches, schools, or the Red Cross)
- Monitoring water levels (engineer)
- Guarding sandbag walls and other protection measures (police)

A flood response or emergency action plan is the best way to ensure that all bases are covered and that the response activities are appropriate for the expected flood threat. It is developed in coordination with the agencies or offices that have responsibilities under the plan.

A flood response plan should include a flood stage forecast map. This map relates flood levels to topographic information to show where various floods will go. The plan should identify different activities for the different flood levels. Drills and exercises should be conducted between floods to ensure that key participants understand their duties. The result is a coordinated effort implemented by people who have experience working together so that available resources will be used most efficiently.

Most communities' emergency response plans do not address the known local flood hazard. With a little warning and a flood stage forecast map that relates the predicted crests to affected areas, communities could prepare more site-specific and more useful response plans. Related information and technical assistance for these activities is available from the Greenville-Spartanburg National Weather Service office.

Critical facilities protection

The South Carolina Emergency Preparedness Division (EPD) defines a critical facility as a structure or system identified by a local government that performs an essential emergency function. Critical facilities fall into the categories of warning, health and medical, utilities, emergency operations and bridges on priority transportation or evacuation routes. County emergency managers periodically update their lists of critical facilities and report them to EPD.

Protecting critical facilities during a flood is a vital part of any emergency services effort. If a critical facility is flooded, workers and resources may be unnecessarily drawn away from protecting the rest of the community. If such a facility is prepared, it will be better able to support the community's flood response efforts.

Each critical facility should have its own flood response plan coordinated with the community's. Most critical facilities have fulltime professional managers or staffs who are responsible for the facility during a disaster. These people often have their own emergency response plans. DHEC regulations require all health care facilities to have an emergency plan. The requirement was originally for fire safety purposes, but has since grown and been interpreted to include tornadoes, hurricanes, flooding and hazardous materials. Other critical facilities may or may not have emergency plans. For example, local school districts determine whether their schools should have one. Similarly, local emergency managers may or may not have coordinated with the critical facilities in their jurisdictions.

Health and safety maintenance

Preventing dangers to health and safety is critical after a flood. The flood response plan should identify appropriate measures to take. These include:

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- Patrolling evacuated areas to prevent looting
- Providing safe drinking water
- Vaccinating residents for tetanus and similar diseases
- Clearing streets
- Cleaning up debris and garbage
- Evaluating damaged buildings to determine if they can be reentered

The plan also should identify which agencies will be responsible for carrying out these measures. Normally, they are the police, sheriff, or public health authorities. Many people are more interested in returning to and repairing their flooded properties than in taking health and safety precautions. A public information program to counter this natural tendency is an essential part of any flood response plan.

Post-disaster recovery and mitigation

After a disaster, communities should undertake activities that can prepare people and property for the next one. They are implemented during recovery to keep people from immediately going "back to normal" (i.e., the same way they were before the disaster). These measures include:

- Regulating reconstruction to ensure that it meets all code requirements, including the National Flood Insurance Program's "Substantial Damage Regulations," which provide standards for the re-construction of damaged structures that are covered by the federal flood insurance program
- Public information to advise residents about mitigation measures they can incorporate into their reconstruction work (e.g., using waterproof materials and elevating utilities above flood level)
- Evaluating damaged public facilities to identify mitigation measures that can be included during repairs
- Acquiring substantially or repeatedly damaged properties from willing sellers
- Planning for long term mitigation activities
- Applying for post-disaster mitigation funds

Requiring permits, making inspections and enforcing the substantial damage regulations can be very difficult for local, partially-trained and understaffed offices after a disaster. If not done right, not only does a community miss a tremendous opportunity to redevelop or clear out a hazardous area, it may be violating its obligations to the federal National Flood Insurance Program, which could jeopardize the ability of property owners from receiving coverage in the future.

The National Flood Insurance Program (NFIP)

The original authorizing legislation for the National Flood Insurance Program was passed in 1968. The NFIP was founded on the principle that managing floodplain development at the local level will lead to avoidance and minimization of future flood damage. It creates a partnership based on a mutual agreement between the Federal Government and the community. The federal government makes NFIP flood insurance and other federal assistance available to residents and businesses, and communities agree to regulate mapped flood hazard areas to reduce future flood damage.

When a community decides to participate in the NFIP, it accepts the responsibility to adopt, administer, and enforce floodplain management provisions that either

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meet or exceed the minimum NFIP requirements. Communities become partners with the Federal Emergency Management Agency. The objectives of the partnership are to reduce safety risks to people, protect the natural and beneficial functions of floodplains, to mitigate flood damage to real and personal property, and to create disaster resistant communities.

The National Flood Insurance Program is administered by the Federal Emergency Management Agency and has three main elements:

1. *Hazard identification and mapping*, under which engineering studies are conducted and flood maps are prepared to delineate areas that are predicted to be subject to flooding under certain conditions;
2. *Floodplain management criteria for development*, which establish the minimum requirements for communities to apply to development within mapped flood hazard areas with the intent of recognizing hazards in the entire land development process; and
3. *Flood insurance*, which provides financial protection for property owners to cover flood-related damage to buildings and contents.

Federal flood insurance is designed to provide an alternative to disaster assistance and disaster loans for home and business owners. Disaster assistance rarely comes close to covering all of the costs to repair and clean up. While available to qualified victims, disaster loans do not significantly ease the financial burden due to repayment terms. Disaster loans are available only after major disasters and when the U.S. Small Business Administration determines that an event has affected a certain number of uninsured homes and businesses. In contrast, NFIP flood insurance claims will be paid any time damage from a qualifying flood event occurs.

Another important objective of the NFIP is to break the cycle of flood damage. Many buildings have been flooded, repaired or rebuilt, and flooded again. Before the NFIP, this cycle occurred every couple of years in some areas, with people rebuilding in the same flood prone areas and using the same construction techniques that did not adequately resist flood damage the first time. By encouraging communities to guide development to lower-risk areas, and requiring elevation of new buildings and non-conforming buildings that sustain major damage, the NFIP is an important part of creating disaster resistant communities.