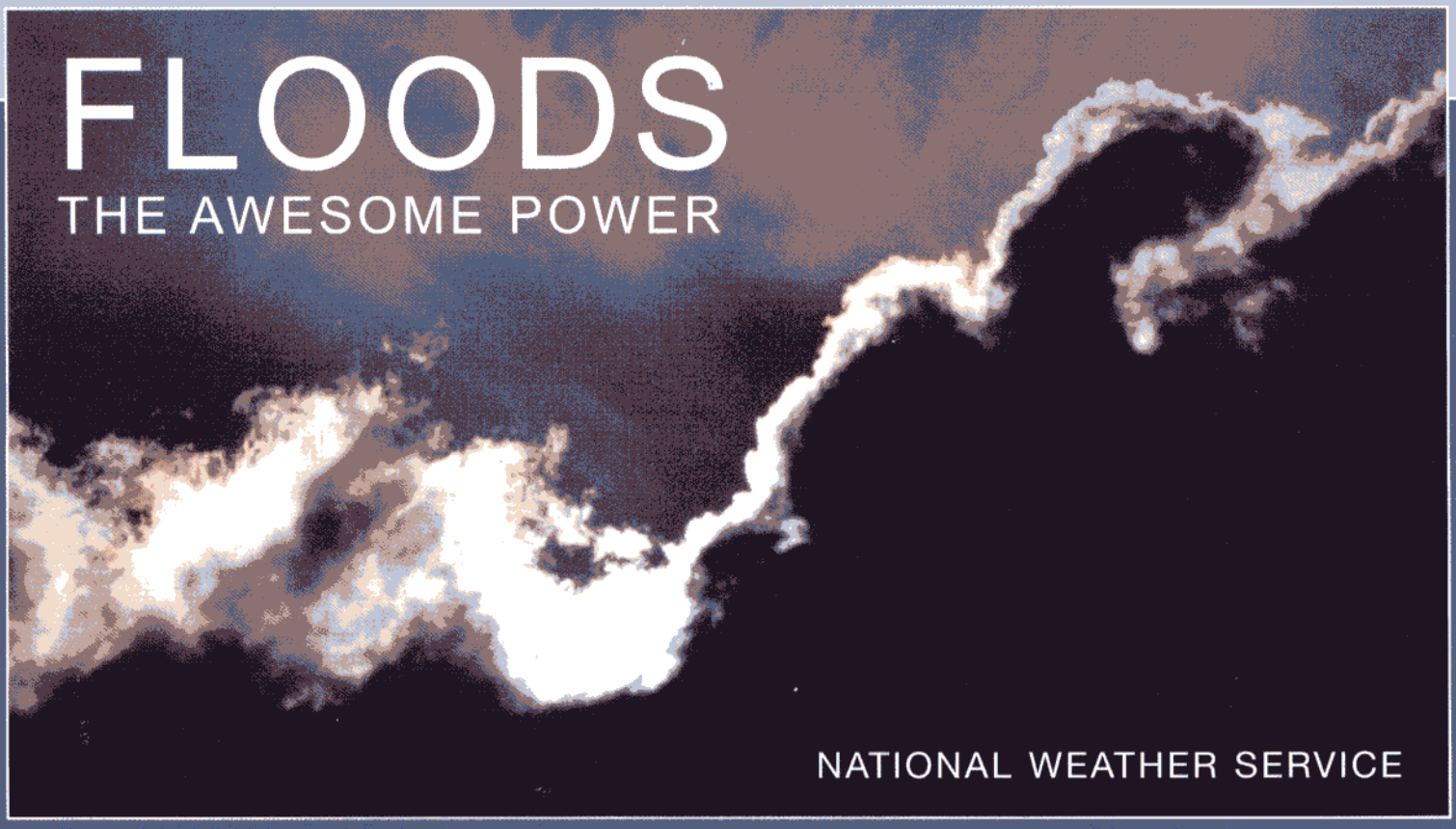
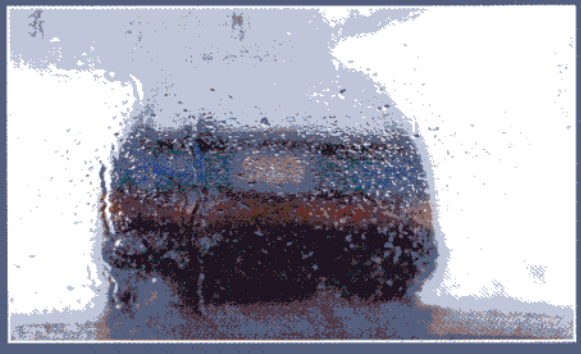
FLOODS

THE AWESOME POWER



NATIONAL WEATHER SERVICE



U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration
NOAA's National Weather Service
March 2005

NOAA/PA 200467

FLOODS
THE AWESOME POWER

"Flooding never happens here. Tom was trying to get home. He drives on the road near the stream every day. We knew it had been raining a lot, but it had been so dry, we were actually happy about the rain. Tom saw some water on the road, but thought it wasn't that deep. And, after all, he was in his truck, high up off the ground. But then his truck started to float, and before he knew it, his truck was washed downstream with him in it. Fortunately, his truck got stuck on a rock or something, and someone saw him and threw him a line. Tom got out okay. But we really learned from this, not to drive in floods."

– Testimony of Marilyn and Tom
(last name requested to be withheld)

INTERVIEWED BY THE AMERICAN RED CROSS AFTER TROPICAL STORM ALLISON STRUCK TEXAS IN JUNE 2001

Why Should I Be Concerned About Flooding?

This preparedness guide explains flood-related hazards and suggests lifesaving actions you can take. With this information you can recognize a flood potential, develop a plan, and be ready when threatening weather approaches. Remember... your safety is up to YOU!

In the long term, floods kill more people in the United States than other types of severe weather. In recent years, only heat surpassed flood fatalities. Floods can roll boulders the size of cars, tear out trees, destroy buildings and bridges, and pose a significant threat to human lives.

Online Resources

Additional flash flood/flood-related safety information can be obtained at:

American Red Cross
http://www.redcross.org/

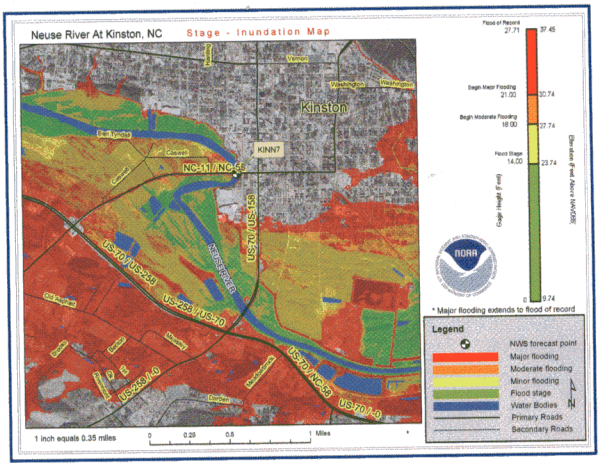
Federal Emergency Management Agency
http://www.fema.gov/

U.S. Geological Survey
http://www.usgs.gov/

National Weather Service
http://www.nws.noaa.gov/

Once a river reaches flood stage, the flood severity categories used by the NWS include minor flooding, moderate flooding, and major flooding. Each category has a definition based on property damage and public threat.

Graphical depiction of NSW severity Categories.



Flood Severity Category

The NWS characterizes flood severity to more effectively communicate the impact of flooding. It uses the following categories:

Minor Flooding – minimal or no property damage, but possibly some public threat or inconvenience.

Moderate Flooding – some inundation of structures and roads near streams. Some evacuations of people and/or transfer of property to higher elevations.

Major Flooding – extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.

The impacts of floods vary locally. For each NWS river forecast location, flood stage associated with each of the NWS flood severity categories are established in cooperation with local public officials. Increasing river levels above flood stage constitute minor, moderate, and major flooding. Impacts vary from one river location to another because a certain river stage (height) above flood stage in one location may have an entirely different impact than the same level above flood stage at another location.

BARRICADES ARE PUT UP FOR YOUR PROTECTION.
TURN AROUND AND GO ANOTHER WAY!

What Are Flash Floods?

A flash flood is a rapid rise of water along a stream or low-lying urban area. Flash flood damage and most fatalities tend to occur in areas immediately adjacent to a stream or arroyo, due to a combination of heavy rain, dam break, levee failure, rapid snowmelt, and ice jams. Additionally, heavy rain falling on steep terrain can weaken soil and cause debris flow, damaging homes, roads, and property.

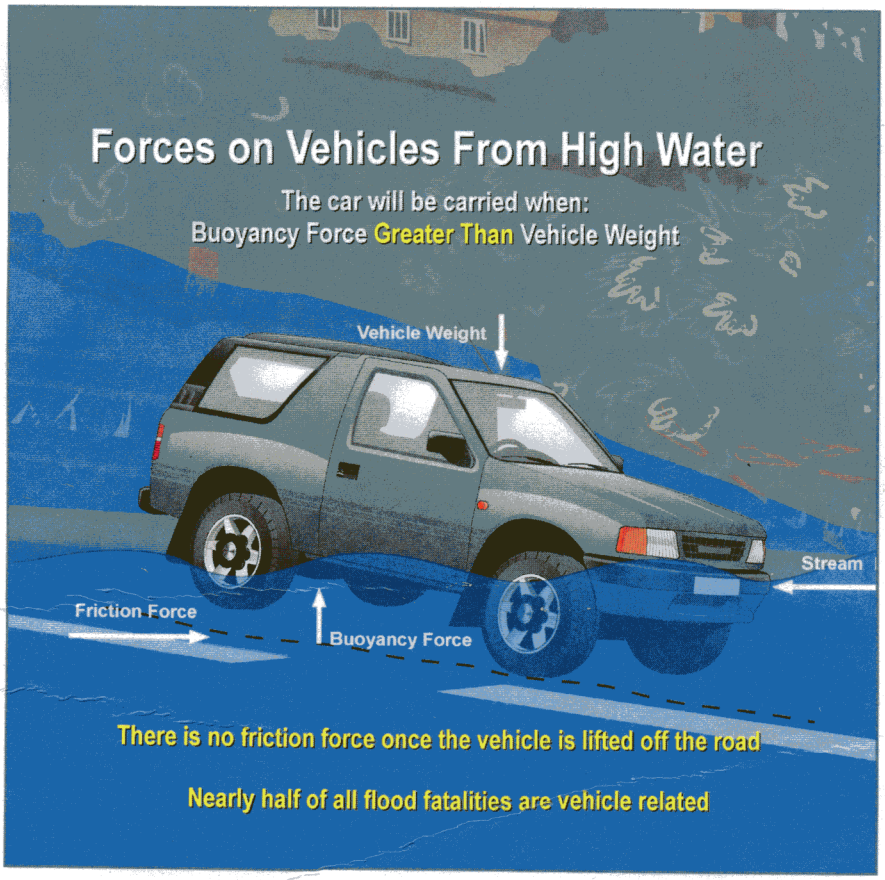
Flash floods can be produced when slow moving or multiple thunderstorms occur over the same area. When storms move faster, flash flooding is less likely since the rain is distributed over a broader area.

Flash Flood Risk in Your Car, Truck, or Sport Utility Vehicle (SUV)

Almost half of all flash flood fatalities occur in vehicles. Contrary to popular belief, many people don't realize two feet of water on a bridge or highway can float most vehicles. If the water is moving rapidly, the car, truck, or SUV can be swept off the bridge and into the creek.

Water can erode the road bed, creating unsafe driving conditions. Underpasses can fill rapidly with water, while the adjacent roadway remains clear. Many flash floods occur at night when flooded roads are difficult to see.

When you approach a flooded road, TURN AROUND, DON'T DROWN!



Warning Sign

This Federal Highway Administration compliant Warning Sign should be permanently deployed at locations where the incident of flooding is high, the onset of flooding is rapid, and/or where flooding occurs in isolated locations. For details on producing this FHWA sign, go to:

http://mutcd.fhwa.dot.gov/SHSm/warning.pdf
Select W8-13 for template of Warning Sign.

Incident Sign

This Federal Highway Administration compliant Incident Sign should be temporarily deployed by emergency personnel on an as needed, event driven basis. For details on producing this FHWA sign, go to:

http://mutcd.fhwa.dot.gov/SHSm/warning.pdf
Select W11-12 for template of Incident Sign.

▲ Photo: Harris County Flood Control District, Houston, Texas

Major flooding from Tropical Storm Allison in Houston, Texas, June 2001.

Flash Flood Risks at Home, Work, or School

Since many flash floods occur along small streams, you can determine your risk by knowing your proximity to streams. Flooding can be caused by rain falling several miles upstream and then moving downstream rapidly.

Densely populated areas have a high risk for flash floods. The construction of buildings, highways, driveways, and parking lots increases runoff by reducing the amount of rain absorbed by the ground. This runoff increases the flash flood potential. Sometimes, streams through cities and towns are routed underground into storm drains. During periods of heavy rainfall, storm drains may become overwhelmed and flood roads and buildings. Low spots, such as underpasses, underground parking garages, and basements can become death traps.

Embankments, known as levees, are built along rivers and are used to prevent high water from flooding bordering land. In 1993, many levees failed along the Mississippi River, resulting in devastating flash floods.

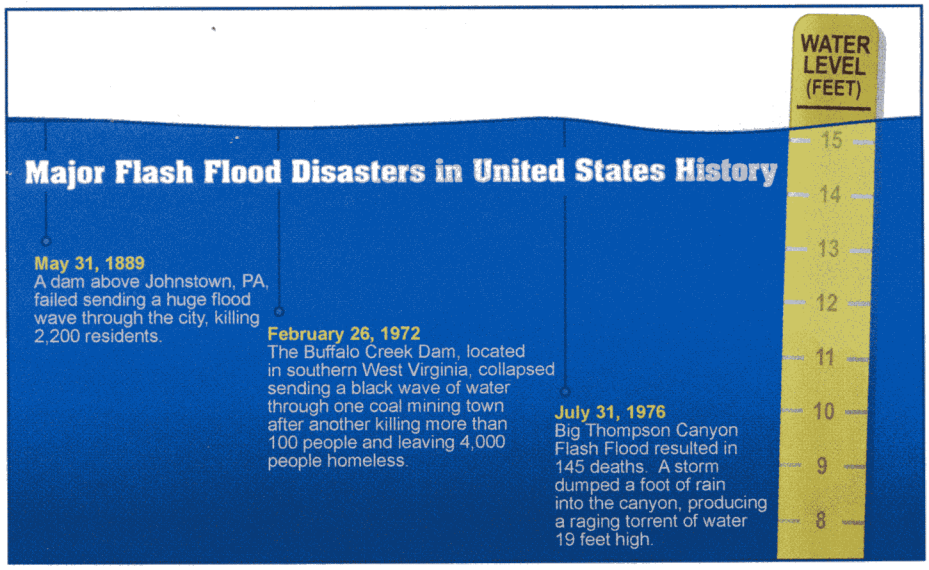
Dam failures have played a deadly role in the history of flash flooding. The United States has about 76,000 dams, and about 80 percent of those are of earthfill construction. Be aware of any dams upstream of your location. Earthen dams are more easily compromised by heavy rainfall than are concrete structures. Water flowing over an earthen dam can cause the dam to weaken or fail, sending a destructive wall of water downstream.

Flash Flood Risk to Recreation (Camping, Hiking, Boating, Fishing)

Many people enjoy hiking, fishing, or camping along streams and rivers. Listen to weather forecasts and keep away from streams if thunderstorms have happened or have been predicted upstream from where you are. A creek only 6 inches deep in mountainous areas can swell to a 10-foot deep raging river in less than an hour if a thunderstorm inundates the area with intense rainfall.

When thunderstorms are in the area, stay alert for rapidly changing conditions. You may notice the stream start to rise quickly and become muddy. You may hear a roaring sound upstream that may be a flood wave moving rapidly toward you. Head immediately for higher ground. Don't be swept away by the rising water. There are dangers associated with fast-moving water, but with common sense and some preparation, outdoor enthusiasts can enjoy a safe day along a stream or river.

Source: **National Weather Service** ▸



LISTEN FOR ROARING SOUND UPSTREAM AS FLOOD WATERS COULD BE HEADED YOUR WAY!

LOOK FOR RAPIDLY RISING WATER AND/OR WATER TURNING MUDDY!

REMEMBER TO CLIMB TO SAFETY IF YOU HEAR OR SEE SIGNS OF A FLOOD!

◂ Photo: Steve Allen Photography, Waitsfield, VT
Road damage as a result of flash flooding.

Where You Are Determines Your Flash Flood/Flood Risk

Mountains and steep hills produce rapid runoff and quick stream response. Rocks and clay soils do not allow much water to infiltrate the ground. Steep narrow valleys generate rapid flowing waters that can rise quickly to a considerable depth. Saturated soil also can lead rapidly to flash flooding.

Very intense rainfall can produce flooding even on dry soil. In the West, most canyons and "small streams" are not easily recognizable as a source of danger. Canyons can be scoured with sudden walls of water 10-15 feet high (e.g., Antelope Canyon, Arizona, August 1997, 11 fatalities).

Additionally, high risk locations include low water crossings, recent burn areas in mountains, and urban areas from pavement and roofs which concentrate rainfall runoff.

PERSISTENT THUNDERSTORMS OVER THE SAME GEOGRAPHICAL AREA CAN LEAD TO RIVER FLOODING.

What Are River Floods?

A flood is the inundation of a normally dry area caused by an increased water level in an established watercourse. River flooding is often caused by:

- Excessive rain from tropical systems making landfall.
- Persistent thunderstorms over the same geographical area for extended periods of time.
- Combined rainfall and snowmelt.
- Ice jam.

Photo: Jim Rackwitz, St. Louis Post-Dispatch ▸
River flooding due to excessive rain.

Photo: Steve Allen Photography ▸
River flooding due to ice jam.

FLOODS ARE LONG TERM EVENTS AND MAY LAST DAYS, WEEKS, OR LONGER!

Tropical Cyclones and their Remnants

Floods are often produced by hurricanes, tropical storms, and tropical depressions. A tropical cyclone's worst impact may be the inland flooding associated with torrential rains.

When these storms move inland, they are typically accompanied by very heavy rain. If the decaying storms move slowly over land, they can produce rainfall amounts of 20 to 40 inches over several days. Widespread flash flooding and river flooding can result from these slow-moving storms.

A hurricane also can produce a deadly storm surge that inundates coastal areas as it makes landfall. Storm surge is water pushed on shore by the force of the winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the average water level 15 feet or more.

The worst natural disaster in the United States, in terms of loss of life, was caused by a storm surge and associated coastal flooding from the great Galveston, Texas, hurricane of 1900. At least 8,000 people lost their lives.

▲ Deaths from hurricane coastal flooding have fallen dramatically in recent years, but storm surge remains a great threat.

"50% of deaths associated with tropical cyclones are a result of inland flooding over the last 30 years."

–Ed Rappaport, National Hurricane Center

1972	1994	1999	2001
Hurricane Agnes 122 deaths	**Tropical Storm Alberto** 33 deaths	**Hurricane Floyd** 56 deaths	**Tropical Storm Allison** 44 deaths
Agnes produced floods in the northeast United States contributing to $6.4 billion in damages.	Alberto drifted over the southeast United States producing torrential rainfall and drowning 33 people. Damages exceeded $750 million dollars.	Floyd brought intense rains and record flooding to the eastern United States. Of the 56 people who perished, 50 drowned from inland flooding.	Allison flooded the coastal sections from the Gulf Coast to New England. More than 3 feet of rain was reported along the Gulf Coast.

Stay Informed

Listen to National Oceanic and Atmospheric Administration (NOAA) Weather Radio All Hazards, commercial radio, or television; or go to the Internet for the latest flash flood and flood **watches, warnings, and weather advisories** at: http://iwin.nws.noaa.gov/iwin/nationalwarnings.html

For planning purposes, Flood Hazard Map information is only a click away by going to the Federal Emergency Management Agency web page at: http://www.fema.gov/mit/tsd

The Advanced Hydrologic Prediction Service (AHPS)

AHPS of the National Weather Service provides improved river and flood forecasting and water information. AHPS has a suite of graphical Internet products to assist community leaders and emergency managers in making better life- and cost-savings decisions about evacuating people and moving property before a flood occurs.

AHPS major themes:

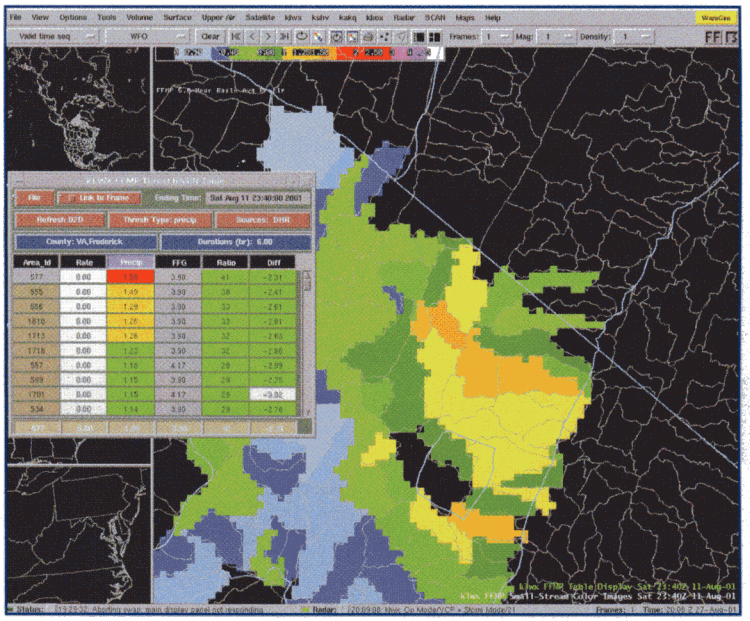
- Short-term through long-term forecasts (from minutes to months including probabilistic products for risk management decisions).
- Real-time flood forecast maps depicting a real extent of flooding.
- More timely and accurate flash flood warnings through the use of enhanced flash flood decision assistance tools.

According to the National Hydrologic Warning Council report, "Use and Benefits of the National Weather Service River and Flood Forecasts," AHPS, once fully implemented throughout the United States, will provide more than $750 million in economic benefits each year.

Additional AHPS information can be obtained at: http://www.nws.noaa.gov/om/water/Ahps.shtml

Source: National Weather Service

AHPS Weather Display



Use NOAA Weather Radio All Hazards!

NOAA Weather Radio All Hazards is the best way to receive warnings from the National Weather Service. NOAA Weather Radio All Hazards is a nationwide network of radio stations broadcasting continuous weather information direct from a nearby National Weather Service office.

NOAA Weather Radio All Hazards broadcasts National Weather Service warnings, watches, forecasts, and other hazard information 24 hours a day. The average reception range is a 40-mile radius from the transmitter, depending on topography. Be aware of the potential for flooding before the heavy rainfall begins by listening to NOAA Weather Radio All Hazards.

Purchase a NOAA Weather Radio All Hazards that has a battery back-up, a Specific Area Message Encoder (SAME) feature, which automatically alerts you when a Watch or Warning is issued for your county or parish, and one that can receive all seven NOAA Weather Radio frequencies.

NOAA Weather Radio All Hazards can also broadcast post-event information for all types of hazards – both natural (earthquakes, hurricanes and volcanos) and environmental (chemical or oil spills).

The NOAA Weather Radio All Hazards network has more than 650 transmitters, covering the 50 states, adjacent coastal waters, Puerto Rico, the U.S. Virgin Islands, and the U.S. Pacific Territories. NOAA Weather Radio requires a special radio receiver or scanner capable of receiving the signal. Broadcasts are found in the public service band at these seven frequencies (MHz): 162.400, 162.425, 162.450, 162.475, 162.500, 162.525, 162.550 (also known as channels 1 through 7).

NOAA Weather Radio All Hazards requires a special radio receiver or scanner capable of picking up the signal. These receivers can be purchased at retail electronic and sporting good stores.

NOAA WEATHER RADIO BANDS: CHANNEL FREQUENCIES (MHz)

1	162.400
2	162.425
3	162.450
4	162.475
5	162.500
6	162.525
7	162.550

To help America prepare for the ravages of flash floods and floods, the National Weather Service has designed StormReady, to arm America's communities with the communication and safety skills necessary to save lives and property.

More information is available at: www.nws.noaa.gov/stormready

Community Preparedness Plans

After you have developed a personal/family safety plan, find out about your community safety plan. Each community prone to a flash flood/flood should develop a safety plan. Local officials should have detailed information for your immediate area. Please listen and follow their recommendations before, during, and after a storm.

The best way to prevent loss of life is to design and build communities where roads remain usable and undamaged during floods, and where homes and businesses are protected. While this may not always be possible, it is a goal we hope every community strives to reach.

Protect yourself, your home, your family, and your financial future.

National Flood Insurance Program

One of the most important things you can do to protect your home and family before a flood is to purchase a flood insurance policy. You can obtain one through your insurance company or agent. Your agent can tell you whether the standard or preferred policy (for medium or low risk) is most appropriate for you. Flood insurance is backed by the National Flood Insurance Program (NFIP), administered by the Federal Emergency Management Agency. Your homeowners insurance does not cover flood damage. Everyone has some flood risk and anyone in a participating community is eligible. Don't wait until a flood is coming to purchase your policy. It normally takes 30 days after purchase for a flood insurance policy to go into effect. For more information about the NFIP and flood insurance, contact your insurance company or call the NFIP at 800.427.4661.

Check with your city or county government (start with the Building or Planning Office) to find out if you live in a participating community and what flood risk information is available where you live.

What My Community Can Do

- Provide river and rainfall readings to emergency managers and the National Weather Service.
- Establish early warning procedures.
- Create and operate a Local Flood Warning System to identify areas vulnerable to flooding.
- Produce and follow the flood emergency plans.

Contact your local emergency management agency or local National Weather Service office for further information on Local Flood Warning Systems, or visit:

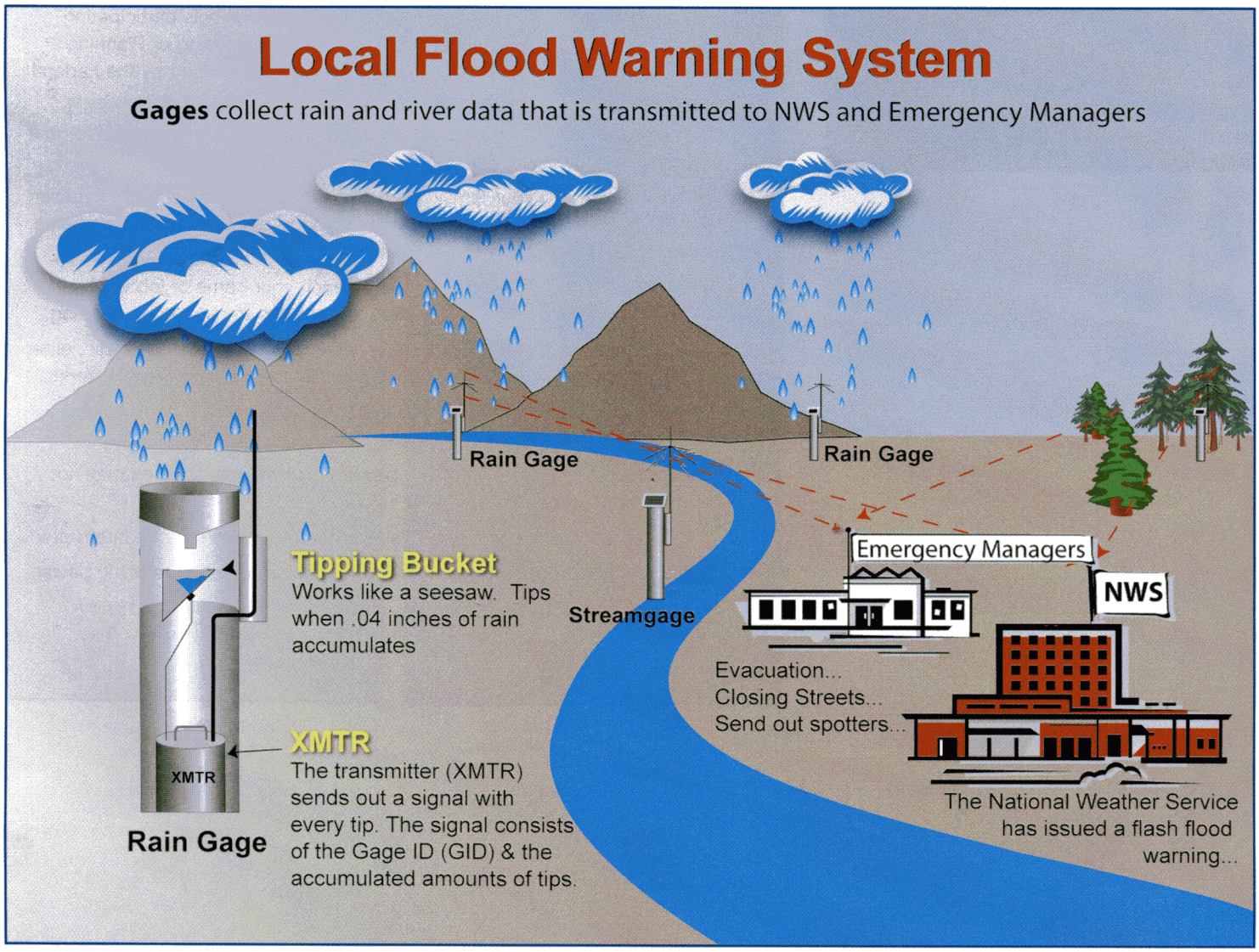
www.nws.noaa.gov/oh/docs/alfws-handbook

NATIONAL WEATHER SERVICE FORECASTERS RELY ON A NETWORK OF ALMOST 10,000 STREAMGAGES TO MONITOR THE HEIGHT OF RIVERS AND STREAMS ACROSS THE NATION

Streamgage Data Saves Lives

National Weather Service forecasters rely on a network of almost 10,000 streamgages to monitor the height of rivers and streams across the Nation. This information provides present river conditions and is the initial information needed to develop a river forecast. Most of the streamgages are maintained by the U.S. Geological Survey, the U.S. Army Corps of Engineers, and the Department of Agriculture. Some streamgages are read manually by dedicated volunteer observers. If you would like to volunteer as a cooperative observer, visit the web site at: http://www.nws.noaa.gov/om/coop/become.htm

Many communities nationwide have partnered with the National Weather Service and other federal agencies (e.g., U.S. Geological Survey and the U.S. Army Corps of Engineers) to implement dense networks of precipitation gages and streamgages to monitor and detect flooding in their community. These networks are often referred to as Local Flood Warning Systems.



What You Can Do Before the Flood...

When you receive a Flood Watch:

- A Watch is issued when flooding is possible within the watch area. When a flood watch is issued, you should be aware of potential flood hazards. Everyone in a Watch area should be ready to respond and act quickly.
- Have an evacuation plan in place BEFORE flooding occurs. Flooded roads may cut off your escape route. Head for higher ground before the water becomes too deep. Remember–just six inches of rapidly flowing water can knock you off your feet. For information on how or what to do if you are advised to evacuate, visit the American Red Cross web page at: http://www.redcross.org/services/disaster/beprepared/evacuation.html
- Know your flood risk and the elevation above which flooding occurs. Do streams or rivers near you flood easily? If so, be prepared to move to a safe place. Know your evacuation routes.
- Find out if you are located in a high, medium, or low flood risk area. Check with your city or county government to find out if your community is participating in the National Flood Insurance Program. Start with the Building or Planning Department to review the Flood Insurance Rate Maps, published by the Federal Emergency Management Agency.
- Develop an evacuation plan. Everyone in your family should know where to go if they have to leave.
- Discuss flood plans with your family. Everyone should know what to do in case all family members are not together. Discussing flood plans ahead of time helps reduce fear and anxiety and lets everyone know how to respond.
- Determine if the roads you normally travel to reach your home or job will be flooded during a storm. If so, look for alternative routes to use during flooding.
- Keep a NOAA Weather Radio All Hazards, a battery-powered portable radio, emergency cooking equipment, and flashlights in working order with extra batteries.
- Have a professional install check-valves in plumbing to prevent flood waters from backing up into the drains of your home.
- Keep your automobile fueled; if electric power is cut off, gas stations may not be able to operate pumps for days.
- Store drinking water in food-grade containers. Water service may be interrupted.
- Keep a stock of food requiring little cooking and no refrigeration; electric power may be interrupted.
- Keep first-aid supplies and prescription medicines on hand.

DURING A FLOOD WARNING, DON'T DRIVE WHENEVER POSSIBLE!

Myth or Fact

MYTH	FACT
A 100-year flood occurs only once every 100 years.	The 100-year flood is a climactic average; there is a 1% chance that a 100-year flood will occur in any given year.
Flash floods mainly occur in the eastern United States.	Flash floods occur in all 50 states, including Alaska and Hawaii.
Flash floods occur only along flowing streams.	Flash floods can occur in dry arroyos and urban areas where no streams are present.
Flash floods occur mainly in the late afternoon and evening.	Many flash floods occur at night.
Homeowners insurance policies cover flooding.	Unfortunately, many homeowners do not find out until it is too late that their policies do not cover flooding. Contact your insurance company or agent to buy flood insurance.
You can't buy flood insurance if your property has been flooded.	You are still eligible to purchase flood insurance after your home, apartment, or business has been flooded, provided your community is participating in the National Flood Insurance Program.
Larger vehicles, such as SUVs and pickups, are safe to drive through flood waters.	Two feet of rushing water can carry away most vehicles including SUVs and pickups.

DO NOT VISIT DISASTER AREAS FOLLOWING A FLOOD. YOUR PRESENCE MAY HAMPER URGENT EMERGENCY RESPONSE AND RESCUE OPERATIONS.

▲ Photo: Federal Emergency Management Agency

What You Can Do During the Flood…

When you receive a Flood Warning:

- If advised to evacuate, do so immediately! Families should use only one vehicle to avoid getting separated and reduce traffic jams. Move to a safe area before access is cut off by flood water. Continue listening to NOAA Weather Radio All Hazards, radio or television for information concerning the flooding.
- Don't drive if you don't have to.
- Get out of areas subject to flooding. This includes dips, low spots, canyons, washes, etc. Do not attempt to cross flowing streams.
- Never try to walk, swim, drive, or play in flood water. You may not be able to see how fast the flood water is moving or see holes or submerged debris.
- Do not camp or park your vehicle along streams and washes, particularly during threatening conditions.
- Be especially cautious at night when it is harder to recognize flood dangers.
- Do not attempt to drive through a flooded road. The depth of water is not always obvious. The road bed may be washed out under the water, and you could be stranded or trapped.
- Do not drive around a barricade. Barricades are there for your protection. Turn around and go another way!
- If the vehicle stalls, leave it immediately and move to higher ground. Rapidly rising water may engulf the vehicle and its occupants, sweeping them away. Vehicles can be swept away by as little as two feet of water.
- Children should NEVER play around high water, storm drains, viaducts, or arroyos. It is very easy to be swept away by fast-moving water.
- If you come upon a flowing stream where water is above your ankles, STOP! Turn around and go another way. Climb to higher ground. If it is moving swiftly, even water six inches deep can knock you off your feet. Many people are swept away wading through flood waters, resulting in injury or death.

What You Can Do After the Flood...

- Get necessary medical care at the nearest hospital. The American Red Cross can help by providing shelters, food, water, and first aid, as well as helping you meet your immediate disaster-caused needs.
- Do not visit disaster areas. Your presence might hamper rescue and other emergency operations.
- If the power is out, use flashlights, not candles.
- Use flashlights, not lanterns, torches, or matches, to examine buildings. Flammables may be inside.
- Report broken utility lines to appropriate authorities.
- Boil drinking water before using. Wells should be pumped out and the water tested for purity before drinking. If in doubt, call your local public health authority.
- If fresh or canned food has come in contact with flood waters, throw it out.
- Take steps to reduce your risk of future floods. Make sure to follow local building codes and ordinances when rebuilding, and use flood-resistant materials and techniques to protect yourself and your property from future flood damage.

Do You Have a Family Disaster Plan?

I. Gather Information About Hazards

Contact your local National Weather Service office, emergency management office, and American Red Cross chapter. Find out what types of disasters could occur and what you should do. Learn about your community's methods of warning people and evacuation plans. Ask your insurance agent about flood insurance. Find out what you can do to protect your home from the effects of natural hazards that could occur where you live. Meet with your family to create a plan.

Discuss the information you have gathered. Pick two places to meet: a spot outside your home for an emergency such as a fire, and a place away from your neighborhood in case you can't return home. Choose an out-of-town family member or friend as your family check-in contact for everyone to call if the family gets separated, and a backup out-of-neighborhood friend in case the first one does not answer. Discuss what you would do and how to do it if advised to evacuate.

II. Implement Your Plan

- Post emergency telephone numbers by phones and in address lists each person carries with them. Include cell phone numbers of family and contact-points.
- Install safety features in your home, such as smoke alarms and fire extinguishers.
- Inspect your home for potential hazards such as items that can move, fall, break, or catch fire, and correct them.
- Make physical changes that will make your home less vulnerable; install check-valves and hurricane shutters; strap the hot water heater to wall studs.
- Have your family learn basic safety skills such as CPR/Automated External Defibrillator (AED) and first aid; how to use a fire extinguisher; and how and when to turn off water, gas, and electricity at the main switches and valves. Know how to operate a NOAA Weather Radio All Hazards.
- Teach children how and when to call 9-1-1 or your local Emergency Medical Services number.
- Keep emergency supplies in your home sufficient for three days to a week, if your area has ever lost basic water, electricity and gas service for a week or longer. Assemble a disaster supplies kit with things you will need if you have to evacuate. Store these supplies in sturdy, easy-to-carry containers such as backpacks or duffel bags.
- Keep important family documents in a waterproof and fire-resistant container.
- Keep a smaller emergency kit with seasonal supplies, tools, and clothes in the trunk of your car.
- Each person who has a cell phone should carry it and keep it turned on to receive calls in any emergency situation.

III. Prepare a Disaster Supplies Kit to Include:

- At least a 3-day water supply (one gallon per person per day)
- Food that won't spoil
- One change of clothing and footwear per person
- One blanket or sleeping bag per person
- First aid kit
- Prescription medicines
- Emergency tools
- Battery-powered NOAA Weather Radio All Hazards
- Portable radio
- Flashlight with extra batteries
- Extra set of car keys
- Cash and credit card
- Special items for infant, elderly, and disabled family members
- Map of local area

Local Sponsorships

ARC 4493
NOAA/PA 200467