

G0361: Flood Response Operations

Student Manual

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FEMA

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Course Overview

Visual 1: Welcome

Flood Response Operations

Visual 2: Administrative Information

- Registration
- Emergency exits and procedures
- Location of restrooms
- Procedures for breaks
- Procedures for questions
- Course materials
- Evaluation forms

Visual 3: Course Purpose and Objectives

- Help communities plan for and respond to riverine flooding
- **Not** a comprehensive planning course

Visual 4: Course Overview

Lesson 1: Introduction to Riverine Flooding

Lesson 2: Information Gathering

Lesson 3: Planning and Coordination

Lesson 4: Flood Response Methods

Lesson 5: Decision Making

Lesson 6: Volunteer Management

Lesson 7: Flood Works Monitoring

Lesson 8: Reports and Documentation

Lesson 9: Returning to Normal

Visual 5: Participant Introductions

- Name
- Location
- Job description
- Flood experience



Lesson 1: Introduction to Riverine Flooding

Visual 1: Lesson 1: Introduction to Riverine Flooding

OBJECTIVE: Discuss the basic concepts related to riverine flooding

Lesson Overview

There are over 3 million miles of waterways in the United States. These waterways range from creeks and brooks that are only a few feet across to expansive waterways, like the Mississippi River, that contribute millions of dollars to the national economy. These large and small waterways have one important element in common -- they are subject to flooding.

In this lesson, you will learn about the basic concepts related to riverine flooding.

Visual 2: Supporting Objectives

- Define the basic terms associated with riverine flooding
- Explain the relationship between a river, its floodway, and its floodplain
- Describe different methods for monitoring flood levels

You need to become familiar with riverine flooding terms for effective communications during emergencies. It is also important to understand how a river relates to the floodway and the floodplain.

Visual 3: The Flood Threat in the U.S.

- Over 20,000 communities
- Approximately 1/3 of the population
- High economic losses
- May allow time for planning



The Flood Threat in the U.S.

Over 20,000 communities in the United States, and approximately one-third of the U.S. population, are exposed to some degree of flood threat. These communities were likely established along the banks of rivers long ago to take advantage of the economic, recreational, and utility benefits of these valuable natural resources. In most cases, floods are rare events. During periods of normal water levels, riverfront communities expand and grow oblivious to the flood threat they face.

However, during high water events, waterfront communities come face to face with the threat of devastating flooding. Floods take an enormous toll on human beings, physically, emotionally, and financially.

The economic losses due to flooding are particularly high since normal homeowners and business casualty insurance policies do not provide flood coverage. It is easy for flood damages to run into the millions of dollars. The costliest natural disaster in U.S. history, Hurricane Katrina, caused more than \$200 billion in losses.

Unlike other natural disasters, such as tornadoes, floods may allow time for a community response to combat the flood threat in an attempt to prevent or reduce the devastation. A flood response can be likened to a war time mobilization. To be successful, every community resource, including people and physical resources, will have to be mobilized to combat the enemy floodwaters. As in war, some areas of the community may have to be sacrificed to the rising waters in order to direct resources to other areas that are more defensible.

The most important element in conducting a successful flood response is planning. In a crisis situation, the plan and process that created it will prove to be invaluable. Under the guidance of a well developed flood response plan, the many issues associated with a flood emergency become more manageable.

Visual 4: Activity: Knowledge Bowl

Team Activity: Knowledge Bowl

Team Activity: Knowledge Bowl

A list of terms you'll be asked about in this activity appears on the next two pages of this manual. Definitions for these terms can be found in your glossary. You are encouraged to take notes of any additional information shared about each term on the following pages.

For this activity, the class will be divided into two teams. A captain for each team will be designated.

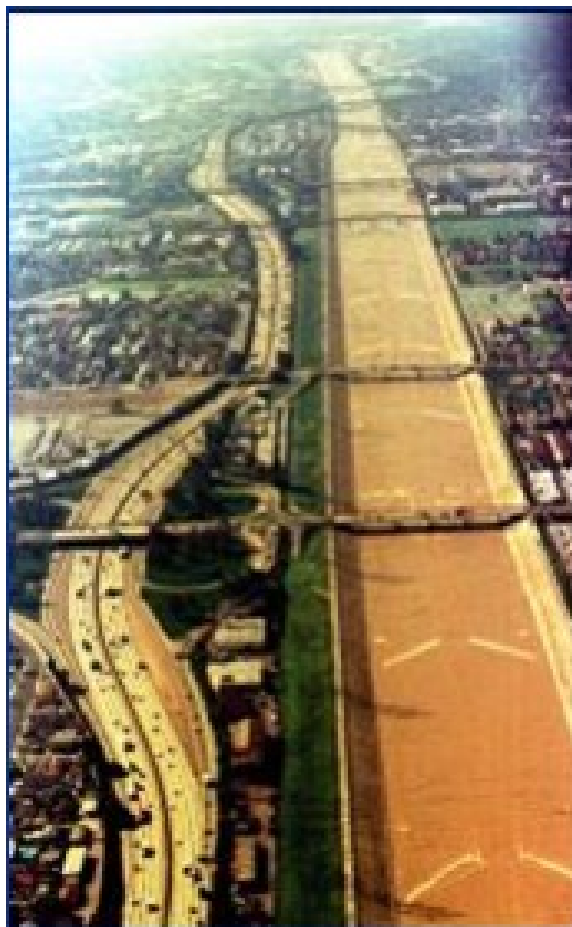
Teams will have 5 minutes to study the glossary terms, and then the knowledge bowl will begin. When it is your team's turn to answer, you will have 15 seconds to provide the correct response. If you do not provide the correct answer, another team will have a chance to answer.

Visual 5: Question 1

This is a natural or artificial watercourse that has a definite bed and banks to confine and direct the waterflow

Visual 6: River Channel

- Carries the entire water flow
- Visible and well-defined



River Channel

It is difficult to judge the real size of a river. Normally, the river channel carries the entire water flow.

Since the channel is a well-defined geographical feature, many people falsely believe that the size of the river is solely defined by the visible channel.

Visual 7: Question 2

This is a low plain next to a river that is made of river deposits and is prone to flooding

Visual 8: Floodplain

- Every river has a floodplain
- Floodplains and channels determine river size
- Floodplain may not be equal on both sides



Every river also has a floodplain. The boundaries of the floodplain are harder to identify than the river channel and are therefore subject to encroachment. Floodplains and the channel determine the true size of a river. Note that the size of the floodplain may not be equal on both sides of the river.

Visual 9: Question 3

This is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height

Visual 10: Floodway

- River channel and the adjacent land
- Must be reserved to discharge base flood
- Must not increase water elevation more than designated height



A floodway is the channel of a river or other watercourse and the adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than a designated height.

Visual 11: Question 4

This is used for describing a location when facing downstream

Visual 12: Right or Left River Bank

- Used to describe the area on your right or left when facing downstream
- Easier than traditional compass points



Visual 13: Question 5

This is an area of land where water from rain or snowmelt drains into a body of water

Visual 14: Drainage Basin or Watershed

- Area where water from precipitation drains into a body of water



A drainage basin is an area of land where water from precipitation drains into a body of water. Precipitation may include rain, snow, or hail. A drainage basin may be as small as a few hundred square feet or as large as thousands of square miles. It may contain only a single stream (small upland tributary) or an extensive network of the main river and its multitude of tributary systems. The watershed boundary usually follows a ridge line (highest ground elevation).

Visual 15: Question 6

This is a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices, to contain, control, or divert the flow of water so as to provide protection from temporary flooding

Visual 16: Levee

- Man-made earthen embankment
- Constructed in accordance with sound engineering practices
- Purpose is to divert water to provide protection from flooding



A levee is a man-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices, to contain, control, or divert the flow of water so as to provide protection from temporary flooding.

It is important to note that levees are designed and constructed to provide protection against a specific type of flood and aren't always respected by mother nature.

For levees to be recognized by FEMA, evidence must be provided that they have been adequately designed and operation and maintenance systems are in place to provide reasonable assurance that protection from the base flood exists. Certification by a registered professional engineer must be provided along with the certified as-built plans to indicate such evidence of structural requirements. In lieu of this certification, a Federal agency with responsibility for levee design, such as the US Army Corps of Engineers, may certify that the levee is adequately designed and constructed to provide protection against the base flood.

Visual 17: Question 7

This is a mound of earth shorter than a levee engineered to keep water out of a floodplain

Visual 18: Berm

- A mound of earth shorter than a levee
- Engineered to keep water out of floodplains



A berm is a mound of earth shorter than a levee that is engineered to keep water out of a floodplain.

Visual 19: Question 8

This is a stage indicating the maximum amount of water that the river channel can carry (also known as the channel capacity)

Visual 20: Bank-full

- A stage indicating the maximum the river can carry
- Also known as channel capacity



A series of benchmarks charts the increasing water levels. The first benchmark reached by the waterway is the bank-full stage. However, there may be some minor flooding of low lying areas before the bank-full stage.

The bank-full stage is often used as a trigger point for mobilizing flood response operations.

Visual 21: Question 9

This is an artificial water level established by the NWS in cooperation with local officials designed to indicate an elevation where appreciable damage begins to occur to urban or agricultural properties

Visual 22: Flood Stage

- Artificial water level
- Established by NWS and local officials
- Indicates elevation where appreciable damage begins to occur



As water levels increase, the river begins to overtop its banks and expand out onto the floodplain. The next benchmark that may be reached is flood stage.

Note that a river may be out of its banks and still not be at flood stage. Also, flood stages may be adjusted from time to time as changing conditions warrant. For example, a buy-out program may remove properties from the floodplain and raise the flood stage for a given location along the river.

Visual 23: Question 10

This is issued by the National Weather Service when conditions are favorable for flooding

Visual 24: Flood Watch

- Issued by NWS
- Issued when conditions are favorable for flooding
- Does not mean flooding will occur
- Gives warning of a potential flood threat



A flood watch does not mean that flooding will definitely occur, but it does give the community warning of a potential flood threat.

Visual 25: Question 11

This is issued by the National Weather Service when flooding conditions are expected

Visual 26: Flood Warning

- Issued by NWS
- Issued when flood conditions are expected
- Accompanied by a predicted flood height
- Accuracy of plus or minus one foot



The flood warning will typically be accompanied by a predicted flood height expressed as river stage or height above flood stage. National Weather Service forecasters strive to issue flood forecasts with an accuracy of plus or minus one foot.

Visual 27: Question 12

This is also popularly known as a 100-year event

Visual 28: 1% Flood

- Indicates 1% chance of flooding each year
- Also called a 100-year event
- Can happen in back-to-back years
- Homes in 1% floodplain have 26% flooding chance while under 30-year mortgages



You may often hear about the 100-year floodplain. This term is a bit misleading and does NOT mean that the floodplain will be under water only once every 100 years. In fact, 100-year floods can happen several times in back-to-back years.

The 1% chance flood is also known as the base flood and means the flood has a one percent 1% chance of being equaled or exceeded in any given year.

Statistically, a home located within the 1% (100-year) floodplain has a 26% chance of being inundated by floodwaters over the life of a 30-year mortgage.

Visual 29: Question 13

This is also known as a 500-year event

Visual 30: 0.2% Flood

- Indicates 0.2% chance of flooding each year
- Also called a 500-year event
- Homes in 0.2% floodplain have 6% flooding chance in a 30-year period



Visual 31: Question 14

This is a level that is mapped using topographic data to produce a 1% floodplain

Visual 32: Base Flood Elevation (BFE)

- Are mapped using topographic data
- Produce the 1% floodplain



The base flood elevation is the level that is mapped using topographic data to produce a 1% floodplain. It is the computed elevation to which floodwater is anticipated to rise during the base flood.

Visual 33: Question 15

This is a federally administered program under which flood-prone areas are identified and insurance is made available to residents and property owners in participating communities

Visual 34: National Flood Insurance Program

- Federally administered program
- Flood-prone areas are identified
- Insurance is available for residents and property owners



The National Flood Insurance Program is a federally administered program under which flood-prone areas are identified and insurance is made available to residents and property owners in participating communities.

Visual 35: Question 16

This is published by FEMA to show the boundaries of certain high water events

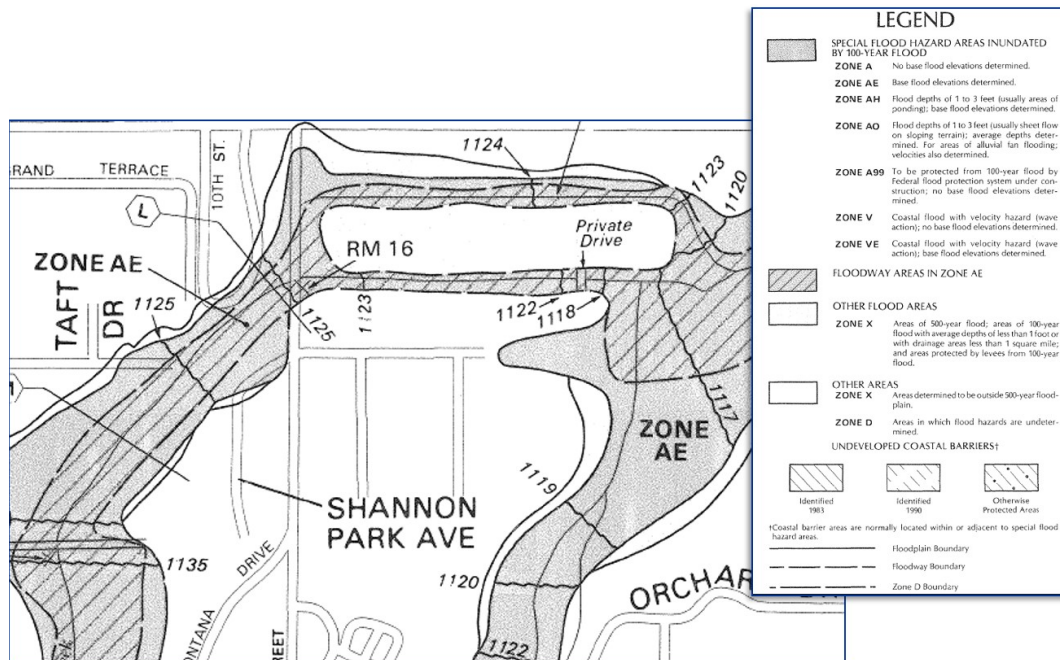
Visual 36: Flood Insurance Rate Map (FIRM)

- Published by FEMA
- Displays boundaries of high-water events



In order to better define the threats posed by floods, the NFIP has attempted to locate the boundaries of certain high water events. These boundaries can be seen on a Flood Insurance Rate Map (FIRM).

Visual 37: Example FIRM



Example FIRM

For purposes of the NFIP, the 1% floodplain is also called the Special Flood Hazard Area (SFHA). This is the land area covered by the floodwaters of the base flood. The SFHA is contained within the 0.2% floodplain.

On the FIRM, SFHAs are labeled as zones beginning with A (e.g., Zone A, AO, AH, etc.) or V (e.g., Zone V, VE, or V1-V30).

Moderate flood hazard areas are labeled Zone B or Zone X (shaded) on the FIRM, and are the areas between the limits of the base flood and the 0.2-percent-annual-chance (or 500-year) flood.

The areas of minimal flood hazard, which are the areas outside the SFHA and higher than the elevation of the 0.2% annual chance flood, are labeled Zone C or also as Zone X (shaded) on the FIRM.

Visual 38: Comparison of Flood Terms

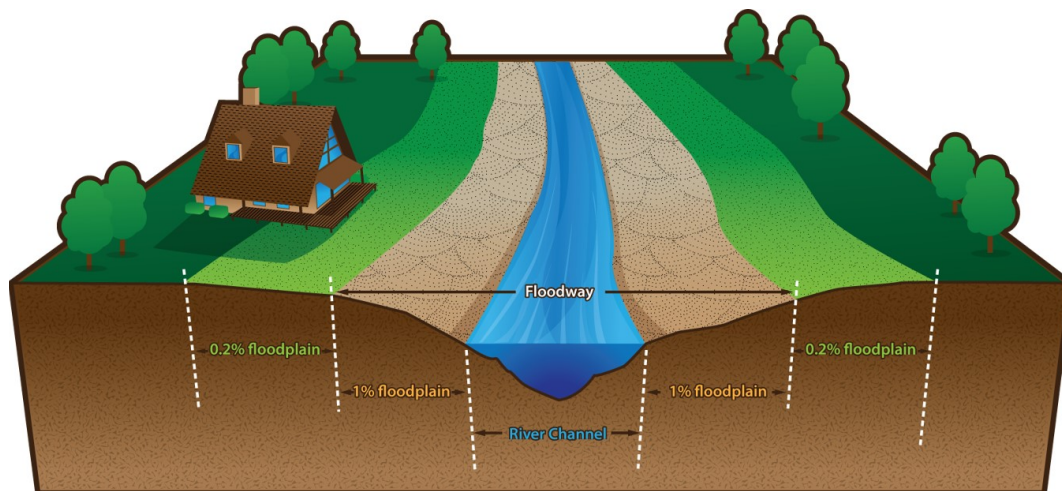
Preferred Term	Also Called	FIRM Labels
1% Floodplain	100-year Floodplain	SFHA Zones beginning with A or V
0.2% Floodplain	500-year Floodplain	Usually shaded as Zone X or Zone B

Comparison of Flood Terms

Remember, these terms are engineered limits to define the flood threat. Floods are not limited to these areas.

Preferred Term	Also Called	FIRM Labels
1% Floodplain	100-year Floodplain	SFHA Zones beginning with A or V
0.2% Floodplain	500-year Floodplain	Usually shaded as Zone X or Zone B

Visual 39: The River, the Floodway, and the Floodplain



Water entering the river system has two noticeable effects on the river.

- Increased flow raises the water level in the channel.
- As the river rises, the velocity of the water flow increases.

Visual 40: Monitoring River Levels

- United States Geological Survey
- Formal monitoring stations
- Private river gages
- All river gages should be “zeroed”



- United States Geological Survey
- Formal monitoring stations
- Private river gages
- All river gages should be “zeroed”

For more information about the National Geodetic Vertical Datum (NGVD) of 1929 and the North American Vertical Datum (NAVD) of 1988, visit the [National Geodetic Survey](http://www.ngs.noaa.gov/faq.shtml) Frequently Asked Questions page: <http://www.ngs.noaa.gov/faq.shtml>

The United States Geological Survey (USGS) maintains a system of river monitoring stations. A complete system of river gages is an important river forecasting tool that can increase the accuracy of flood warnings.

Ideally, gages are placed where they can be easily read, even at high water levels.

The “zero” of a gage is the elevation added to a gage to obtain the true height of the gage above the datum.

Visual 41: Gage Readings

- Normal conditions:
 - 7:00 a.m.
- High water conditions may require:
 - 1:00 p.m.
 - 7:00 p.m.
 - 1:00 a.m.

Accurate river forecasts require regular gage readings. Normally, river gages are read at 7:00 a.m. and reported to the National Weather Service (NWS). During periods of high water, additional gage readings may be requested.

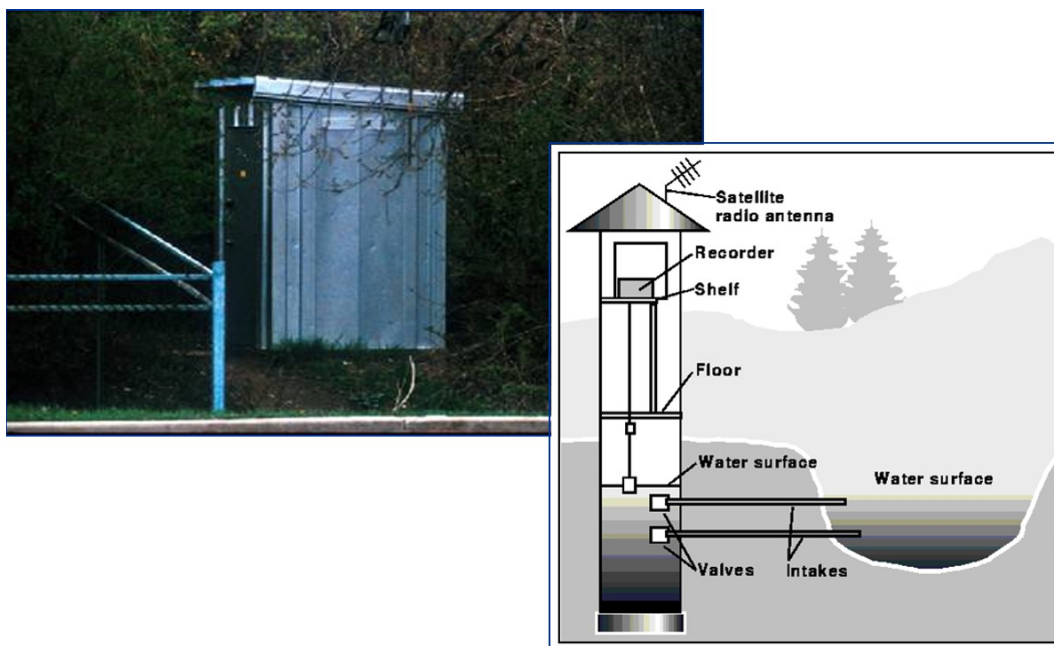
Visual 42: Gage Readings - Type A Gage



This is an example of a Type A wire weight gage used by the National Weather Service to measure river stage. This gage consists of a drum wound with a single layer of stainless-steel cable attached to a bronze weight, a graduated disc, and a counter, all within a cast-aluminum box.

The weight is lowered until the bottom of the weight cylinder just touches the surface of the water. The water level can be determined from the combined readings of the counter and the graduated disc inside the housing box. This type of gage is secured with a padlock that should be serviced occasionally to ensure that it is in proper working order. Road salt, particularly when gages are mounted to bridge railings, can corrode the lock and make entry difficult. A program whereby all locks are lubricated and checked for vandalism at least quarterly is recommended. Properly keyed replacement locks should be available if emergency entry to the gage is required.

Visual 43: USGS Gage



The picture on the left shows a standard USGS gage hut. These locations are secured by padlocks and are used to house a variety of gages including bubble units and stilling well gages (as shown in the diagram on the right). The diagram also identifies satellite radio antenna, recorder, shelf, floor, water surface, valves, and intakes.

Note that this site has a solar panel to charge the gage batteries and uses a phone line connection for remote data access. These stations are routinely serviced by USGS agents who calibrate the units, repair vandalism and bullet holes, and deal with other maintenance issues.

Visual 44: Bubble System



The photo on the right shows a bubble system, which can be used when construction of a well is not feasible. The photo on the left shows the interior layout of a bubble gage station. This river gage uses a cylinder of compressed gas and backpressure monitoring system to record water levels.

A change in water level results in a corresponding change in pressure in the pipe. The change in pressure is fed to a recorder or data collection platform which records the gage height.

Visual 45: How River Monitoring Information is Used

- Used by NWS to determine
 - Volume of water in river
 - When to issue flood watch or warning
- NWS also uses other data
 - Rainfall reports
 - Soil saturation
 - Snow depth
 - Temperature readings

How River Monitoring Information is Used

Information from river gages is used by the National Weather Service to determine the volume of water flowing in the river. The water flow is typically expressed in cubic feet per second (cfs). One cubic foot per second is equivalent to approximately 7.5 gallons per second. Volumetric information can then be used to determine water levels and issue river forecasts.

The National Weather Service also uses data from other sources including rainfall reports, soil saturation information, snow depth information, temperature readings, etc. to issue river forecasts. Depending on the river system and the amount of data available, these forecasts may be highly detailed stage forecasts or general warning statements on anticipated flood threats.

The National Weather Service, in turn, uses this river monitoring information to determine when to issue flood watches and warnings.

But there are many variables that can enter into this forecast. Some of these variables are difficult to predict, yet have a great impact on flood forecasts. For example, a broken levee system upstream can actually reduce the flood threat downstream. Flood debris can get caught on bridge supports reducing the channel capacity and resulting in upstream flooding. Local officials must monitor weather service reports and remember that flood forecasts are dynamic and subject to change.

Visual 46: Forecast Variables and Dealing With the Flood Threat

- Levee failures
- Debris
- Flood control works



Dealing With the Flood Threat

In an attempt to reduce the flood threat faced by a community, some areas have constructed massive flood control projects. Common flood control works include levees, dikes, and flood walls. Flood control projects that prevent the natural inundation of the floodplain can have drastic effects on the waterway.

If the river is confined by levees and dikes, the total volume of water that must flow past a given point is forced to do so in a narrower area. This results in increasing the height and velocity of the flood flow. The heights in a levee-confined channel are higher than those that would be normally expected in an unrestricted natural floodplain.

In addition, the safe capacity of the river may decrease when it is confined by levee systems. During the summer of 1993, there were extensive and devastating floods along the upper Mississippi River. Records suggest the total water flow through this flood zone was far below previous record volumes although flood heights reached record levels.

If a levee were to breach, the flood depth on the breach side would likely be higher than if the water had been allowed to naturally inundate the entire floodplain. In addition, the violence of a levee breach might cause more damage than would the slowly rising waters of the natural inundation process. A levee breach also provides little time for evacuation and public protection.

Expedient Flood Works

It is not economical to construct a flood control system that will withstand and contain all high water events. Instead, flood control systems are designed and built to withstand high water events based on calculated risk factors. This may mean that expedient flood works are required on top of existing levee systems to withstand flood events greater than the design of the original containment system. In reality, this requires constructing expedient flood works over miles and miles of levees under difficult conditions.

Expedient flood control works are temporary projects designed to hold back floodwaters. Typical expedient flood control works include sandbag lines, expedient levees, flashboard, mudboxes,

and similar items. More information on expedient flood protection can be found later in this course.

In most flood responses, the goal is to have two feet of freeboard on all flood works based on the predicted river crest. The freeboard is the amount of space between the water and the top of the flood control structure or works.

Keep in mind that FEMA requires a minimum of three feet above the BFE for levees.

Floods are dynamic events that affect all waterways. When floods occur, they can disrupt activities over thousands of square miles and leave devastation in their wake. Since flooding is so prevalent and costly in the United States, every community should be prepared to deal with the effects of a high water event.

Visual 47: Lesson Summary

Below is a list of some of the terminology used in this lesson:

- 0.2% flood
- Drainage basin/watershed
- Floodplain
- 1% flood
- FIRM
- Floodway
- Bank-full
- Flood stage
- Levee
- BFE
- Flood warning
- NFIP
- Berm
- Flood watch
- Right/left river bank
- River channel
- SFHA

Visual 48: Review Question 1

What is the relationship among a river, its floodway, and its floodplain?

Visual 49: Review Question 2

What are different methods available for monitoring river levels?

Suggested Action Items

- Contact the USGS office for your area and obtain a printout of the river gages in your community. Would all these gage sites be accessible in high water conditions?
- Contact your local weather service office and learn the reporting procedures for river gages in your area. Who is responsible for reading these gages?
- If you have levees in your community, investigate when they were last inspected. Are all levees being properly maintained or did the inspection find problem areas?
- When was the last flood in your community? Was the flood stage accurate in predicting when appreciable flood damage would occur in urban and rural areas?

Lesson 2: Information Gathering

Visual 1: Lesson 2: Information Gathering

OBJECTIVE: Analyze flood threats for a given scenario

Lesson Overview

Before the emergency planning process can begin, members of the planning team must gather a great deal of information. The success of the planning process will partly depend on the accuracy and amount of information obtained and readily used by local planners. While the information gathering process may seem tedious, it is a critical step and is a fairly easy task to complete.

In this lesson, you will learn how to analyze flood threats for a given scenario.

Visual 2: Supporting Objectives

You will be able to:

- Summarize the types and sources of information needed for flood planning
- Explain how different types of maps are used in flood planning
- Explain the difference between a topographic map and a Flood Insurance Rate Map (FIRM)
- Use a map to identify locations that are vulnerable to flooding

Supporting Objectives

Knowing the various types of maps and their uses is critical when combining other information gathered to effectively plan for floods.

You should explore and use all of the information resources at your disposal.

Visual 3: Maps

An extensive collection of maps will be used and cross-referenced during the planning process.

The basic map types include:

- Topographic Maps
- Highway and Minor Road Systems
- Levee and Water Control Systems
- Sewer and Utility Systems
- Zoning and Plat Grids
- FEMA Flood Insurance Rate Maps
- Specialty Maps and Photographs

Maps

An extensive collection of maps will be used and cross-referenced during the planning process.

Visual 4: Topographic Maps

- Produced by the USGS
- Usually updated every 10 years
- Land elevations remain stable
- Map features change

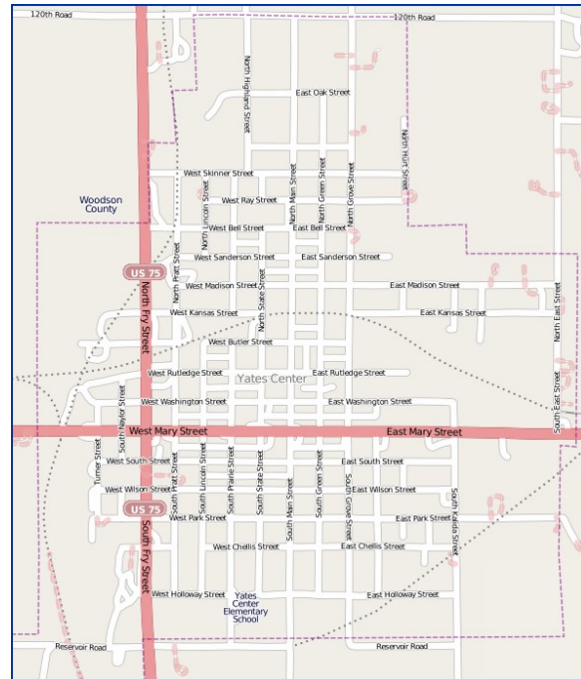


Commonly called “topos,” these maps display information on river channels and elevations that can be used to determine and plot areas of inundation. Topographic maps provide accurate information that is critical when determining flood risks and planning a flood response.

Visual 5: Highway and Road System Maps

Can be used to:

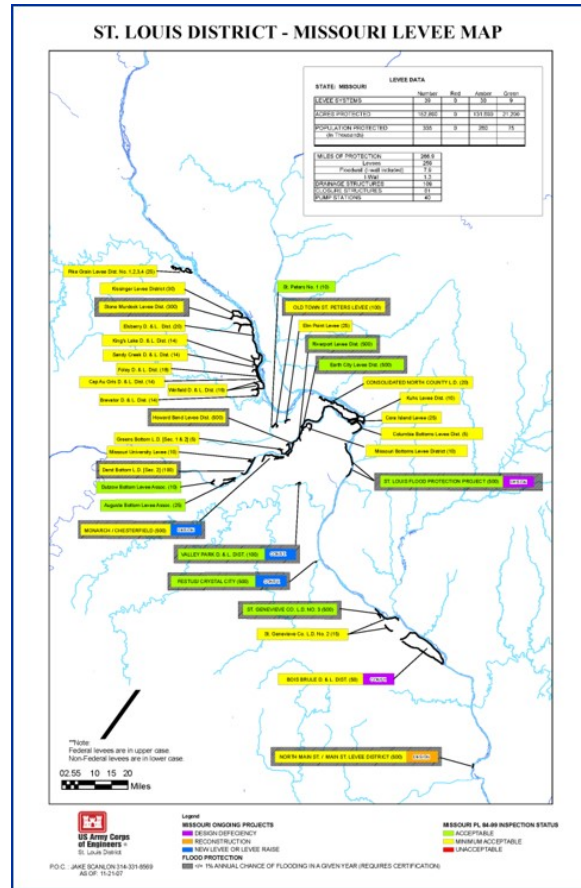
- Indicate flood-affected roads
- Find secure evacuation and supply routes



Highway and road system maps will also be used. These maps can be used to indicate road systems affected by flooding, access routes to water control structures, and to plot secure evacuation and supply routes. Because many road systems are disrupted by flood waters, highway and road system maps showing safe routes should be available for distribution to trucking companies and others supplying critical resources.

Visual 6: Levee and Water Control System Maps

- Rivers and waterways
- Access roads
- Sewer outfall locations
- Conduit and utility crossings
- Railroad gap placements
- Floodgates and barriers
- Dams and water control systems



Levee and water control system maps are invaluable. These are highly detailed maps that provide excellent information on rivers and waterways.

Visual 7: Sewer and Utility Maps

- Utility crossings
- Pipelines
- Sewer outfalls
- Transformer stations
- Water treatment facilities

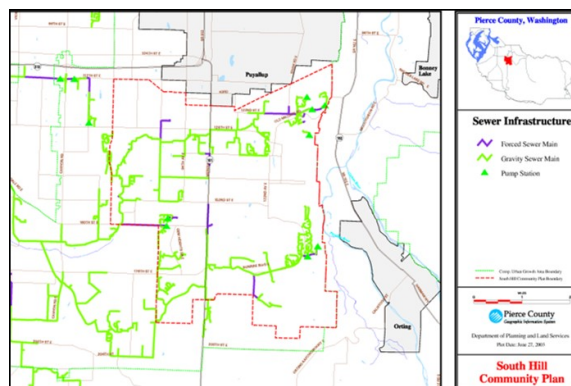


Image credit: Pierce County, WA

Sewer and utility maps are essential to flood response planning. Knowing the locations of all sewer outfalls and their piping patterns helps emergency planners prepare and deal with backflow issues, which can negate flood response efforts.

Sewer and utility maps may also identify the locations of vital facilities, such as transformer stations and water treatment facilities, that may require special protection during high water events.

Visual 8: Zoning and Plat Grids

- Define land use around river systems
- Set priorities for expedient flood protection
- Map historic flood plots

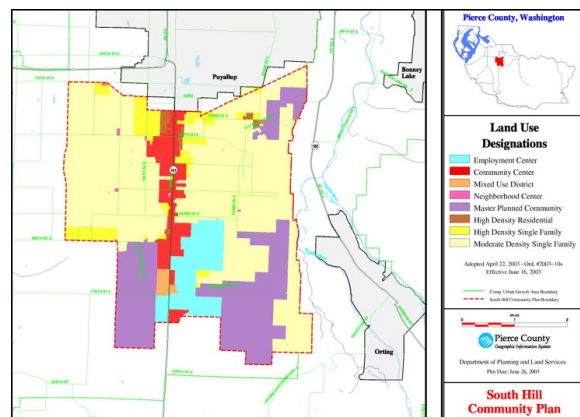


Image credit: Pierce County, WA

Zoning and plat grids define the land use around river systems. Knowing if the inundation area is primarily set aside for housing or industrial uses is important information during the planning process.

Visual 9: Flood Insurance Rate Maps (FIRMs)

- Expected floodplain and floodway boundaries
- Based on 1% and 0.2% events
- Developed for NFIP Used to determine actuarial rates



FEMA produces FIRMs that can assist during the flood planning process.

FIRMs document the expected floodplain and floodway boundaries for rivers and streams in many communities. FIRMs are used to determine the actuarial rates that apply to structures within established flood zones.

Visual 10: Specialty Maps

- Chemical facilities
- Cemetery and burial ground maps
- Park system maps
- Soil composition maps
- Railroad maps
- Field drainage maps

There are many specialty maps that you should become familiar with to aid you in the flood response planning process. The time spent in collecting this type of information will be beneficial during the planning process and may prove to be invaluable in the response phase.

Visual 11: Reports and Analysis Data

Specific materials that fall into this category include:

- Historic Flood Information
- After-Action Reports
- Flood Studies (Public & Private)
- Hazard Analysis Information

Reports and Analysis Data

In addition to maps, reports and analysis data should be collected and reviewed.

Information on historic flood events should be gathered. Since record high water events are usually a once-in-a-lifetime occurrence, the planner may have to dig out this information.

Newspaper archives, historical societies, and universities are often good sources of information.

Remember that some of the historical information may have to be put into perspective to account for the addition of water control or other facilities since the last historic flood event.

Visual 12: Historic Flood Information



Photographs can be a tremendous tool to identify flood areas and review past flood conditions. Pictures of past floods and high water events provide a visual reference showing inundation areas and other information. Some flood planners use photographs to show the locations of proposed expedient flood works. This can be an effective field placement tool when detailed surveys are not possible. Good sources of old photographs include newspaper archives and historical societies.

Information on 0.2% (500-year) flood events may be extrapolated from geologic data and information. Universities, zoning departments, and the U.S. Army Corps of Engineers are good sources for this data.

Historic flood plots are also very useful tools during the planning process. Information on previous high water events can serve as the basis for future flood planning. After-action reports and historic maps also provide excellent information. Historic charts give actual data on known flooding problem areas. By studying past floods, many accurate predictions can be made about conditions for future high water events.

Visual 13: After-Action Reports

- Collected and filed by one agency
- After last event



After-Action Reports

Obviously, detailed after-action reports are valuable sources of information. Ideally, these reports were collected and filed by one agency after the last event, but researchers should be prepared to go agency-to-agency to obtain this information.

Visual 14: Flood Studies

- Insurance reports
- Hazardous waste investigations
- Subdivision reports
- Bank and underwriting reports
- Community development studies
- Agricultural agencies

Flood studies may have been commissioned by planning agencies or private development interests. Such studies can range from highly scientific reports to general overviews. Information on flood threats can be found in insurance reports, hazardous waste site investigations, subdivision reports, bank and underwriting reports, and community development studies just to name a few. Agricultural agencies and farm services may have detailed studies on watersheds and rural communities that can be extremely valuable during the flood planning process.

The Natural Resources Conservation Service (NRCS) of the US Department of Agriculture (USDA) may have detailed flood studies for the community and surrounding areas.

Visual 15: Hazard Analysis Information

- Emergency preparedness office
- Flood mitigation plan



Hazard Analysis Information

The emergency management office may have a formal hazard analysis that covers the flood threat. This analysis may be a general overview of the threat or a highly detailed document. In either case, it can provide the basis for further risk assessment during the flood planning process.

If the community has received federal disaster aid for past floods, it is likely to have a flood hazard mitigation plan. This plan provides information on the steps that were and are to be taken to reduce future flood threats. If available, this document should be reviewed and evaluated to learn the status of flood mitigation programs and how they affect the current planning effort.

Visual 16: Existing Planning Documents

Example materials include:

- Local/Agency Flood Plans
- Regional Flood Plans
- State Flood Plans
- Planning Guides and Reference Materials

Existing Planning Documents

Existing planning documents and reference materials should be reviewed before undertaking any additional efforts. Time and money can be saved if these documents are used and modified to meet local needs.

Visual 17: *Local/Agency Flood Plans*

- Municipalities
- Water utilities
- Other utilities
- Railroads
- Industrial complexes



Localities may have plans and procedures in place to protect water treatment facilities and pumping stations. Since flood planning is a community-wide process, existing local flood plans should be incorporated into the final comprehensive planning package.

Visual 18: Regional and State Flood Plans

- Flood is often a regional problem
- Plans may already exist for:
 - Watershed districts
 - Conservation zones
- Local plans should coordinate with regional and state flood plans

Regional and State Flood Plans

It is important that local plans integrate into larger planning efforts wherever possible. Since flooding is often a regional problem, regional flood plans may have already been created. Local flood response operations may be partially addressed by regional flood plans that cover entire watershed districts or conservation zones. Local emergency planners should see that all local operations fit into the concepts and operational design of the regional plan to produce a seamless response program.

Likewise, state emergency management agencies usually have flood plans that should be reviewed by local planners.

Understanding the basic components of these documents can be critical, particularly if state or federal resources are needed to support local response efforts. Local flood plans should mesh into these documents and systems to prevent jurisdiction and coordination problems.

Visual 19: Planning Guides and Reference Materials

- Emergency planning guides
 - FEMA CPG 101
 - State emergency management agencies
 - U.S. Army Corps of Engineers
 - Salvation Army

Planning Guides and Reference Materials

Many organizations and agencies publish reference documents. Emergency planning guides, such as FEMA's Comprehensive Preparedness Guide (CPG) 101, provide general planning information and guidance.

There are a variety of planning guides and documents published by federal, state, and regional agencies. These guidance documents should be reviewed for applicability to local planning programs and efforts.

State emergency preparedness agencies may have sample plans and specific planning formats for use by local emergency planners. The U.S. Army Corps of Engineers distributes flood emergency handbooks to local officials. The American Red Cross has information on individual flood preparedness. Information from these and other sources should be incorporated into the flood response plan.

Visual 20: Forecasts and Warning Systems

- National Weather Service
 - River forecasts
 - Bulletins
 - Flood watches and warnings
- Other warning systems



Forecasts and Warning Systems

Information should also be gathered on the forecasting resources available to the community. The National Weather Service (NWS) is usually the primary source of river forecasts. Communities should find out which weather service office will be responsible for issuing river forecasts and bulletins for their area.

Because a close working relationship with the weather service is essential, an affiliation should be made with this office before a high water event. Not only will the weather service provide local communities with information, but there is likely a need for communities along the river to give information back to the weather service. This can include gage readings, weather observations such as rainfall amounts and snow depths, and other forms of data that can make river forecasts more accurate.

There are usually other warning systems in the community that can be used during a flood emergency. Information should be gathered on media-based warning systems, such as the Emergency Alert System (EAS), outdoor warning alarms and sirens, and private emergency communication systems such as cable systems. Communicating with the public is a vital consideration before and during a high water event.

Visual 21: Lesson Summary

Types of Maps

- Topographic
- Highway/Road Systems
- Levee/Water Control Systems
- Sewer/Utility
- Zoning/Plat Grid
- FIRMs
- Specialty

Information to Review

- Historic Flood Data
- After-Action Reports
- Flood Studies
- Hazard Analysis
- Existing Plans
- Forecasting Resources
- Warning Systems

Lesson Summary

The data collection process is essential to the completion of a workable planning system and document. Although it may seem to be a tedious process, in the days and weeks to come its value will be proven time and time again. Once the information and talents have been identified and collected, the planning process may begin in earnest.

Visual 22: Review Question 1

What could be some of the difficulties in using historical information for flood planning?

Visual 23: Review Question 2

Explain the difference between a topographic map and a FIRM

Visual 24: Review Question 3

How are different types of maps used in flood planning?

Visual 25: Review Question 4

What type of information is needed for flood planning?

Where might this information be obtained?

Visual 26: Review Question 5

What information might the LEPC have and why would it be valuable to flood planners?

Visual 27: Review Question 6

Why is it important to coordinate local actions with regional organizations?

Visual 28: Review Question 7

Why is it important for agencies to work together during the flood planning process?

Visual 29: Group Activity: Analyzing Flood Threats in Peabody City

Group Activity: Analyzing Flood Threats in Peabody City

Group Activity: Analyzing Flood Threats in Peabody City

In this activity, you will analyze flood threats for the fictional community of Peabody City.

As a group, you will be given 30 minutes to read the scenario information, discuss the questions, and record your answers.

Select a spokesperson to report your findings to the class.

Lesson 3: Planning and Coordination

Visual 1: Lesson 3: Planning and Coordination

OBJECTIVE: Determine how to coordinate with multiple agencies, groups, and organizations to plan for riverine flooding

Visual 2: Supporting Objectives

- Describe the pre-flood planning process
- Describe the agencies and organizations with which partnerships should be established for effective flood planning
- List methods of coordinating the flood plan with other emergency management plans

Visual 3: Supporting Objectives (Continued)

- List potential members of the planning team
- List key areas that should be considered in pre-flood planning
- Summarize the special hazards or concerns that should be considered when planning for a high water event
- Explain the steps involved in phased response planning

It is important to note that this is not intended to be a comprehensive planning course. More training on creating emergency plans is available from FEMA and State emergency management agencies.

Visual 4: Elements of Effective Flood Planning

Flood plans must:

- Be based on what can be done
- Complement other planning documents
- Serve as basis for private flood plans
- Identify roles and responsibilities
- Be proactive

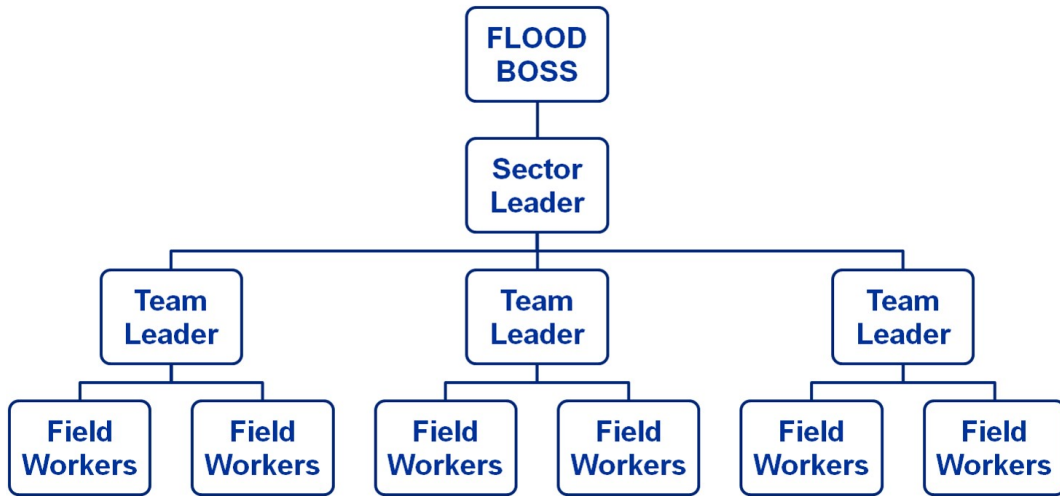
Elements of Effective Flood Planning

You can learn more about mitigating flood damages in the FEMA training course E0273, Managing Floodplain Development through the National Flood Insurance Program (a 4-day course).

Remember these elements of a flood plan:

- Plans must be based on what you can do, not what you would like to do.
- When the flood response plan is completed, all planning documents should fit together into a seamless response system.
- Local flood plans should serve as a basis for private flood plans.
- The plan must contain information on the command and reporting systems to be used in the community for directing emergency operations.
- The most important step communities can take to be better prepared for flooding events is to ensure compliance with the National Flood Insurance Program (NFIP).

Visual 5: Who Is in Charge?



Visual 6: Partnerships in Flood Planning

- Not a one-person (or one-agency) job
- Information comes from a variety of sources
- Coordination issues can be resolved early



Visual 7: Local Organizations and Agencies



School Districts



Utility Providers



Civic Organizations

Visual 8: State Agencies

- Department of Natural Resource
- Insurance Commission
- Waterway Commission
- National Guard Unit
- Emergency Management Agency

Visual 9: Regional Agencies

Some regional organizations may have an interest in your local flood response/recovery programs.

Agencies in this category include:

- Levee boards and commissions
- Drainage districts
- Wetland commissions
- Canal authorities
- Regional planning commissions and organizations
- Harbor and dock authorities
- Natural resource protectorates
- Water reclamation districts

Visual 10: National Weather Service

- Forecast information
- Flood stages
- River monitoring systems
- Flood warning bulletins



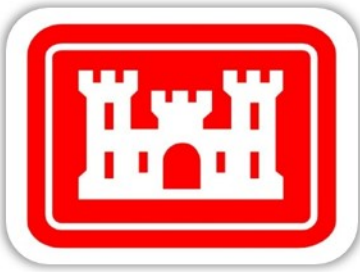
Visual 11: United States Geological Survey (USGS)



Assists with:

- Interpretation of topographic maps
- Use and positioning of river gages
- Water level reporting systems

Visual 12: U.S. Army Corps of Engineers



- Surveys waterways and flood-prone areas
- Assists in planning and flood response



Visual 13: Federal Energy Regulatory Commission (FERC)

- Provides flood planning guidance regarding hydroelectric dams
- Coordination with dam owners/operators is essential

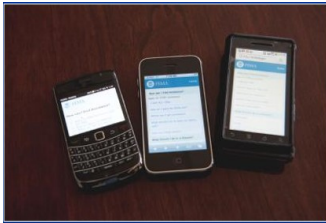


Visual 14: Private Forecasting Services

- Used by power utilities with hydroelectric capabilities
- Internet weather forecasting supplements other forecasts
- All forecasting services can be useful

Visual 15: Communication Resources

- Amateur radio
- Citizen band (CB) radio
- 2-way radios
- Cellular telephones
- Normal public service radio systems



Visual 16: The Planning Process



Visual 17: Select a Lead Agency

- Emergency Management Office, Levee Authority, or similar body
- Must produce documents, coordinate schedules, and gain respect
- May be appointed or selected

Visual 18: Coordinate the Planning Effort

- Collect and organize information
- Identify the key players
- Call an initial organizational meeting



Visual 19: Form a Core Group

- Include the primary players
- Maintain a manageable size
- Use subcommittees to expand base

The lead agency should then form a core group to work on the flood response plan. This core group should be comprised of the primary players involved in a flood crisis.

To be effective, the primary planning group should be kept to a manageable size, with no more than 15 representatives.

Subcommittees can be used to expand the planning team base and to add the input of planners with specialized skills.

Visual 20: Establish an Effective Meetings and Work Plan

- Schedule regular meetings
- Meet frequently in initial planning stages
- Decrease frequency as plan evolves
- Focus on building relationships

The planning team should meet on a regular basis. Meeting regularly fosters the growth of planning team relationships that may prove to be useful during emergency operations. Different organizations in the community may be able to work together more effectively during an emergency if they have already formed relationships.

Visual 21: Planning Meeting Practices

- Use an agenda
- Establish timelines
- Follow a process
- Stay on track



Planning meetings must be conducted using basic business practices. The standard practices of using an agenda, establishing timelines, following processes, and staying on track. These practices keep the meeting focused and directed, allowing the most value in flood preparation.

Visual 22: Analyze the Hazard

- Review existing flood control systems
- Evaluate critical facilities
- Plot expected flood levels
- Review land uses



A key starting point is the creation or review of a flood hazard analysis. A complete and up-to-date hazard analysis will provide a comprehensive review of the threat faced by the community during a flood response event.

- Review existing flood control systems
A review should be made of any flood control systems already in place which helps assess the risk faced by a community during a high water event.
- Evaluate critical facilities
Specific flood response plans and options may be needed for these and other critical facilities to maintain normal service levels.
- Plot expected flood levels
Expected flood crests can be plotted on topographic and other maps so various response options can be evaluated.
- Review land uses
When determining how to plan for flood emergencies, the planners should review the land use of affected areas that have been plotted on the maps.

Critical facilities include:

- Power substations and switching yards
- Water treatment plants
- Potable water facilities
- Hospitals
- Prisons
- Major economic centers
- Extended medical care facilities
- Emergency services (police, fire)
- Emergency operations centers
- Government buildings
- Chemical storage facilities
- HAZMAT facilities
- Backup data/information storage facilities

- Computer centers
- Childcare facilities
- Assisted living facilities

Visual 23: Example



Example

This hospital was constructed years ago along this scenic river. Over the years, the hospital was allowed to expand, even though it was located in an identified flood zone (SFHA). Now the hospital presents a major problem to flood emergency planners. Not only is the facility subject to inundation, but the only access road to the hospital is quickly submerged by rising water levels during flood events.

Visual 24: Key Areas to Consider

During the pre-flood planning process, the planning team will need to:

- Identify evacuation routes
- Identify borrow areas/pits
- Identify work areas for filling sandbags
- Evaluate potential backflow issues
- Identify vulnerable populations
- Identify vulnerable properties
- Identify fueling stations

Visual 25: Identify Evacuation Routes



Once the flood zones are plotted on maps, evacuation routes should be identified using locally accepted traffic patterns.

Visual 26: Identify Borrow Areas



Borrow areas must be identified to obtain the clay soils, sand, and stone needed for levee capping and the construction of other expedient flood works.

Visual 27: Identify Sandbag Work Areas



Visual 28: Evaluate Potential Backflow Issues



Visual 29: Identify Vulnerable Populations



Visual 30: Identify Vulnerable Properties



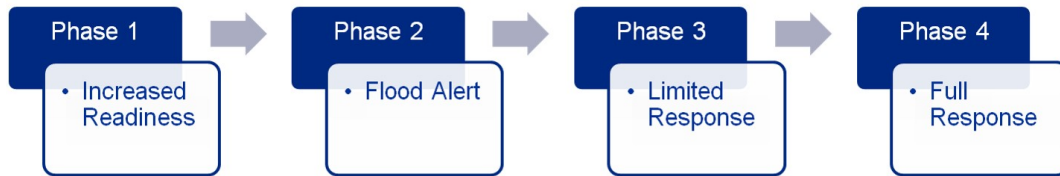
Visual 31: Identify Fueling Stations



Visual 32: Special Considerations

- Fires
- Hazardous material releases
- Contamination of private wells
- Evacuation of agricultural areas
- Evacuation of pets
- Damaging of cemeteries
- Sightseers
- Wild animals and vermin

Visual 33: Planning to Use a Phased Response System



Visual 34: Phase 1: Increased Readiness

Phase 1: Increased Readiness

- **Review planning documents**
- **Train key personnel**
- **Perform operations checks**
- **Inspect waterways and drainage channels**
- **Begin public awareness outreach**
- **Replenish supplies**

Phase 1: Increased Readiness

The Increased Readiness Phase is generally called when there are strong indicators of a flood threat. These indicators may include excessively deep snowpacks, the approach of seasonal flood threats, or predicted long-term changes in weather patterns.

Visual 35: Phase 2: Flood Alert

Phase 2: Flood Alert

- **Establish or renew partnerships**
- **Perform equipment checks and top off supplies**
- **Review evacuation / shelter procedures**
- **Increase public awareness**

Phase 2: Flood Alert

If the flood threat continues to rise, a Flood Alert may be declared. This is a higher state of readiness, but still short of a flood response.

Common response actions include making regular contact with the local weather service office and increased monitoring and reporting of river stages, precipitation reports, and snowpack depths.

Visual 36: Phase 3: Limited Response

Phase 3: Limited Response

- **Prepare the EOC**
- **Monitor river levels and flood control works**
- **Verify elevations**
- **Locate sites for expedient flood works**
- **Train an expedient workforce**

Phase 3: Limited Response

As the rivers approach the bank full stage, or when the National Weather Service issues a Flood Watch, communities initiate preliminary actions to mount a flood response and go into the Limited Response Phase. At this point, a community may already have minor flooding in low-lying areas.

Visual 37: Phase 3: Limited Response (Continued)

Phase 3: Limited Response cont'd

- **Continue public information programs**
- **Stage heavy equipment**
- **Prepare congregate care centers**
- **Prepare volunteer recruitment sites**
- **Test communication lines**
- **Move farm equipment and animals**

Phase 3: Limited Response (Continued)

Any actions that can be taken now will save precious time if a full scale flood response is mounted.

Visual 38: Phase 4: Full Response

Phase 4: Full Response

- **Evaluate:**
 - **Amount of time before the river crest(s)**
 - **Height of expected river crest(s)**
 - **Duration of the crest(s)**

Phase 4: Full Response

When the National Weather Service issues a Flood Warning, it triggers a Full Response. Steps taken during this response may vary and are based on a careful evaluation of the threat outlined in the flood forecast.

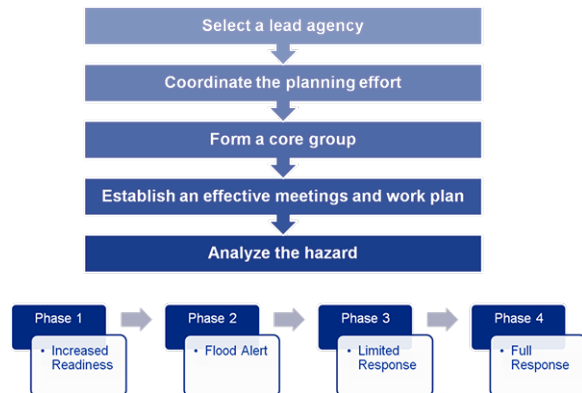
At this point, local officials should gather and review the threat and their response options. These response actions can include evacuating the public from the threat, conducting a limited or full flood response, or a combination.

Visual 39: Planning for Recovery

- Clean-up and debris removal
- Restoration of critical services
- Inspections, permits, and zoning applications
- Mental health counseling
- Medical treatment



Visual 40: Lesson Summary



Consider:

- Evacuation routes
- Borrow and work areas
- Backflow issues
- Vulnerable populations and properties
- Fueling stations

Visual 41: Review Question - 1

What actions should be taken as part of the “Analyze the Hazard” step of the planning process?

Visual 42: Review Question - 2

What are some methods of coordinating flood plans with other emergency plans and with other agencies?

Visual 43: Review Question - 3

× **Who are some potential members of the flood planning team?**

Visual 44: Review Question - 4

× **What are some key areas that should be considered during pre-flood planning?**

Visual 45: Review Question - 5

What are some special concerns that should be considered when preparing for a high water event?

Visual 46: Review Question - 6

What are the four recommended phases in the phased response system?

Visual 47: Group Activity: Plan Coordination

Group Activity: Plan Coordination

Group Activity: Plan Coordination

The instructions for this activity are on the next page of this manual. Supporting materials can be found in Appendix A.

Your group will have 30 minutes to review the sample plan and discuss the questions.

Choose a spokesperson to share your group's responses to the questions with the rest of the class.

Lesson 4: Flood Response Methods

Visual 1: Lesson 4: Flood Response Methods

OBJECTIVE: Explain the advantages and disadvantages of expedient flood works

Lesson Overview

Selecting the proper flood response technique is essential to the success of the operation. This lesson provides an overview of some of the basic flood response methods.

In this lesson, you will learn the advantages and disadvantages of expedient flood works.

Visual 2: Supporting Objectives

More specifically, you will be able to:

- Describe various expedient flood works
- Identify four methods of capping a levee
- Identify the basic materials required for various methods of expedient flood control

Visual 3: Selection Variables

- Current and wave conditions
- Duration of water exposure
- Soil composition
- Terrain



Selection Variables

A flood response method that works in one community may not work in another. Selection variables include current and wave conditions, duration of water exposure, soil composition, and terrain to name only a few. Before selecting any form of expedient flood works, it is advisable to consult with the U.S. Army Corps of Engineers on what will work best in your situation.

Visual 4: Categories of Expedient Flood Protection

- Adding height to existing flood works
- Creating flood works in open areas
- Floodproofing structures



The type of expedient flood works that may be used will depend on the location where flood protection is needed.

Visual 5: Placing Expedient Flood Works on Existing Levees (Capping)

- Build to 2 feet above predicted flood crest
- Place on the crown of the structure



Expedient flood works placed on top of levee systems and berms is called capping. Several methods of capping are available depending upon the situation.

Normally, capping is constructed on the crown of the levee to a height of two feet, plus or minus six inches, above the predicted flood crest.

Visual 6: Preparing a Levee for Expedient Flood Works

- Watertight bond
- Establish or verify gradelines
- Depressions restored to natural grade

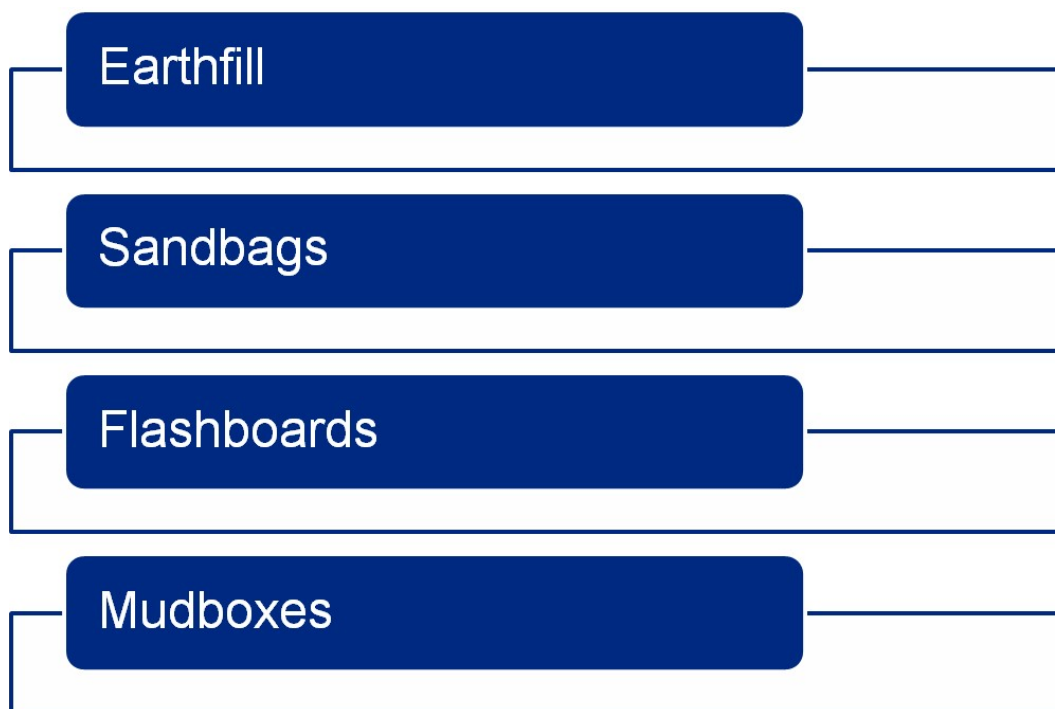


When preparing a levee for expedient flood works, the bond between the levee and the capping must be as watertight as possible.

The first step in the process is to establish or verify gradelines and elevations.

All depressions should be restored to the natural levee grade and provided with an adequate cross section.

Visual 7: Methods of Capping a Levee



Methods of Capping a Levee

The following four basic methods have traditionally been used to cap a levee:

- Earthfill
- Sandbags
- Flashboards
- Mudboxes

Each method has its own advantages and disadvantages that must be evaluated by local responders.

Visual 8: Considerations for Selecting a Capping Method

The capping method selected will depend on many variables, including:

- Expected crest and duration
- Current and wave conditions
- Time available for construction
- Available materials, equipment, and personnel
- Condition of the levee

Considerations for Selecting a Capping Method

No single capping method is best for all sites. Remember, the U.S. Army Corps of Engineers should be consulted on the best method to use in any given situation.

Because crest forecasts have been known to increase, it may be wise to select a capping method that can be easily modified upward should the need arise.

Visual 9: Earthfill

- Relatively easy and fast
- Susceptible to erosion
- Restricted to 3'



Earthfill is a simple and relatively easy method of capping a levee that is used quite often. Since heavy equipment is used, it is a relatively fast method of adding several feet of protection to a levee. However, earthfill capping is susceptible to erosion problems, and most applications restrict it to heights of 3 feet.

It is best to use heavy equipment to construct an earthfill cap. Scrapers and trucks can work on top of the levee when it is dry and stable, but if the levee is wet and soggy, the equipment vibration may cause the levee to fail. In these circumstances, wheelbarrows and hand labor must be used.

Visual 10: Sandbags

- Dependable and easily adaptable
- Resistant to wave actions and erosion
- Very labor intensive
- Relatively slow

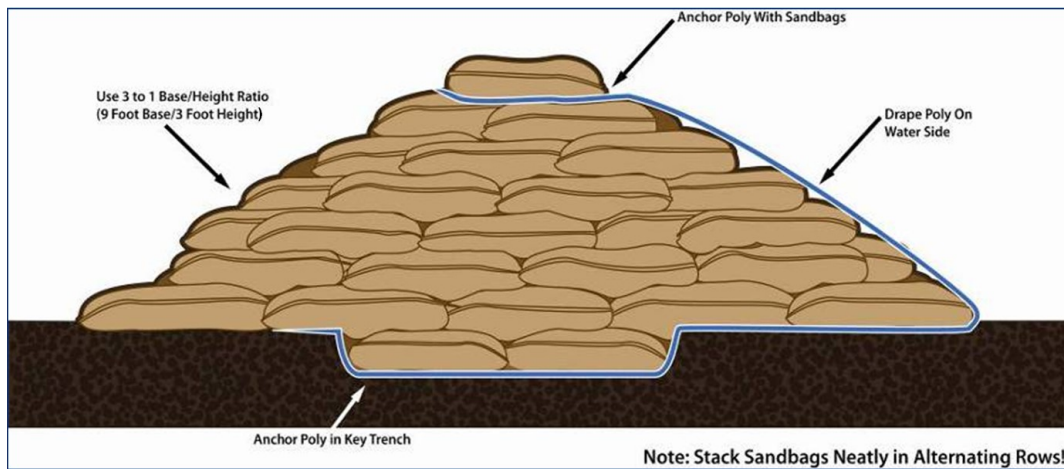


Sandbags

Another way of capping a levee is to use sandbags. This is a dependable method that is easily adaptable to a variety of conditions. Sandbag caps are relatively resistant to wave action and erosion. However, the process of filling and laying sandbags is very labor-intensive which makes this method relatively slow to construct, particularly as the height of required protection grows.

Since this method is labor intensive, detailed procedures should be developed for the evacuation of the massive workforce should the levee fail.

Visual 11: Sandbag Expedient Levee (1 of 3)



The height of the sandbag cap is restricted by the width of the crown. Sandbag flood works are built using a 3 to 1 base/height ratio. For every foot in height, a three-foot base is required to support the sandbag cap. For example, a sandbag cap three feet high will require a nine-foot base. Remember that room must be left on the crown as an access route for workers and flood patrols.

Sandbags must be neatly stacked, not dumped into place. The joints between rows and layers of sandbags should be lapped to improve strength and reduce water seepage. Joints are lapped and the ends of the bags all face down-stream. If available, polyethylene sheeting is placed on the water side of the sandbag line to reduce seepage. When completed, a well-built sandbag line should look as neat as a brick wall.

Visual 12: Sandbag Expedient Levee (2 of 3)



Thousands of sandbags are needed for even minor capping. The process of filling sandbags is very labor intensive. Hundreds of workers may be employed to fill sandbags while a handful of people can lay the output on the levee. Effective systems must be used to fill sandbags to maximize the output from a limited workforce.

If the levee is in good shape and there is ample room and access to the site, the sandbags may be filled at the base of the levee and passed using gang lines to the crown. However, if the levee is in poor shape or water is near the crown, it may be preferable to fill the bags at remote locations and transport them to the levee for use.

Visual 13: Sandbag Expedient Levee (3 of 3)



This slide shows 300,000 sandbags stockpiled for use in the 2009 floods in Fargo, North Dakota. Often shopping center parking lots are used as filling sites. These locations offer some the basic support services needed by the workforce, such as restrooms, water, etc., and may have loading equipment, such as fork lift trucks. Sandbags are filled and then loaded 50 to a standard pallet, which will fit inside the bed of pick-up truck and weighs about 2,000 pounds. This load can be managed by most fork lift trucks and the pallet can be transported to the flood line by pick-up trucks or other vehicles and laid by a second crew. By palletizing loads, the time consuming and back-breaking job of handling individual sandbags can be lessened.

Filling the sandbags at a remote site lessens confusion along the expedient flood works as well as the danger to the workforce. It also reduces problems of evacuating large numbers from the levee in case of an emergency.

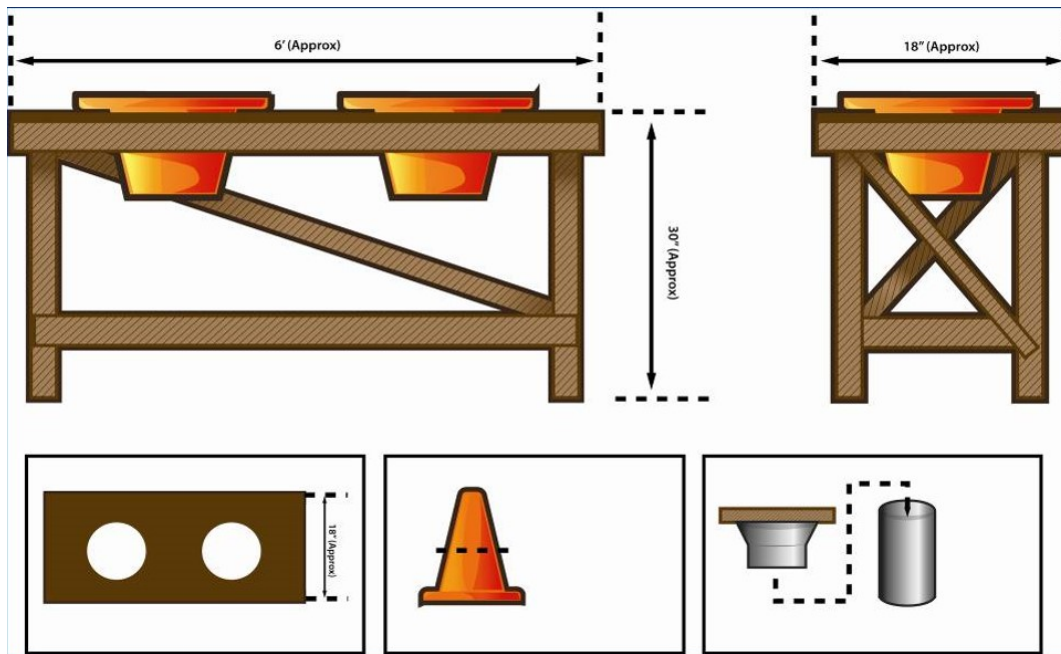
Visual 14: Filling Sandbags



To be effective, sandbags must be properly filled. The average sandbag is approximately 14 x 26 inches and should be filled approximately half full or to about 30-35 lbs. Untied sandbags are recommended for most situations. Tied sandbags should be used only when special situations require pre-filling and stockpiling. Properly filled sandbags are relatively easy to handle and when tamped into place make a tight structure.

To speed the process of filling sandbags, filling stations may be constructed. This can be as simple as using a ladder supported by sawhorse, as shown on the slide.

Visual 15: Filling Sandbags (Continued)



A sandbag filling station can also be constructed out of lumber, as this plan shows. These sandbag filling stations staffed with a crew of 5 can fill about 150 bags per hour.

Visual 16: Sandbags (Continued)

Materials Required per 100' Sandbag Expedient Flood Protection

Height	Sandbags Required	Tons of Sand Required*	Cu. Yd. Sand Required
1 Foot	800	13	8
2 Feet	2,400	41	25
3 Feet	5,000	84	52
4 Feet	8,800	147	91
5 Feet	13,600	228	141
6 Feet	19,500	327	202

*Wet sand weight, all figures rounded

This chart illustrates the number of sandbag required per 100 feet for various heights. Note that as the height of the sandbag wall increase, the number of sandbags required increases in almost geometrical proportion. Faced with limited resources and time, it is generally not practical to construct properly built sandbag walls over 3 or 4 feet in height.

Visual 17: Flashboards

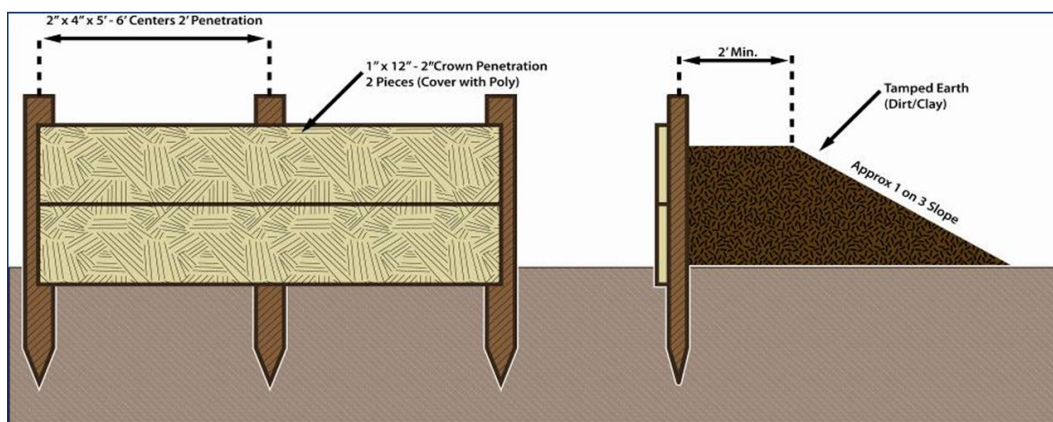
- Used if required capping is:
 - Greater than 1.5 feet
 - Less than 3 feet
 - Exposed to waves, currents, or erosion
- Useful on barrow crowns, limited space
- Costly to construct

Flashboards

Flashboards may be used if the required capping is greater than 1.5 feet but less than 3 feet, or if the capping is likely to be exposed to waves, currents, or erosion. They are also useful on narrow crowns and other locations where space is limited.

With this method, a board fence is built approximately two feet from the riverside edge of the levee crown. Earthfill is used on the landward side to reinforce the fence and provide resistance against the hydrostatic forces of the flood waters.

Visual 18: Two Board Style

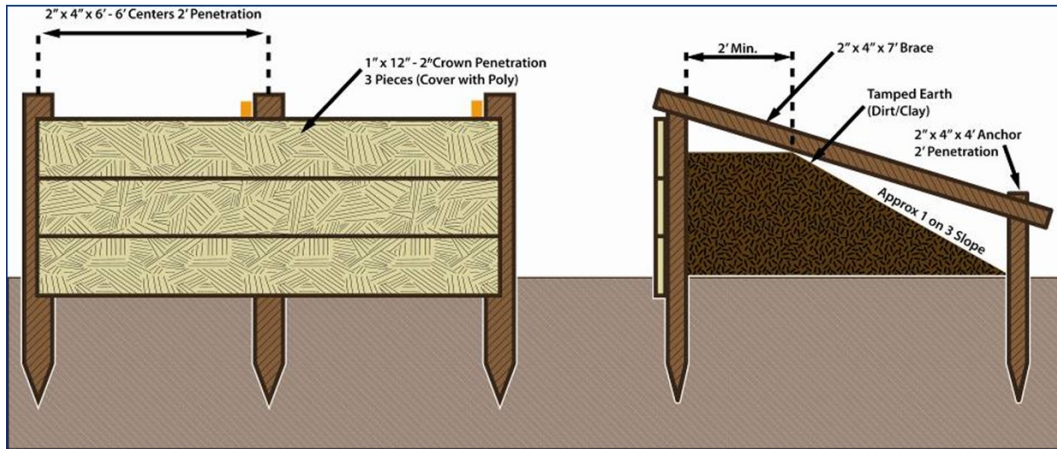


There are two flashboard designs:

- Two-board

The two-board style adds about two feet to the crown of a levee, by using two 1" x 12" boards for each section of the levee, sealed with poly and held in place with tamped earthfill, extending at least two feet horizontally behind the boards, and then meeting the crown at a 3:1 slope.

Visual 19: Three Board Style



- Three-board

Three-board flashboards may be used to add about three feet to the height of a levee. If longer stakes are used, a two-board system can be easily increased to a three-board cap.

Due to the added water pressure that will be exerted against the flashboard, bracing is added to the top of the works.

Visual 20: Building Flashboards

- Drive the stakes
- Do not excavate holes
- Tamp all backfill firmly
- Use poly sheeting
- Use marine grade materials

When building the flashboard, it is important to drive the stakes rather than excavate holes and backfill the posts. It is also extremely important to tamp all the backfill firmly into place. Poly sheeting is used on the face of the flashboard to reduce water seepage and to maintain the integrity of the flashboard structure if wave action is a problem.

If the flashboard is subject to extended high water conditions, the deterioration and warping of the wood can become a significant problem. Using marine grade-materials may help with this issue, but will significantly increase the cost of the project. Even when marine-grade materials are not used, flashboards are rather expensive to construct, which is always a consideration during flood response operations.

Visual 21: Mudboxes

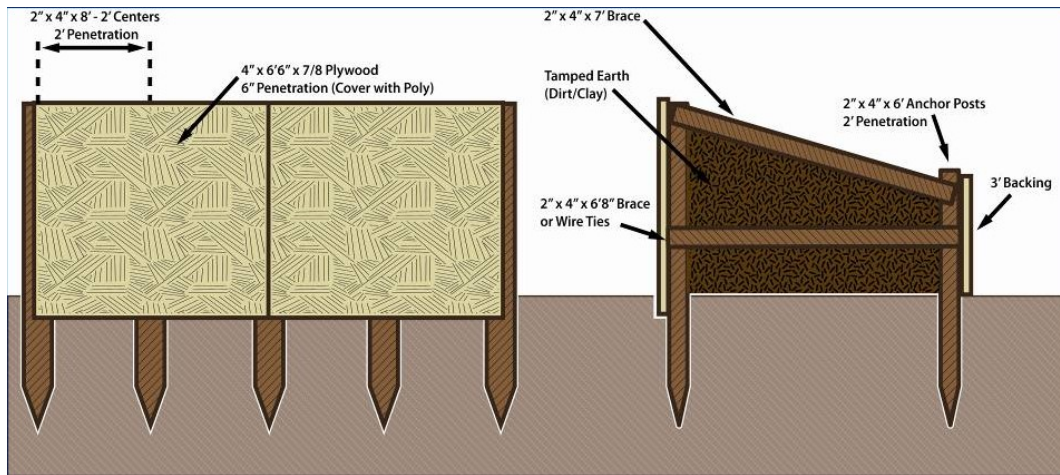
- Useful on narrow crowns
- Can add 6 feet of height
- Costly to construct
- Very labor and time intensive

Mudboxes

Mudboxes, though rarely used due to high costs, can be useful on narrow crown levees and can add up to six feet in height. This method involves constructing a wooden box near the river edge of the levee crown and filling the box with tamped earth or clay fill. The box should never be filled with sacks or sandbags.

Mudboxes are extremely costly to construct and very labor- and time-intensive. On narrow crowns, it may be necessary to haul fill material by hand in wheelbarrows or other devices. Due to the great pressures that are exerted by flood waters, the quality of construction on mudboxes must be above average. Remember, cutting corners in construction techniques or materials can lead to catastrophic failures.

Visual 22: Six Foot Mudbox



If possible, the width of the mudbox should be twice the height of the fill. As with flashboards, the stakes must be driven rather than drilled and backfilled. It is extremely important to firmly tamp the backfill into place. Voids left in the fill can cause the failure of the system.

Some designs use wire to tie the box together. Caution should be used with this method as the wire can cut through the wet lumber, reducing the strength of the system.

Visual 23: Considerations for Using Mudboxes

- Subject to erosion if waves overtop
- Erosion must be monitored and corrected
- Use marine grade materials

Mudboxes are subject to erosion problems if waves overtop the construction. In order to maintain the integrity of the mudbox, erosion of the fill must be monitored and corrected. Sandbags or added poly covers may be used to limit or reduce fill erosion.

During extended high water events, the mudbox may deteriorate, particularly if standard grades of plywood are used. Standard plywood will begin to delaminate after water exposure of about 4 days. For extended high water conditions, serious consideration should be given to the use of marine grade materials, which may increase the cost of the project as much as ten-fold but may reduce more expensive losses in the community.

Visual 24: Expedient Flood Works in Open Areas

- Provides more space for floodwaters to fill
- May affect overall crest
- Keeps flood works away from current scour
- Lessens damage by floating debris



Placing Expedient Flood Works in Open Areas

The majority of rivers do not have levees or other flood control structures. Open areas offer different challenges and advantages for the construction of expedient flood works.

Visual 25: General Considerations

- Access and right of way issues
- Gradelines are difficult to establish and maintain
- Seal sewer lines and drain tiles

General Considerations

When locating expedient flood works in open areas, it is best to keep the construction as far away from the waterway as possible. This serves two purposes:

- It provides more space for the floodwaters to fill, which may have an effect on the overall crest.
- It keeps the flood works away from current scour and lessens damage by floating debris.

If a roadway or other surface with the capability of supporting heavy equipment is present, an expedient levee may be constructed there as a relatively quick and easy means of providing emergency flood protection. Roadways are often used because the road surface provides a sound base for the structure and allows easy access for construction equipment.

In some areas, access and rights of way may be a problem, particularly when constructing expedient levees on private property. These considerations must be addressed in the planning process. The Corps of Engineers cannot provide assistance in the construction of expedient levees until access issues have been resolved.

Unlike levee crowns, which by design have almost constant elevations, open areas have gradelines that are more difficult to establish and maintain. This variability in gradelines increases the difficulty of constructing expedient flood works. It is important for survey crews or engineers to set gradelines and heights for any flood works set in open areas. During construction, these lines must be closely monitored and followed by all flood response teams.

As with any method of flood protection, it is essential to seal sewer lines, and drain tiles and other conduits that would allow water to bypass the expedient flood work and flood the area. Once these systems have been plugged, provisions may be needed to pump sewer lines or systems to prevent other forms of flooding.

Visual 26: *Methods for Building Expedient Flood Works in Open Areas*

- Flashboards and mudboxes
 - Difficult to adapt to changing grades
- Sandbags
 - Versatile, commonly used
 - Very labor intensive
- Earthfill
 - Fast and easy
 - Subject to erosion

Methods for Building Expedient Flood Works in Open Areas

Because flashboards and mudboxes are difficult to adapt to changing grades, they are generally not used in open areas. Since sandbags are so versatile, they are commonly used in open areas for expedient flood protection, following the same basic techniques that are used for stacking sandbags when capping levees. However, this process is very labor intensive and may require more time than is available.

Earthfill is often used for building expedient levees because it is a faster, easier method than sandbags that provides better protection in open areas than flashboards and mudboxes. However, keep in mind that earthfill levees are subject to erosion problems.

Visual 27: Constructing an Earthfill Expedient Levee

- Survey the area
- Build in one-foot increments
- Compact each layer
- Base is 4 times height (minimum)

Constructing an Earthfill Expedient Levee

Construction of the expedient levee begins after the area has been surveyed. The levee is built in one-foot increments preferably using cohesive materials such as clay. Each layer is compacted before the next layer is placed down. At a minimum, the base of the expedient levee should be four times the height of the structure. If available, polyethylene sheeting can be used to protect the river side of the expedient levee from erosion and reduce seepage. Another alternative to limit erosion is to cover the river side slope of the expedient levee with sand bags.

It may not be possible to locate expedient levees in a way to protect all property from flood waters. In many cases, expedient levees have been placed down the roadways protecting one side of the street while sacrificing the other side to flood waters. This creates obvious political problems, but there may not be any other alternative. In these cases, the homes on the water side of the flood works should have their contents moved to higher ground in an attempt to lessen the damage.

Visual 28: Jersey Barriers

- Readily available materials
- Restricted to 3 feet
- Must use heavy machinery
- Used only on flat surfaces



Visual 29: Constructing a Levee Using Jersey Barriers

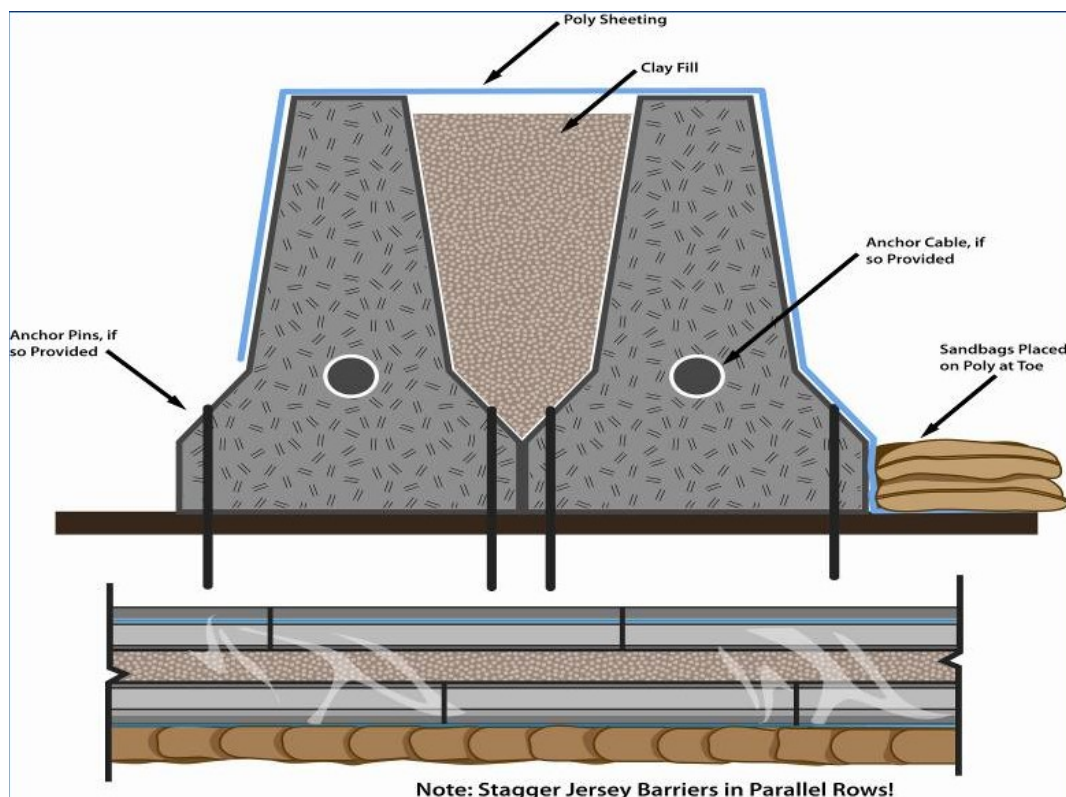
- Survey the area
- Use two rows of barriers side-by-side
- Stagger the joints between the rows
- Use tamped earth to fill in gaps
- Use polyethylene and sandbags to reduce seepage

Constructing a Levee Using Jersey Barriers

Another method that can be used to create expedient flood works in opens areas is the use of Jersey Barriers. These concrete barriers may be readily available through a variety of sources in the community such as highway and street departments, or construction firms. They offer a means of expedient protection where only three feet or less of added protection is required. However, their application is restricted not only by their limited height but also the fact that machinery is always required for their placement, and they may be placed only on flat surfaces such as roadways.

As with all expedient levees, a survey should be performed before placement to assure that the level of protection given by the barriers will be sufficient for the expected crest.

Visual 30: Constructing an Levee Using Stagger Jersey Barriers



To create the most effective expedient levee using Jersey Barriers, two rows of barriers should be set side-by-side on a level surface, staggering the joints between the two rows. Tamped earth is used to fill the space between the rows, and to provide the mass that is needed to withstand the pressure of the flood waters.

It is absolutely essential that the barriers be anchored to prevent movement when they are exposed to the tremendous forces of the flood waters. The barriers should be locked to each other by cables or pins and further anchored to the ground with drive spikes or pins through the anchor holes provided in the barrier. Some models use a continuous anchor cable that runs through the center of the barrier.

If available, polyethylene can be placed under the river side of the barrier and draped over the works. A row of sand bags may then be placed at the base of barriers to secure the poly in place. This reduces seepage and the need for pumping operations.

Visual 31: Advanced Methods

- HESCO Bastion Concertainer®
- Rapid Deployment Flood Wall (RDFW®)
- Portadam® system

Advanced Methods

For many years sandbags have been used to create interim, barrier-type flood-response structures in the United States. However, sandbag structures are back-breaking and tedious to build. More expedient, cost-effective, interim flood-response technologies are now available.

Although there are many options available, the U.S. Army Corps of Engineers has used the following three products with much success:

- HESCO Bastion Concertainer®
- Rapid Deployment Flood Wall (RDFW®)
- Portadam® system

The HESCO Bastion, RDFW, and the Portadam structures are capable of being built more quickly and with a much smaller work force than similar sandbag structures.

Visual 32: HESCO



HESCO Bastion Concertainer®

The HESCO Bastion Concertainer is a structural system of linked baskets containing fill material. This system can be used to construct expedient levees in open areas or to add height to existing levees.

The baskets are stackable, so they are versatile and adaptable for the needs of the flood response. Furthermore, a HESCO system can be constructed in much less time than traditional sandbag methods. In fact, according to the manufacturer's website, a wall the equivalent of 1500 sandbags can be built by two workers using a front loader in 20 minutes. Building the same size sandbag levee would take approximately seven hours and ten workers.

The cost to buy the HESCO system is comparable to using sandbags, and the system is reusable. However, in USACE testing, it took over 36 man-hours to remove a levee constructed using the HESCO system, compared to 3 ½ man-hours to remove a comparable sandbag levee.

Visual 33: RDFW



Rapid Deployment Flood Wall (RDFW®)

The RDFW is a collapsible plastic sand grid system that can be assembled with as few as two people. After being expanded into place, the RDFW is filled with a loader or other piece of earth-moving equipment. Like the HESCO Bastion Concertainer, the system is stackable and can be used in open areas or on existing levees.

A container holding 100 RDFW units easily fits into the bed of a pickup and, the units are light enough to be handled by two people. An RDFW levee needs half the amount of fill that a levee using sandbags would require. According to manufacturer's information, a wall that can be constructed in one hour by seven workers would take 35 people almost 20 hours to build using sandbags.

The RDFW units cost up to five times as much as sandbags. However, like the HESCO system, the RDFW units are reusable. In USACE testing, approximately 10% of the units were damaged during removal.

Visual 34: PORTADAM



Portadam® System

The Portadam system is made of a steel framework supporting a vinyl liner which acts as a dam to prevent floodwater damage inside the area protected by the structure. No fill materials are required to use the Portadam, but sandbags are typically used to weigh down the liner's bottom edge (the apron). The top edge of the Portadam liner is tied to the steel frame for additional security.

Unlike the HESCO and RDFW systems, the Portadam cannot be stacked to allow for additional height. With a footprint of 15 feet in width, the Portadam is most appropriate for use in open areas. It can also be placed in open water up to 12 feet deep on uneven bed contours. The system is easy to install and can be constructed in multiple configurations.

Of the three methods tested by USACE, the Portadam was the quickest in both building and removal. The system costs more than twice as much as sandbags initially, but is completely reusable.

Visual 35: Comparison of Advanced Methods

Comparison Item	Portadam	Hesco Bastion	Sandbags	RDFW
Construction man-hours	26.2	57.5	453.1	48.4
Fill	450 sandbags	91 cu yd	132 cu yd	85 cu yd
Removal man-hours	12.6	36.3	3.5	113.4
Total man-hours	38.8	93.8	456.6	161.8
Reusability	100 %	> 95 %	0 %	> 90 %
Materials cost	\$71,300	\$26,398	\$30,000	\$151,525

Comparison of Advanced Methods

As shown in the chart, in USACE field tests, all three advanced methods were less time-consuming and labor-intensive than sandbags, and all were reusable to some extent, while sandbags are not.

Comparison of Advanced Methods

Comparison	Portadam	HESCO Bastion	Sandbags	RDFW
Construction man-hours	26.2	57.5	453.1	48.4
Fill	450 sandbags	91 cu yd	132 cu yd	85 cu yd
Removal man-hours	12.6	36.3	3.5	113.4
Total man-hours	38.8	93.8	456.6	161.8
Reusability	100 %	> 95 %	0 %	> 90 %
Materials cost	\$71,300	\$26,398	\$30,000	\$151,525

Visual 36: Lesson Summary



Lesson Summary

As part of the planning process, options should be listed for the placement and use of expedient flood works. Several options may be presented for each situation as this allows for adaptation to changing water conditions, resource capabilities, and time before the crest.

Remember, no single structure is suitable for use in all situations. The selection of the proper style of expedient flood works can be a complex issue driven by many variables.

Visual 37: Review Question - 1

How should local officials determine the best method of expedient flood works to use?

Visual 38: Review Question - 2

What are some considerations when selecting methods to cap a levee?

Visual 39: Review Question - 3

If wave action will be a concern, which capping methods would work best?

Visual 40: Review Question - 4

What are four traditional methods of capping a levee?

Visual 41: Review Question - 5

What basic materials are required to cap a levee using earthfill?

Sandbags?

Flashboards?

Mudboxes?

Visual 42: Group Activity: Planning for a Flood Event

Lesson 5: Decision Making

Visual 1: Lesson 5: Decision Making

OBJECTIVE: Develop a flood emergency plan for a given scenario

Lesson Overview

Every flood event will present new challenges and require different approaches. During a flood response, decision makers will need to evaluate the response options included in the flood plan and choose the best option for the conditions.

The selection of the correct response option is critical to the success of the flood response. This normally involves a formal decision-making process to evaluate all of the potential viable options.

In this lesson, you will learn how to develop a flood emergency plan for a given scenario.

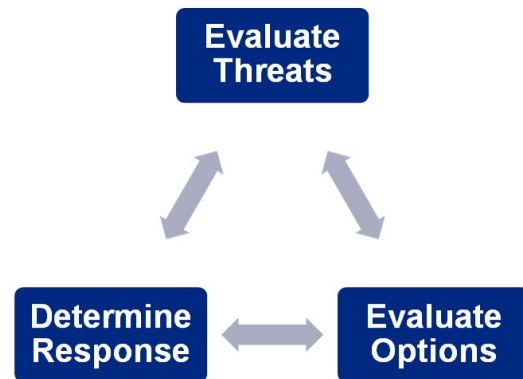
Visual 2: Supporting Objectives

- Describe the decision-making process
- List important questions to ask during the decision-making process
- Summarize the priorities that should be set before and during the flood response
- Examine factors that can influence the decision-making process
- Identify available resources for the flood response

There are many factors that come into play when making decisions for a flood response. We'll explore them here.

Visual 3: Decision Making Process

- Not a one-time process
- Must be adaptable and flexible



The Decision Making Process

Every flood threat is made up of different characteristics, and each element of that threat must be compared and weighed against the available response options. It is important to note that this may not be a one-time process. As variables change in the flood threat equation, different options may emerge or be discarded. The decision-making process must be adaptable and flexible enough to continually evaluate the flood threat and the available options, to ensure that the current course of action remains the most desirable course of action.

Visual 4: Evaluate Threats

- Completely review all flood threats
- Use sound logic, not emotion
- Form a small committee



Evaluate Threats

The first step in the decision-making process is to objectively evaluate the flood threat by conducting a complete review of the threat(s) using sound logic, not emotion. Hard and clear answers may be rare in this step of the process. For example, a stalled weather system can make weather forecasting extremely difficult. Under such conditions, flood forecasts may change frequently and affect the expected flood crest as well. These frequent changes can have a dramatic impact on the flood response process.

It is important to remember that threat evaluations are typically best handled by small committees rather than relying on the judgment of any one person, no matter how knowledgeable that person may be.

Visual 5: Evaluate Options

- Review options for each threat
- Use sound logic, not emotion
- Some situations have no effective options



Evaluate Options

Once the flood threats have been identified, the options for dealing with each threat are reviewed. This too must be handled objectively using sound logic, not emotion. Responders must recognize the unfortunate fact that there will be situations when there isn't an effective response option other than to let the situation play out and deal with clean-up issues after-the-fact.

Visual 6: Key Questions to Ask When Evaluating Response Options

- When will the river crest?
- Are multiple crests expected?
- How long will we have high water?
- How high?
- What structures could be affected?
- Could the flood forecast change?
- What other factors are present?

You must know when a river is expected to crest and at what height, as well as if there will be one or multiple flood crests. If longer duration events are anticipated, different techniques and materials may be required for the flood response. You should also identify structures that could be affected and consider what factors may cause the forecast to change or complicate the response operations.

Visual 7: Determine the Response

- Select the best response
- This may involve elected officials
- There may not be a “best” method

Determine the Response

Once all of the information has been considered, the best response method should be selected from the options outlined in the flood response plan. Generally, selecting response methods involves policy decisions by the elected leadership of the community. As stated earlier, there may not be a best method in some situations, and the selection may boil down to the lesser of two evils.

Visual 8: Response Priorities



Protection of
Human Life



Protection of
Critical Facilities



Protection of
Property

Response Priorities

One part of the decision-making process when determining the best response is to establish response priorities. Response priority decisions often involve policy decisions and are normally influenced and made by elected officials. The flood response planning document should list response priorities based on the policy decisions of the community leadership. The information outlined in the plan will help to create an orderly process for protecting the community at risk.

Visual 9: Protection of Human Life

- May require evacuation
- Consider notification and moving times
- Consider special risk facilities
- Evaluate evacuation routes and care centers
- Consider flood response worker safety

Visual 10: Protection of Critical Facilities

- Waste water treatment plants
- Potable water sources
- Essential government functions
- Hospitals
- Schools



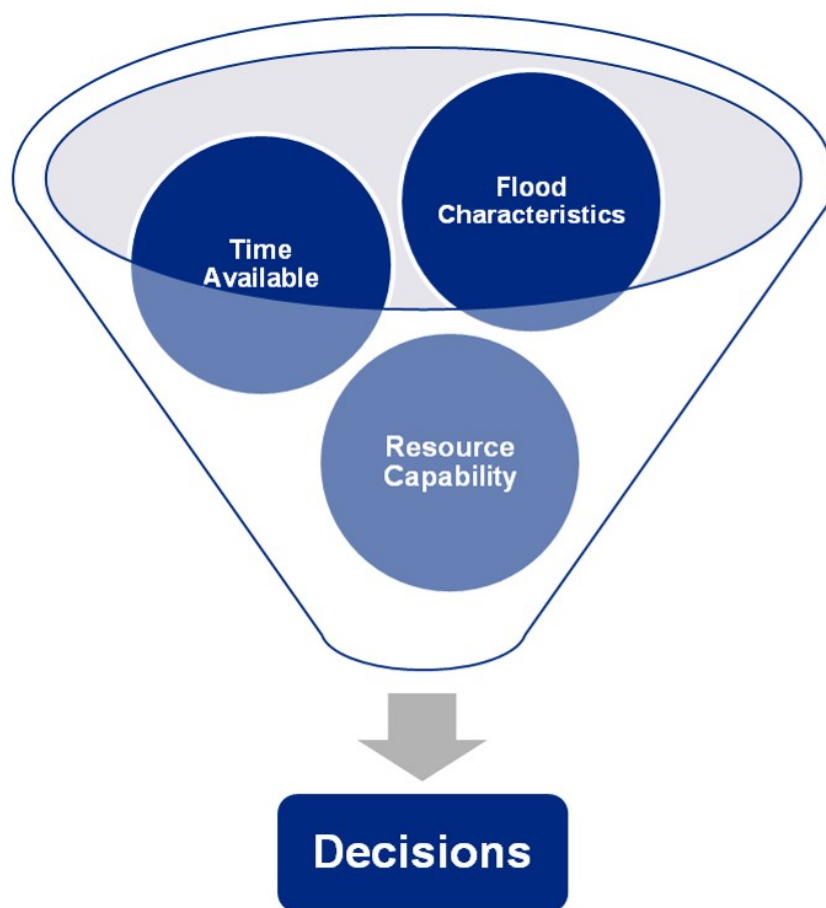
After the protection of human life, the next priority is to protect critical facilities and key resources such as waste water treatment plants, potable water sources, essential government functions, hospitals, and schools. Protecting these facilities may involve limited flood responses as waters rise and flood the surrounding areas.

Visual 11: Protection of Property

- Commercial properties
- Industrial properties
- Personal property



Visual 12: Influencing Factors



Factors that Influence the Decision-making Process

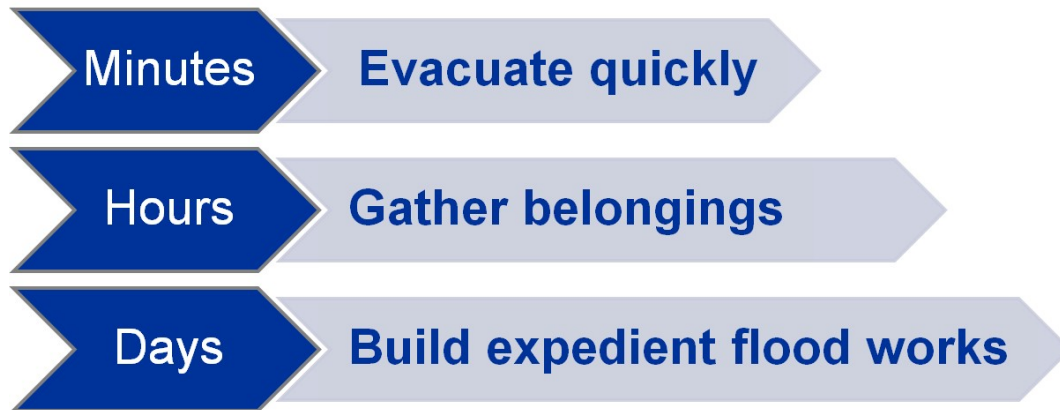
There are many factors that may influence the decision making process during a flood response situation.

Flood Characteristics

Several factors that will influence the decision making process are the characteristics of the flood itself. These flood characteristics include the flood:

- Depth
- Velocity
- Duration
- Location

Visual 13: Time Available



Time Available

Time frames will also play a critical role in the flood response decision-making process. For example, in a rapidly developing flood situation, there may only be enough time to conduct a hasty evacuation. If more time is available, more options can be explored. When more lead time is available, evacuations may still be ordered, but time will also be available for the movement of personal items and household goods as well.

With hours or days available before a flood response, expedient flood works can be constructed on higher ground to gain better overall protection for the community even if it means sacrificing some lower lying property to flood waters.

In reality, most flood response decisions will propose a combination of systems using some actions as delaying efforts while more complex methods can be employed.

Visual 14: Resource Capabilities

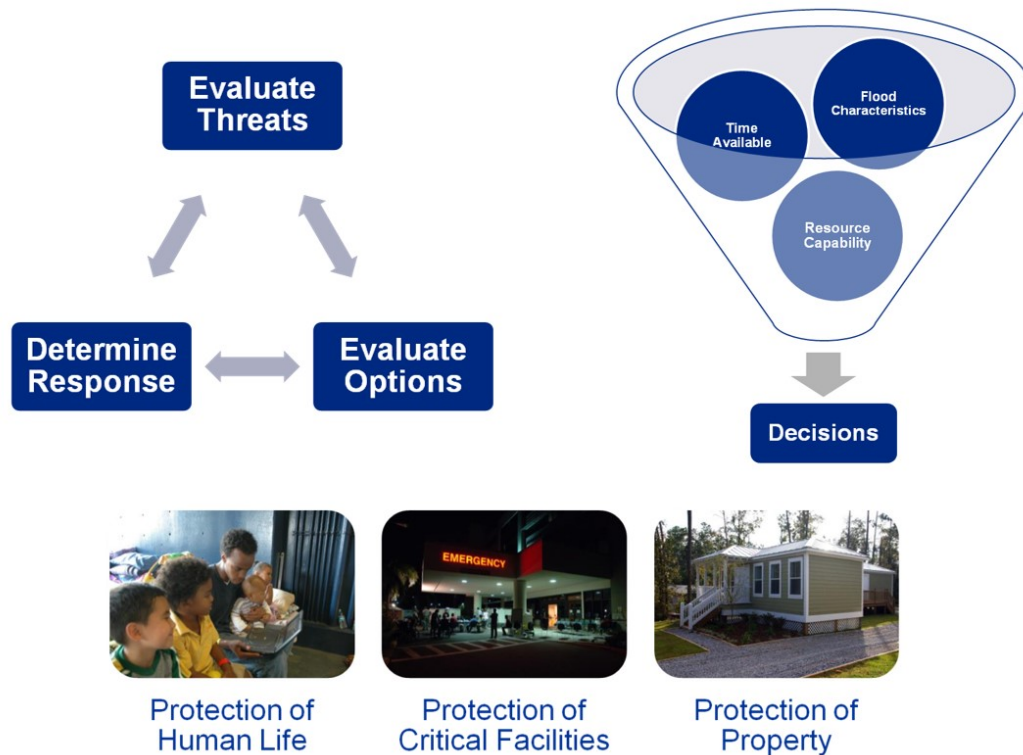
- Equipment
- Materials
- Personnel
- Support Systems



Resources are generally organized into four categories:

- Equipment (e.g., trucks and forklifts)
- Materials (e.g., sandbags, wood, sand)
- Personnel (ensure relief workers and rest periods)
- Support Systems (e.g., mechanics, portable toilets, feeding stations)

Visual 15: Lesson Summary



Lesson Summary

As each flood response factor is considered and weighed, the list of response options changes. Of the options remaining at the end of the evaluation process, the selection should offer the best chance of success and the most flexibility to deal with changing flood response conditions. At the end of the evaluation process, few of the remaining options will be perfect, but they will provide the best possible chance of meeting the flood response objectives.

Remember, no single flood response option is best in all situations, and the goal of the decision-making process is to match the best option with the expected threat to provide the best chance of success in any given situation. It is also important to remember to include back-up plans in the flood response package.

Visual 16: Review Question 1

What are the steps in the decision-making process?

Visual 17: Review Question 2

What are some important questions to ask during the decision-making process?

Visual 18: Review Question 3

What priorities should be set before and during a flood response?

Visual 19: Review Question 4

What factors can influence the decision-making process?

Visual 20: Review Question 5

What are some available flood response resources?

Visual 21: Group Activity: Resource Inventory

Group Activity: Resource Inventory

Group Activity: Resource Inventory

During this activity, your group will represent several entities within Peabody City. During the first 10 minutes of the activity, use the worksheet labeled “Part One” to assess your resource information.

When you are finished (or after 10 minutes have expired), choose approximately half of the group members to be responsible for gathering information from the other groups about the resources they have available, using the worksheet labeled “Part Two.”

The remaining half of the group members will stay at the table to answer questions from other groups.

You will be allowed 15 minutes to gather information in this way.

Lesson 6: Volunteer Management

Visual 1: Lesson 6: Volunteer Management

OBJECTIVE: Identify the considerations involved in managing a volunteer workforce

Lesson Overview

Flood responses are very labor intensive. Plans to address workforce needs, recruitment, training, and support services are every bit as important as those that detail the construction of flood works. Planning ahead for volunteer recruitment, training, and tracking will greatly reduce or eliminate wasted efforts during the flood response and prevent time delays.

In this lesson, you will learn about the considerations involved in managing a volunteer workforce.

Visual 2: Supporting Objectives

More specifically, you will be able to:

- List existing organizations that might be able to provide volunteers for flood emergencies
- List the considerations involved in registering and tracking volunteers
- Identify the services needed to support a volunteer workforce during a flood response
- Match volunteer skills with service areas
- Identify the training needs of flood response volunteers

It is important to plan for the need for human resources during a flood response. You should maintain a list of volunteer sources. Also, you will need to know how to register and track volunteers. As mentioned before, you will need to provide services for the volunteers working for you.

Getting the most out of your volunteers occurs when you match their abilities with your needs. In cases where this match is not possible, ensure that your volunteers are properly trained to perform the duties you will assign them.

Visual 3: How Many Volunteers Are Needed?

- Hundreds, maybe thousands
- A good workforce is a critical resource



The flood emergency plan should make personnel estimates for various flood response options. While such estimates are often “field modified,” they provide a good starting point for recruitment programs.

The workforce must be managed to provide 24-hour coverage, and shifts must be rotated to prevent the volunteers from burning out too early in the flood response.

Visual 4: Recruiting Volunteers

- Develop guidelines
- Research State regulations
- Establish recruitment centers
- Advertise the opportunities

Recruiting Volunteers

Once workforce estimates have been generated, the recruitment planning process can begin. As part of the planning process, communities may want to consider developing guidelines for accepting volunteers such as setting minimum age requirements or conducting criminal background checks. It is also important for communities to adhere to any State regulations regarding the use of volunteers.

Citizens may wish to independently volunteer their services to assist in the flood response efforts. Provisions must be made for individual volunteers who wish to contribute to the community effort. One way to handle this group is to establish recruitment centers where independent volunteer workers can be registered, trained, and directed to job sites. Recruitment centers should be well-advertised in the media. This will help reduce the number of volunteers that “show up” at various operation sites.

Visual 5: Where Can Volunteers Be Found?

- Individuals
- Civic Organizations
- Faith-based groups
- Schools
- Prisons
- Emergency Services



The following are some suggested groups that may provide organized pools of volunteers, depending on the specifications outlined by your community.

Civic Organizations

Many civic and fraternal organizations have well-defined organizational structures that make it easier to train and direct a workforce.

Faith-based Groups

Community churches, synagogues, and other faith-based groups are often the first to volunteer to help others in an emergency.

Schools

Students are accustomed to working in organized groups and have a general willingness to accept and follow directions.

Prisons

Trustees, work release program participants, and the general inmate population have proven to be an effective flood response force.

Emergency Services

Police and Fire Departments are another possible source for volunteers.

Visual 6: How Can Volunteers Be Registered and Tracked?

- Legal requirements
- Designated clothing/tags
- Staging areas and buses
- Processing centers
- Team leaders



Visual 7: What Can Volunteers Do?



**Flood Response
Operations**



**Support
Services**

Visual 8: Types of Support Services

- Congregate care
- Communications
- Child care services
- Food service
- First aid
- Transportation
- Registration / tracking
- General administrative duties

Types of Support Services

While some people may not be able to man the floodline, they can support other operations such as feeding, transportation, and child care. There is room for every volunteer in a flood response.

Other key services to provide include portable toilets (1 unit per 100 workers), hand washing stations, bottled water, and a place for workers to relax and take occasional breaks.

Unless the needs of the volunteer workforce are met, the workers will quickly disappear.

Visual 9: Individual Activity: Volunteer Skills Matching

Activity: Volunteer Skills Matching

Individual Activity: Volunteer Skills Matching

You'll need the National VOAD Members Resource Directory located in Appendix A for this activity

You will find an activity worksheet on the next page with directions for completing the worksheet. You will be allowed 10 minutes to complete the activity.

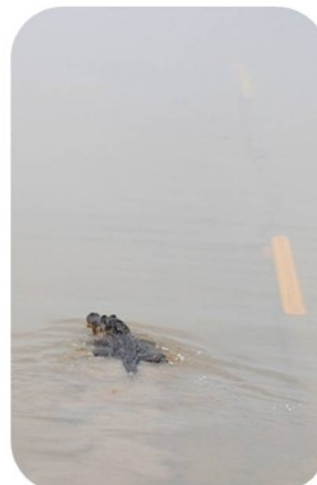
Visual 10: What Training Do Volunteers Need?



**General health
and safety**



**Evacuation
procedures**



**Special
dangers**

What Training Do Volunteers Need?

Most training will involve informal briefings given by the team leader. On-the-job training is an important element, and supervisory staff should take corrective action before problems evolve into more significant issues.

Visual 11: General Health and Safety

- Basic hygiene procedures
- Food handling techniques
- Prevention of slips and falls
- Proper wound care
- Use of safety equipment

General Health and Safety

Because safety and health issues are so important, a section on safety issues should be included as part of the workers' initial briefing.

It is very important to ensure that volunteers understand what safety equipment they need during a flood response and how to use it.

Visual 12: Evacuation Procedures

- Alarm signals
- Escape routes
- Groups of three
- Communications equipment

Evacuation Procedures

Volunteers should be given information on emergency evacuation procedures and signals.

Workers on flood patrols should always travel in groups of at least three. Flood patrols should be provided with mobile phones or two-way radios and every member of the group should understand how to operate the equipment.

Visual 13: Special Dangers

- Manhole covers
- Unstable areas



Visual 14: Activity: Volunteer Management

Visual 15: Lesson Summary



Flood Response Operations



Support Services

The volunteer force can make or break the flood response

Provide training for volunteers



General health and safety



Evacuation procedures



Special dangers

Visual 16: Review Question 1

What existing organizations might be able to provide volunteers?

Visual 17: Review Question 2

What considerations are involved with registering and tracking volunteers?

Visual 18: Review Question 3

What services are needed to support a volunteer workforce?

Visual 19: Review Question 4

On what topics should volunteers receive training?

Visual 20: Review Question 5

What considerations are involved with ensuring the health and safety of volunteers?

Lesson 7: Flood Works Monitoring

Visual 1: Lesson 7: Flood Works Monitoring

OBJECTIVE: Identify the processes, equipment, and considerations for monitoring flood works

Lesson Overview

Levees and expedient flood works should be constantly monitored during periods of high water. The discovery of problems early on may provide time for the repair or reinforcement of failing devices and systems.

If severe damage is discovered, emergency evacuation warnings can be given so that the remaining residents and flood workers can flee to higher ground ahead of the raging floodwaters. An effective monitoring program is essential for safety during flood responses.

In this lesson, you will learn about the processes, equipment, and considerations for monitoring flood works.

Visual 2: Supporting Objectives

More specifically, you will be able to:

- List types of threats to a levee system
- Explain the difference between a clean and a dirty sand boil
- Explain how flood works can be monitored during high water conditions
- Describe the safety procedures to be followed by monitoring teams

Visual 3: Maintenance and Inspection

- Reduces risks to levee systems
- Ensures easier visual inspections
- Enables early identification of problems
- Facilitates corrections and repairs during normal low water periods

Routine Maintenance and Inspection

Adhering to a scheduled levee maintenance program, especially mowing and eliminating growth of vegetation, is crucial to allowing proper levee inspection during normal river flow periods, as well as during high water or flood events.

Visual 4: Importance of Levee Maintenance



Importance of Levee Maintenance

It is virtually impossible to effectively monitor the pictured levee due to the unmowed grass cover. Telltale signs of levee problems are virtually impossible to see and monitor when the levee is in this condition.

Visual 5: Results of Effective Levee Maintenance



Results of Effective Levee Maintenance

In this picture, the results of following a scheduled levee maintenance program are obvious. A levee in this condition makes it very easy to monitor signs of levee problems during normal low water times. A scheduled mowing program makes establishment of woodier vegetation types, such as large bushes or trees whose root structure can degrade levee integrity, almost impossible. The ability to effectively monitor this levee during high water or flood events is also obvious, compared to the previous slide.

Visual 6: Inspect for the Obvious...



Inspect for Obvious Problems

Following an effective maintenance and inspection program during normal low water times can identify obvious problems, such as this flap gate blocked open with driftwood, which can be corrected easily.

Visual 7: ...And the Not So Obvious



Inspect for Non-Obvious Problems

Look closely when following your normal inspection program. Always inspect closely, even if things appear to be “normal” from a distance.

Visual 8: Always Inspect Closely



Inspect Closely

While this flap gate may look fine from farther away, a closer inspection reveals a problem. This gap between the concrete headwall and flap gate frame is now obvious. Failure to correct this problem during normal low water periods will lead to problems you will have to contend with during high water or a flood event, when this structure becomes covered with water and is inaccessible.

Visual 9: Inspect Every System Component



Inspect Every Component

The photograph shows the outfall structure of a levee toe drain system. Following a normal annual maintenance and inspection program will help you document and monitor all of the components of your levee systems. For example, is this a normal occurrence even during normal low water periods, or has this situation only been noticed recently even during normal low water events?

An annual maintenance and inspection program can assist in identifying problems, which can then be more easily investigated and corrected during normal low water events than they can be during high water or flood events.

Visual 10: Inspect Pump Stations



Pump Station Inspection

Pump stations are typically critical components of a levee system. Scheduled inspection and testing, at least annually, of all components ensures they will operate when needed. Any deficiencies found are also much easier to correct when river conditions are normal.

Visual 11: Levee System Threats



Levee System Threats

There are many threats to a levee system that team members should be aware of and report back to the command post.

When in doubt, team members should be instructed to report any levee system issues. Timely reports may help to save the flood works from catastrophic failure.

Visual 12: Group Activity: Levee System Threats

Group Activity: Levee System Threats

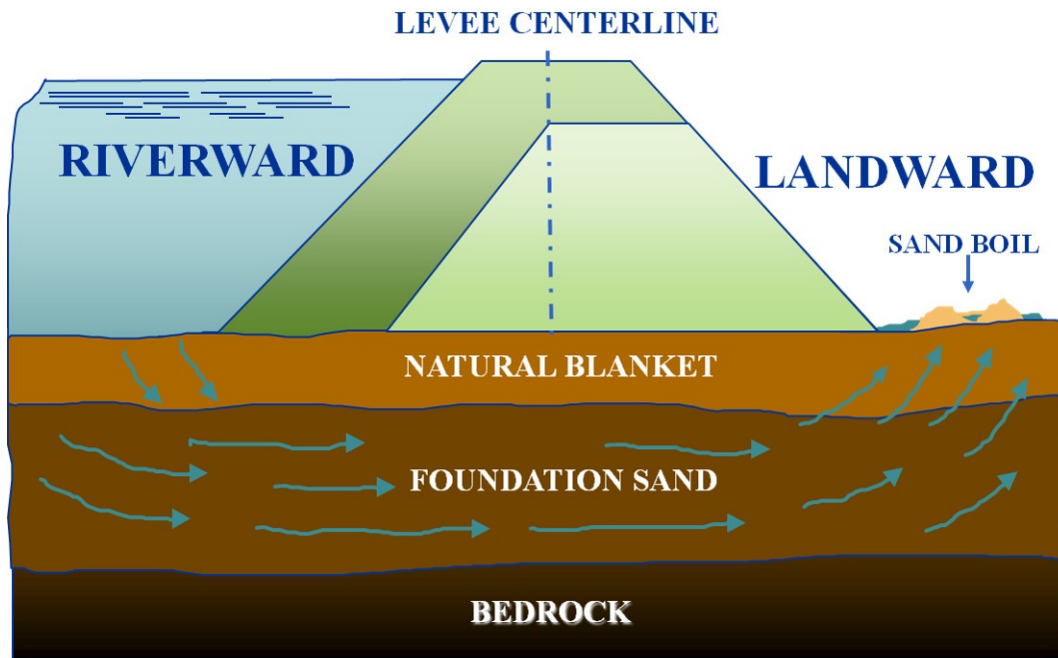
Group Activity: Levee System Threats

With your group, list as many threats to a levee system as you can in 3 minutes.

Visual 13: *List of Levee System Threats*

Listed are some of the most likely types of threats you may have to monitor and contend with on your levee system during high water or flood events.

Visual 14: Seepage / Sand Boils



Seepage

Groundwater seepage is a normal part of the soil and groundwater dynamics beneath a levee. However, the increased head on the groundwater caused by higher river elevations can increase the seepage velocities of the groundwater beneath the levee. When this happens, the groundwater rises to the surface on the landward side of the levee in concentrated locations, causing Sand Boils. This increased velocity of the groundwater may transport subsurface soils with it.

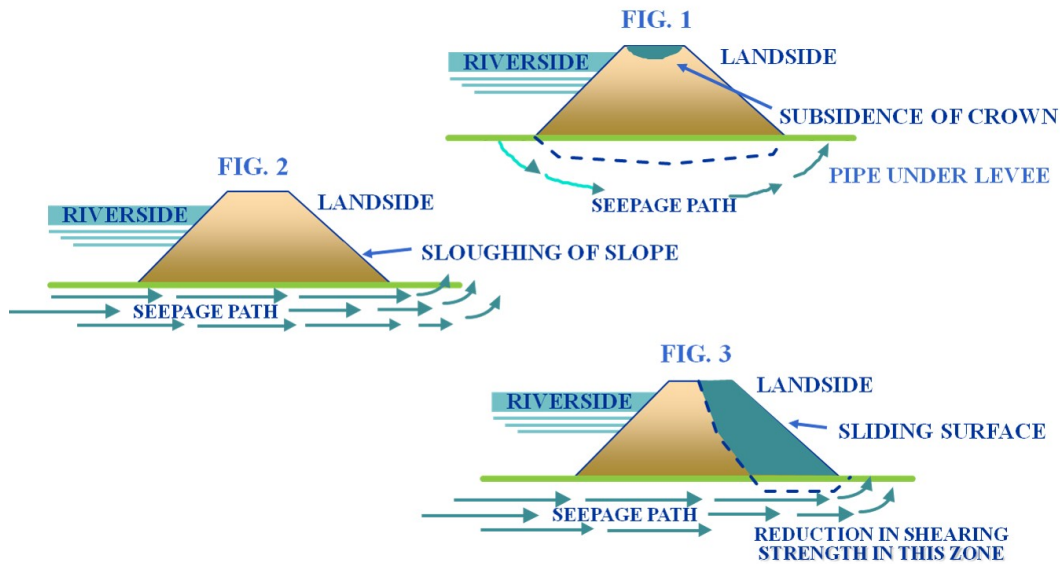
Visual 15: Sand Boils

- Common problem along levees and flood works
- May range from a few inches to several feet across
- May be a single sand boil or a group (boil field)
- Must be monitored
- Can cause flood control structure to fail

Sand Boils

Sand boils are the result of water under pressure finding a path under the flood works, usually through a sand lens, and resurfacing behind the protective device.

Visual 16: Effects of Sand Boils on Levees



Effects of Sand Boils

This slide illustrates 3 potential effects of sand boils on the structural integrity of the levee:

- Figure 1: A concentrated area subsidence of the levee crown, lowering the top of the levee and possibly allowing water to flow through the lowered crown section, leading to severe erosion
- Figure 2: Sloughing of the landside toe of the slope, degrading levee structural integrity
- Figure 3: The development of a shear slide (slope failure) on the landside or the river side of the levee, severely impacting the overall structural integrity of the levee

Visual 17: Clean Sand Boils

- No sand, dirt, or debris in water flow
- Should be reported and monitored
- Do not pose a threat



A clean sand boil is noted by the lack of sand, dirt, and debris in the water flow. Clean sand boils should be reported and monitored.

Visual 18: Dirty Sand Boils

- Sand, dirt, and debris in water flow
- Can cause rapid levee failure
- Report immediately
- Surround by sandbags



A dirty sand boil is another matter, particularly if it occurs within 100 feet of the toe of the levee. A dirty sand boil is noted by the flow of sand, dirt, and debris in the water flow. This is an indication that the water flow is tunneling out an area below the flood works. If enough material is flushed out from under the levee by the dirty sand boil, the levee will fail.

When dirty sand boils are discovered, they should be reported immediately. Dirty sand boils should be surrounded with sandbags to slow, but not stop the water flow. The boil will stabilize and stop eroding material when enough head pressure is built up within the sandbag ring. A qualified geotechnical engineer may need to evaluate the situation.

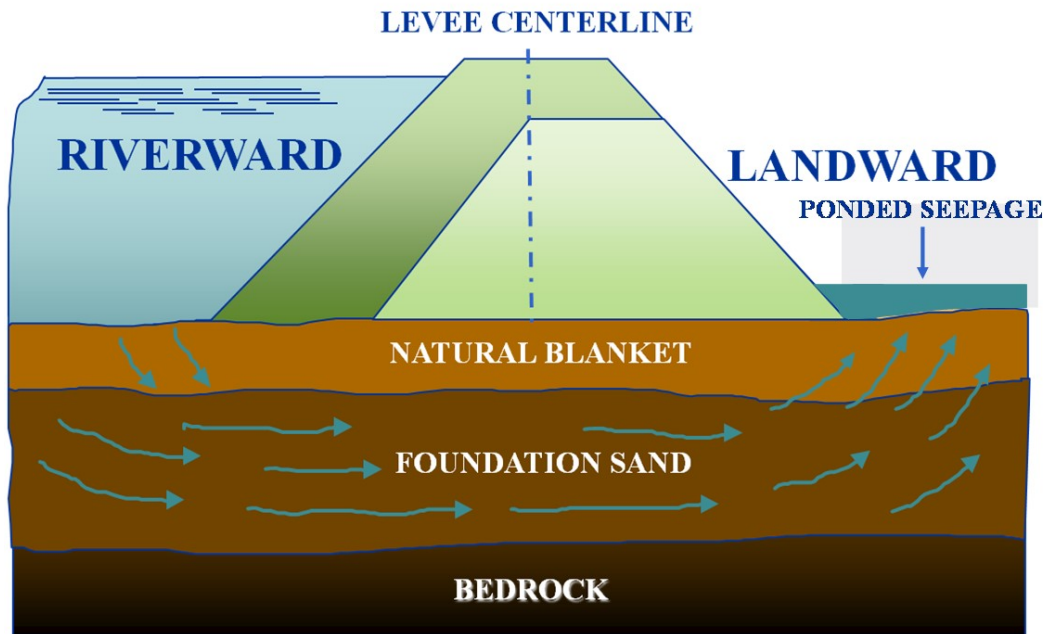
Visual 19: Sand Boil Examples



Sand Boil Examples

Here are two sand boil photographs. Note the soil materials being carried by the sand boil in the upper left photograph. This sand boil must be controlled by establishing a sandbag ring around it as shown in the lower right photograph. Note in this photograph the water is still flowing, but now it is running clear and no longer carrying soil materials with it.

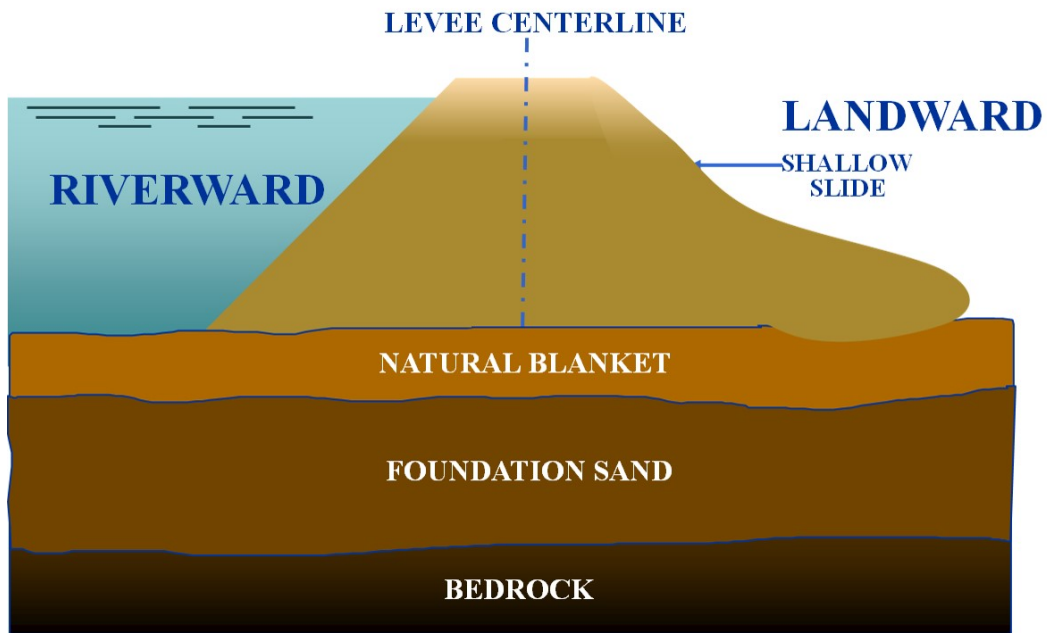
Visual 20: Other Types of Seepage



Other Types of Seepage

At times, groundwater rises to the surface on the landward side of the levee across a wider area, unlike in the concentrated locations shown in the sand boil examples. Despite the area being broader, problems can still develop, and this situation must be monitored.

Visual 21: Slumps, Slides, and Sloughs



Slumps, Slides, and Sloughs

Sloughing was identified earlier as a possible effect of sand boils. One of the most likely impacts of seepage is a slough developing across a large segment of the landward side of the levee.

Visual 22: Slumps and Slides

- Erosion of levee sections exposed to currents
- Affects banks of water saturated levees
- May lead to rapid failure
- Should be reported immediately
- Can be reinforced if detected early

Slumps and Slides

Slumps and slides are caused by erosion of levee sections that are exposed to currents, affecting the banks of water-saturated levees. Slumps and slides can lead to rapid levee failure; thus, they should be reported immediately. They can be reinforced if detected early enough.

Visual 23: Slough Example 1



Slough Example 1

Here is an example of a slough. Note that a slough can develop on the riverside of the levee as well as on the landside.

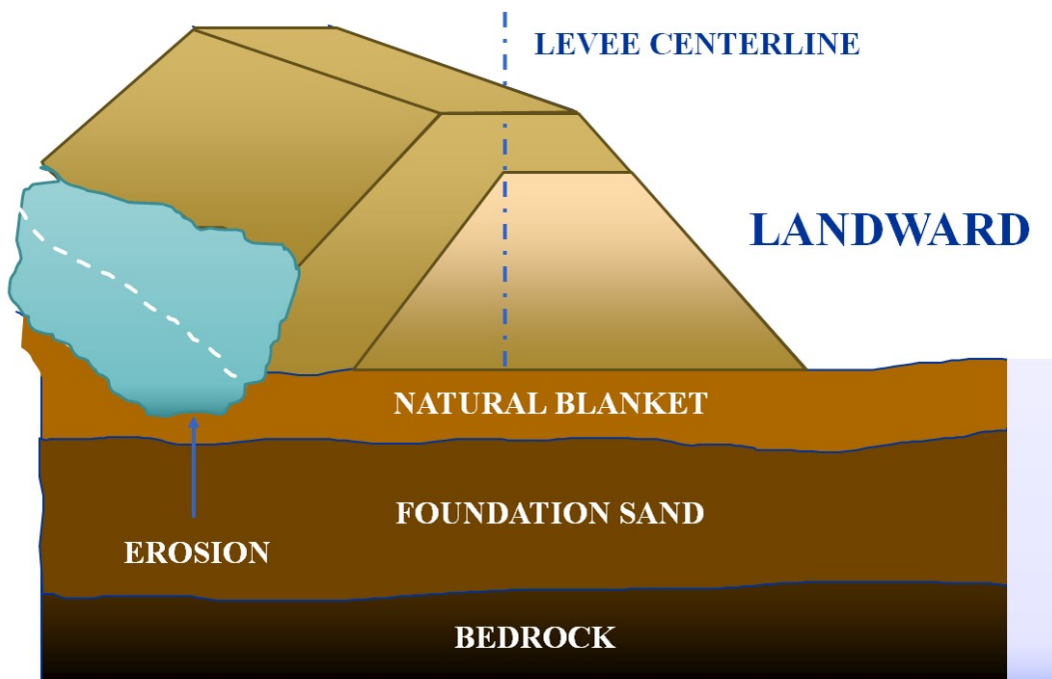
Visual 24: Slough Example 2



Slough Example 2

This slough has developed on the landward side of the levee. While not as dramatic looking as the previous slide, this area must be monitored as the flood event occurs because the levee's overall structural integrity has been compromised in this area.

Visual 25: Erosion

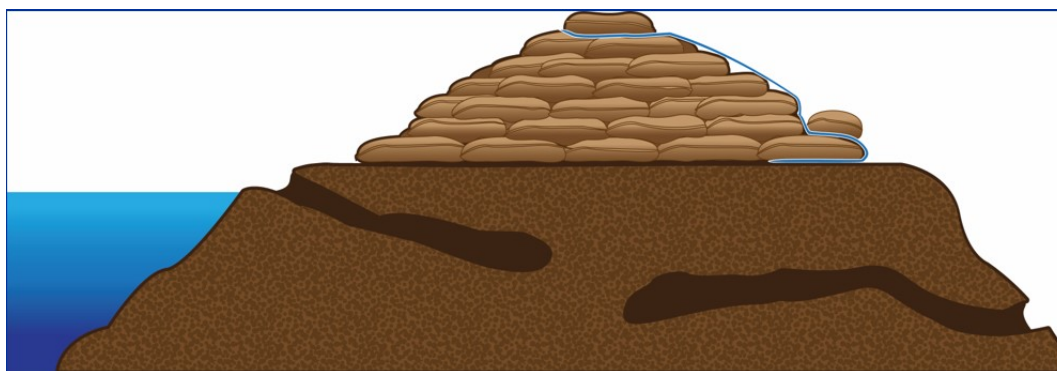


Erosion

Erosion typically occurs along the base of the levee and is caused by increased river flow velocities. This particular type of damage is hard to detect. However, a developing riverside levee slough may be an indication this type of damage is occurring.

Visual 26: Animal Burrows

- Create conduit for water
- Can be identified by vortex on water side
- May have outflow on land side



Animal Burrows

Levee systems should maintain animal control programs to eliminate burrowing animals. An animal burrow makes an excellent conduit for water to flow through the levee and possibly cause it to fail. Animal burrows may be spotted by a vortex forming on the water side of the structure. This may or may not be accompanied by an outflow of water on the land side of the flood works.

Weighted sheets of plastic and other materials may be dropped on the water side of the levee to seal the opening of the burrow and reduce the water flow. Another method uses a mixture of animal manure and straw, which is cast out into the waterway. As the mixture is drawn into the burrow, it effectively plugs the water flow.

Visual 27: Wave Action

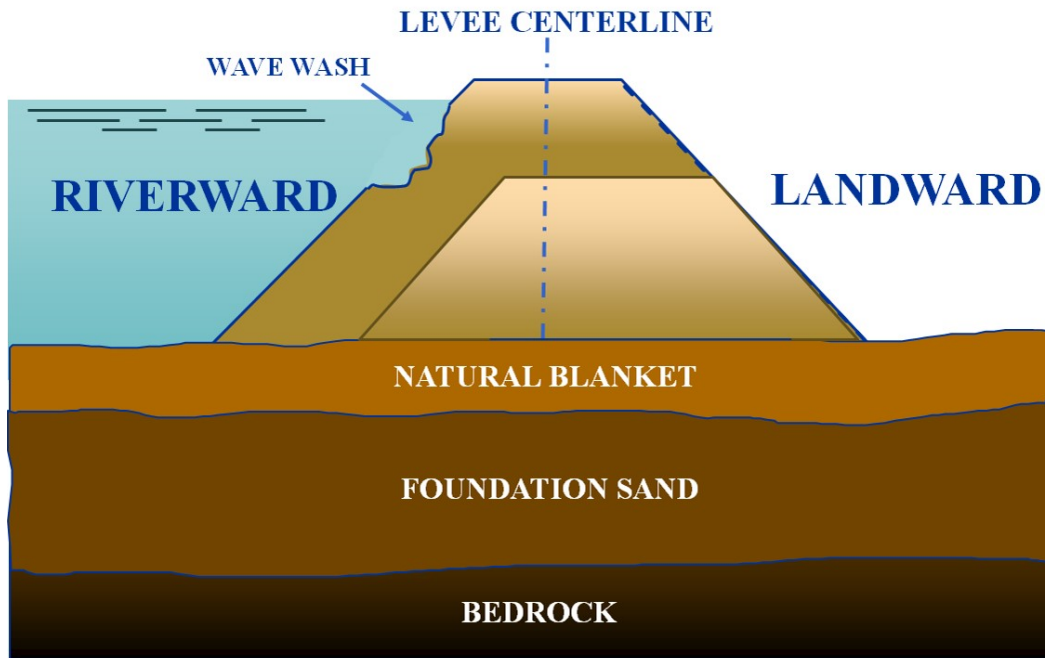
- Occurs along larger waterways
- Waves overtop structures, erode soil and fill
- Erosion leads to structure failure
- Levee can be “armored” to reduce scour

Wave Action

Wave action can be a major problem along larger waterways. Waves can overtop the structures and erode significant quantities of soil and fill. As this material is flushed away, the mass of the structure is reduced and the hydrostatic pressure can cause the failure of the flood control structure.

Wave action can take a severe toll on flood control structures in surprisingly little time. Actions may be necessary to provide additional protection to levee systems exposed to wave assault. The levee may also be “armored” with sheets of plastic and sandbags or riprap to reduce wave impacts on the levee face. Bioengineered options are also available to provide environmentally friendly solutions.

Visual 28: Wave Wash



Wave Wash

Wave action can take a severe toll on flood control structures in surprisingly little time. Wave wash is typically caused by wave action that erodes the riverside of the levee near the waters' surface. It will reduce the overall cross section of the levee and impact the structural integrity of the levee as a result.

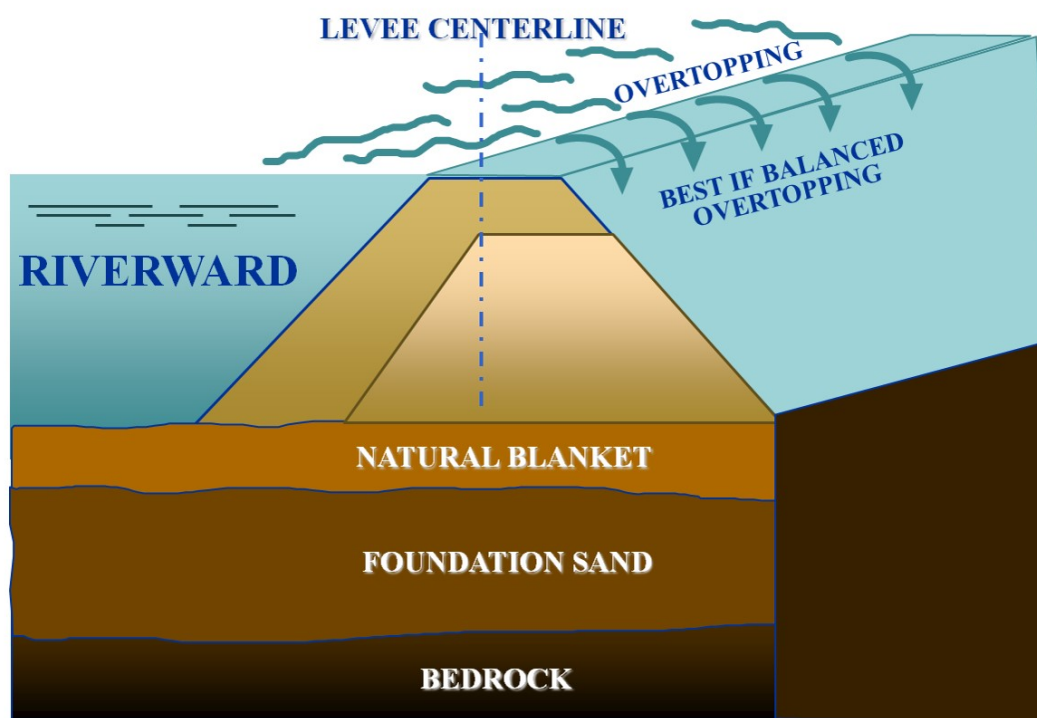
Visual 29: Reinforcing for Wave Action



Actions may be necessary to provide additional protection to levee systems exposed to wave assault. The levee may also be “armored” with sheets of plastic and sandbags or riprap to reduce wave impacts on the levee face. Bioengineered options are also available to provide environmentally friendly solutions.

The photo shows riprap being used along a riverbank.

Visual 30: Overtopping



Overtopping

Here is a graphical representation of overtopping.

Visual 31: Overtopping Examples

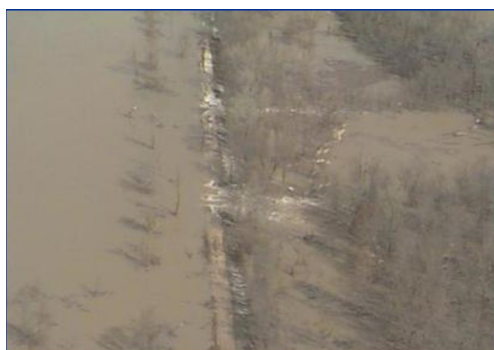


Photo Credit: California Dept. of Water Resources Photo Lab

Overtopping Examples

This slide shows examples of levees overtopping. Concentrated areas of overtopping typically lead to erosion at concentrated areas, which can then lead to a levee breach. If the overtopping occurs over a broader and wider area, the levee erosion and breaching may not occur.

Monitoring the overtopping situation is critical.

Visual 32: Water Movement Through Dams and Spillways

Problematic water movement:

- High velocity flow
- Soil and sand present in flow



Water Movement through Dams and Spillways

Spillways are designed to release water in order to protect a dam from being damaged by overtopping floodwaters. Therefore, water flowing over the spillway is not necessarily a problem, but high velocity flows can cause erosion of unprotected slopes.

Water movement through dams is an ominous sign, particularly if soil and sand can be detected in the flow. If this situation is detected it must be reported to higher authorities at once because rapid failure of the structure could occur.

Visual 33: Backflow Issues

- Sewers
- Manholes
- Utility conduits
- Drain tiles
- Manually operated valves



Backflow Issues

The monitoring team should be alert to problems associated with backflows. Sewers, manholes, utility conduits, or drain tiles which are not blocked may provide easy paths for water to bypass flood works. Also, many levees have manually operated valves, which may cause problems due to the possibilities for human error.

Extreme caution should be used when investigating manholes as the water flow may have already displaced the lid, leaving an open water-filled shaft. Falling into one of these shafts can be deadly as the conditions would make rescue efforts nearly impossible.

Visual 34: Backflow Example



Backflow Example

Here is an example of the effects of backflow. Water from the river flowed back through a storm drain outfall, which did not have any means to prevent the back flow. It caused a sinkhole to develop along that drain line, which was well inside the landward side of the levee.

Visual 35: Debris

- Can damage flood works and harm personnel
- Structures on river bends and near bridges are most susceptible



Debris

Monitoring teams should be on the lookout for damage caused by floating debris. Trees, pieces of houses and other structures, cars, and similar materials can act as battering rams and punch holes through flood works.

Structures on river bends and near bridges are particularly susceptible to debris damage. Use extreme caution when investigating debris as the turbulent waters may cause the material to lurch or shift suddenly and without warning.

Visual 36: Debris Example



Debris Example

This photograph shows debris accumulating across the top of a levee. One impact of this debris accumulation is that the concentration of overtopping may lead to erosion, and a potential breach. Debris accumulating along a levee can also compound the impacts of wave action or erosion.

Visual 37: Sabotage / Terrorism

- Authorized personnel only near flood works or levees
- Report suspicious persons immediately

Sabotage / Terrorism

Sabotage of levee systems and other flood works occasionally occurs. Only authorized personnel may be allowed near flood works or levee systems. Suspicious persons should be reported to authorities at once.

Visual 38: Saturation

- Can be extremely dangerous
- Likely to fail when at the “pudding” stage
- Report saturated levees immediately
- Remove monitoring teams from water, nearby land

Saturation

Saturated levees can be extremely dangerous. When a levee gets to the “pudding” stage, it is likely to fail at any minute. Saturated levees should be reported immediately. Teams monitoring flood works by foot or boat should be pulled from the patrol of unstable levees and flood works as a matter of life safety issue.

Visual 39: Methods of Monitoring Flood Works



Foot Patrols



Boat Patrols



Air Patrols

Methods of Monitoring Flood Works

Levees may be monitored by foot, boat, or air. In addition to these methods, communities may use remote video cameras to monitor levees.

Visual 40: Safety Considerations

- Organization and training
 - Careful selection
 - Proper training
 - 3-person teams
- Equipment
 - Safety
 - Communication

Safety Considerations for Monitoring Teams

Monitoring teams should be carefully selected and trained so every team member has a thorough understanding of what to look for and how to respond to threatening conditions. Remember, flood patrols should consist of three-person teams, so if someone becomes injured, one person can provide first aid while another calls or goes for help.

The monitoring team must be given the appropriate safety equipment, which, at a minimum, should include good quality life vests and waterproof flashlights. Chemical light sticks may also be given to team members as an added safety device.

Visual 41: Lesson Summary

- Monitor levees closely
- Be sure patrol teams are trained



Foot Patrols



Boat Patrols



Air Patrols

Lesson Summary

The monitoring team is the early warning system for the community. By keeping a vigilant watch on flood works and reporting issues immediately, monitoring teams may provide enough advance warning of a potential failure to allow work crews time to save the structure and prevent flooding in the community. It is critical to have carefully selected, well-trained monitoring teams in place to spot trouble before the problem becomes a disaster.

Visual 42: Review Question 1

What are some threats to a levee system?

Visual 43: Review Question 2

What is the difference between a clean and a dirty sand boil?

Visual 44: Review Question 3

What are some ways in which flood works can be monitored?

Visual 45: Review Question 4

What safety procedures should be used by flood works monitoring teams?

Visual 46: Group Activity: Flood Response

Group Activity: Flood Response

The instructor will provide a Flood Response Resource Availability List for this activity.

This activity provides controlled flood response experience, allows you to employ the plans created earlier in the course, and demonstrates the need for planning flexibility.

Working with your group, discuss the beginning scenario information and determine what actions you should take, if any, to deal with the weather events. You will receive additional information as the activity progresses.

Lesson 8: Reports and Documentation

Visual 1: Lesson 8: Reports and Documentation

OBJECTIVE: Evaluate the actions taken during a riverine flood event

Visual 2: Supporting Objectives

More specifically, you will be able to:

- Conduct a debriefing session
- Describe how post-flood evaluations, reports, and meetings contribute to continuous improvement in the planning process

Visual 3: The Value of Debriefing Sessions

- Provide feedback on lessons learned
- Help identify areas for improvement
- Not used to fix blame



Debriefing sessions provide valuable feedback on the lessons learned. While debriefing sessions may not be necessary after every flood event, communities should conduct them after major events or any time flooding results in a loss of life.

While most debriefings are held face to face, some agencies use questionnaires or online surveys to broaden the response base. Surveys may also provide for a more definitive review of problem areas.

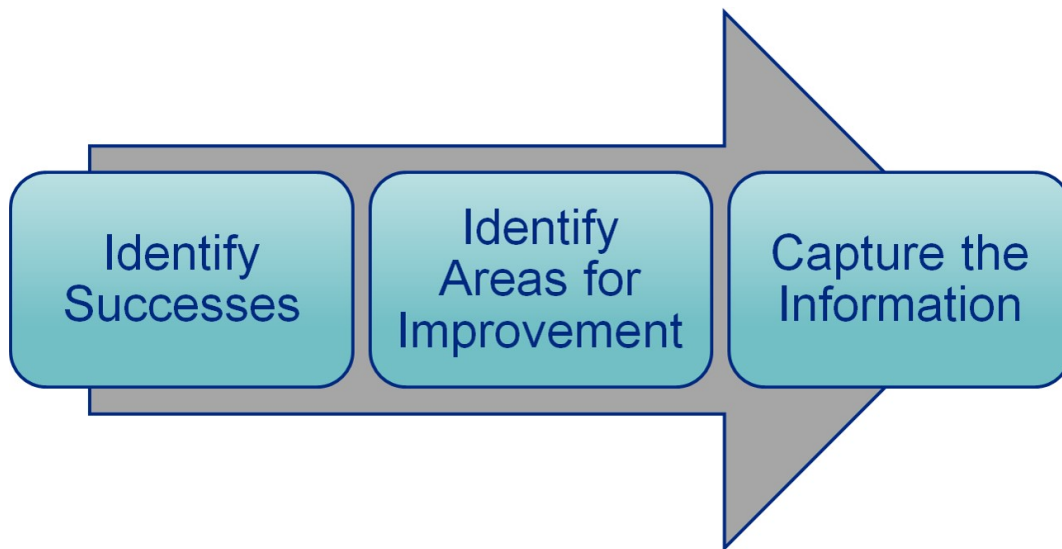
Visual 4: Flood Response Activity Debrief

- In what areas were the options you chose during the activity successful?

- In what areas could you have improved? How?

Consider your group's decisions during the Lesson 7 activity. Your group will be given 10 minutes to discuss these questions in relation to that activity.

Visual 5: The Debriefing Process



Visual 6: Identify Areas of Success

- Start on a positive note
- Validate methods that work
- Identify reasons for success
- Provide positive reinforcement

Identify Areas of Success

It is a good idea to start debriefing sessions on a positive note. Areas and functions that went well should be identified and recorded. It is just as important to validate methods that work as it is to correct areas that need improvement.

Another topic to explore is why a function was successful. Was the success due to effective policies, personnel training, individual initiatives, or a combination thereof? Identifying the reasons for success can be of great value where conflicting information is gathered over a period of time.

The debriefing leader should provide positive reinforcement throughout the process. Everyone likes to be complimented.

Visual 7: Identify Areas for Improvement

- Seek suggestions to correct problems
- Continue to provide positive reinforcement
- Do not fix blame
- Document the findings

Look at areas for improvement and suggestions to correct any problems. Many problems encountered in the field will be solved by individual initiatives that can be used to prevent a recurrence of the situation. Remember, the focus is not on placing blame but on improving response actions.

Visual 8: Capture the Information

- Keep a written record of key ideas
- Consider using stenographers or court reporters
- Collect all notes and reports
- Collate information for the incident record

Capture the Information

Throughout the debriefing sessions, key ideas should be kept on flip charts or otherwise recorded. You might consider involving stenographers or court reporters in the session for this purpose.

After the sessions are conducted, all notes and reports should be collected and collated for inclusion in the incident record.

Visual 9: Formal Critiques

Intra-agency critiques

Several levels of employees within the agency

Inter-agency critiques

Senior staff from various agencies

Share information with all involved

Formal critiques are typically held as the response system and community return to normal. Inter and intra-agency critiques are a valuable feedback source, particularly in dealing with coordination issues.

It is important to share information with all individuals involved.

Visual 10: Final Report

- Compiles the recorded information
- Becomes part of the response record
- Highlights common areas and suggestions

A final report should be drafted using the information recorded throughout the process. This report should capture key points and become a part of the response record.

Visual 11: Using After-Action Reports to Improve the Plan

- Rank areas or functions for improvement
- Evaluate all information
- Ensure the flood plan meets needs

After-action reports can be useful tools for ranking areas or functions for improvement after a test of the flood plan as a result of an actual flood event. It may bring to light issues with the plan that must be reconsidered.

The planning team should evaluate all the information provided after a flood event in order to help ensure that the flood plan meets the community's needs.

Visual 12: Response Data

- Collect hard data on the response effort
- Preserve it for future use
- Save all collected data for review and evaluation



Response Data

Hard data on the response effort should also be collected and preserved for future use and reference. The amount of hard data following a high water event can be staggering. Unfortunately, the value of some documents is underestimated and, as a result, some of these materials may be lost or destroyed. When in doubt, save all the data collected until the materials can be fully reviewed and evaluated.

Visual 13: Examples of Response Data

Examples of response data that should be reviewed during the planning process include:

- Purchase orders and supply requests
- Man-hour estimates
- Financial data and damage estimates
- Legal documents
- Disaster declarations
- Weather reports and bulletins
- Damage reports
- Evacuation and re-entry data

This information can be used to validate or improve planning assumptions. For example, planning estimates of sand use can be compared with actual figures and, if necessary, adjustments can be made in the planning documents and resource lists.

Visual 14: Flood Data

- Surveys
- Photographs and video
- Invoices
- Legal documents
- Information from private sources



Flood Data

Information on the extent and exact nature of the flood should be gathered as soon as the water recedes. This information that should be included is listed to the right.

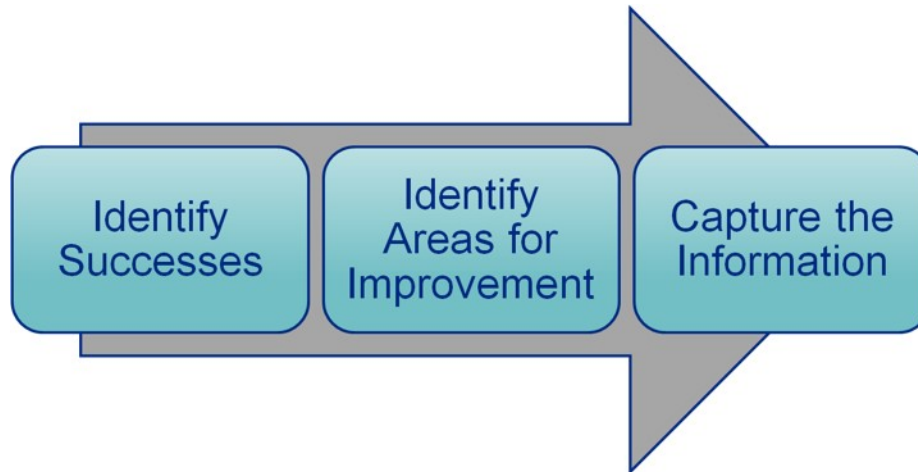
Visual 15: Planned vs. Actual Response

- Compare the plan with actions taken
- Evaluate the plan
- Make revisions



Visual 16: Lesson Summary

- The plan is a living document
- It must be continually reviewed
- Update the plan using after-action reports



Visual 17: Review Question 1

How do invoices from the flood event help with the revision of the flood plan?

Visual 18: Review Question 2

How are surveys used to revise the flood plan?

Visual 19: Review Question 3

How are photographs and videos important to the revision of the flood plan?

Lesson 9: Returning to Normal

Visual 1: Lesson 9: Returning to Normal

OBJECTIVE: Explain the challenges and resources associated with the recovery process

Lesson Overview

Receding flood waters signal the start of the recovery process. Recovery for most communities is an emotionally draining, time-consuming, and expensive proposition. The restoration process may place greater demands on government and private services than the flood response.

In this lesson, you will learn about the challenges and resources associated with the recovery process.

Visual 2: Supporting Objectives

More specifically, you will be able to:

- List sources of recovery information
- List the challenges faced by a community after a flood
- Describe the role of community and social agencies during the recovery process

Visual 3: Sources of Public Education on Recovery

- FEMA
- American Red Cross
- Private Firms



While some training programs or briefings can be conducted in a classroom setting, most information will be disseminated to the public in the form of brochures, flyers, and newspaper articles.

FEMA and the American Red Cross have materials to assist the public during the recovery phase. Some private restoration and recovery firms have excellent information packets for use by their potential clients.

Visual 4: Methods of Distributing Public Information on Recovery

- Packets should be readily available at the following distribution outlets:
 - Disaster assistance and recovery centers
 - Supermarkets
 - Hardware stores
 - Anywhere cleaning/restoration supplies are sold

Methods of Distribution

Informational packets and information should be readily available to the public. Good distribution outlets include disaster assistance and recovery centers, supermarkets, hardware stores, and other locations where cleaning/restoration materials are sold. Other good locations to distribute materials are at entry or security check points that lead into the disaster zone. Children can bring packets of information home from school, and local media outlets can assist in this program.

It is important not to wait until the last minute to begin the distribution of recovery information. The earlier the information is made available to the public, the more effective it will be.

Visual 5: Challenges after a Flood



Economic and
Emotional Loss



Restoration of
Critical Infrastructure



Clean Up

Communities will face many challenges after a flood event. Although community leaders should be able to look to the emergency plan for guidance during this difficult time, many challenges may be unique to the event.

Visual 6: Economic and Emotional Loss

- Homes and household items
- Family records, documents, photographs, and memorabilia
- Post-traumatic stress



Visual 7: Restoration of Critical Infrastructure

- Sewer and drainage systems
- Roads and bridges
- Water systems
- Fire stations
- Hospitals
- 911 centers
- Schools and child care centers



Restoring critical infrastructure as soon as possible is vital to the recovery of the community. The sewer system and drains may have become clogged with mud left by floodwaters and require cable or water jet cleaning. Water systems must also be restored.

Emergency services such as fire stations, hospitals, and 911 centers must be returned to normal working operations as soon as possible.

It is also important to get the school and child care areas within the flood zone back up and running as soon as possible. Children and parents alike will need the normalcy and routine that they provide

Visual 8: Clean Up

- Flood debris
- Personal items
- Hazardous waste
- Mud and dust
- Water damaged furnishings
- Expedient flood works
- Burn/disposal site regulation



Provisions must be made for the removal and disposal of floodborne debris, water damaged furnishings, personal items, and the eventual removal of expedient flood works.

Many of these materials will end up in community landfills, but in certain instances contaminated items may have to be packaged and handled as hazardous or regulated waste.

If the community is providing debris removal for commercial establishments, hazardous waste issues can arise and complicate removal programs. Failure to follow hazardous waste regulations can subject communities to significant fines and penalties.

Communities contemplating the incineration of floodborne debris should thoroughly investigate state and Federal regulations before committing to this course of action.

The receding flood waters are likely to reveal a thick layer of mud covering the flood zone. As the mud dries, dust will become a problem. Dust masks and other forms of respiratory protection will be needed to protect clean-up workers.

Visual 9: The Role of Community and Social Agencies

- Sanitation and health
- Water
- Zoning, building, and business
- Consumer protection
- Mental health
- Public information

The Role of Community and Social Agencies during Recovery

Added demands will be placed on many community and social agencies during the recovery phase. Many of these agencies are not normally included in the planning process and, therefore, may be completely overwhelmed in the aftermath of a disaster.

Visual 10: Sanitation and Health Officials

- Monitor food safety
- Control vector and vermin populations
- Address other public issues

Sanitarians and health officials will be needed to monitor food safety, control the vermin and vector population, and deal with other public health issues.

Sanitation and Health Officials

Sanitation and Health Officials Public health is a critical concern after a flood event. Sanitarians and health officials will be needed to monitor food safety, control the vector and vermin population, and deal with other public health issues. ▭

- Food safety

Spoiled and questionable food stocks should be placed in metal cans with tight-fitting lids pending disposal. Canned goods exposed to flood waters should be destroyed.

▭

- Vector and vermin control

Vector, vermin, and community health issues can be burdensome during the initial restoration efforts. This is particularly true during the hot summer months that greatly favor the growth of bacteria and the spread and breeding of vermin.

Sanitarians and community health officers should be prepared to increase vector and vermin control efforts as the flood waters recede. Expanded mosquito control and rodent extermination programs may be required to deal with extreme situations. It is important to note that the earlier these programs are initiated, the more effective they will be.

▭

- Other public health issues

Animal carcasses discovered when the flood waters recede should be buried or rendered as soon as possible. Animal control officers will be called upon to deal with dangerous or poisonous animals or snakes that may have taken refuge in homes, businesses, or other high locations to avoid the rising flood waters.

Visual 11: Water Department

- Monitor public water systems
- Monitor private wells
- Perform disinfection

Water Department

Harmful protozoa are often present in floodwaters. Cryptosporidium is highly resistant to the standard chlorine disinfection process. Should this protozoan be introduced into a water system, it may be weeks before potable water supplies can be restored.

Private wells also require special attention after a flood. All wells should be thoroughly flushed, disinfected, and tested by competent authorities to assure the safety of the water supply.

Local health officials should be contacted for advice on the need for special testing procedures for cryptosporidium and chemical contamination. It is highly recommended that wells be closely monitored for several months after being subjected to flood waters.

Visual 12: Zoning, Building, and Business Departments

- Handle building permits and inspections
- Resolve zoning issues
- Issue special permits and waivers
- Issue business licenses and tax permits

Zoning, building, and business departments can anticipate an increased workload during recovery, due to:

- Building permits and inspections are required for many restoration activities. These may include general building, electrical, mechanical, plumbing, occupancy, and health permits.
- Zoning and planning departments typically face a difficult period after the flood waters recede. Zoning regulations may prevent citizens from rebuilding or improving their homes in the flood-plain.
- Special permits or temporary zoning variances may be necessary to allow for the placement of emergency housing units on lots or park lands while permanent residences are being repaired. →
- The demand for business licenses and tax permits may increase as a demand for building contractors, restoration services and products become likely after a high water event.

Visual 13: Consumer Protection Departments

- Increase staff if possible
- Handle consumer complaints
- Investigate fraud accusations

While most contractors and restoration services are reputable, problems with unscrupulous vendors will arise. Police and consumer protection agencies should ramp up their staff to be sure they are capable of handling increased consumer complaints and fraud accusations after the flood.

Visual 14: Mental Health Services

- Increase staff if possible
- Be ready to intervene quickly
- Provide training for school staff

Human service agencies and community counseling services should be prepared to deal with the increased need following the flood. Social agencies must be ready to make quick interventions.

Visual 15: Public Information Officer

- Handle all media requests
- Provide timely and accurate information
- Warn public of post-flood dangers

A public information officer should be appointed to deal with media requests. The public should be kept informed with all the necessary and accurate information that can be provided.

Visual 16: Mitigating Future Flood Losses

Remember, mitigation is the most important step communities can take to prevent flood losses. After a flood event, mitigation plans may be required if Federal disaster aid has been received, to identify procedures to reduce future flood losses.

Part of the mitigation plan includes new zoning and land use regulations and changes in building codes and inspection systems.

Encourage residents to buy flood insurance even if they do not live in the Special Flood Hazard Area.

Visual 17: Individual Activity: Your Community

Individual Activity: Your Community

On the next page you will find a Personal Take-away Worksheet. You will be given 10 minutes to answer the questions presented on this worksheet. Refer back to the suggested action items at the end of each lesson for ideas.

Visual 18: Lesson Summary

The process of returning a community to normal following a major flood can be a daunting task. Economic and emotional losses can produce extremely stressful situations; however, out of the ruin also comes an opportunity for community improvement.

Entire communities have relocated to higher ground to prevent a recurrence of past flood disasters. During the recovery phase, public and private partnerships may blossom and set the stage for future cooperative developments and programs.

Visual 19: Review Question 1

What are some good sources of recovery information?

Visual 20: Review Question 2

What are some of the major problems that can be expected during the recovery phase?

In what ways could planning help reduce these problems?

Visual 21: Review Question 3

What is the role of community and social agencies during the recovery process?

Visual 22: Course Summary

Workshop Summary

Flooding is the most common natural disaster in the United States; therefore, it is critical that communities plan to protect themselves against flood losses through effective mitigation and the development of a flood plan.

When developing the document, planners should analyze the kinds of threats faced by their community and include several response options in the plan to deal with those threats.

Effective coordination among multiple organizations and agencies is a vital component of any kind of emergency planning effort.

When a flood event occurs, decision makers will need to evaluate the response options included in the plan and determine the best response. Whatever option is chosen, decision makers must determine priorities and base their decision on available time and resources.

One of the most important resources during a flood response is the volunteer workforce. Flood plans must identify ways to recruit, register, track, and train volunteers.

After a large flood event, planners should reconvene to evaluate the actions that were taken, comparing them to the plan and making revisions as needed. It's also important to document information for reference during future flood events.