

PREFACE

Much of the information in this handbook was adopted from a similar handbook published by the Pennsylvania Emergency Management Agency and the West Virginia Division of Homeland Security and Emergency Management. We gratefully acknowledge their help.

Appreciation is also extended to the National Weather Service for their assistance and on-going support of the Flood Warning Program.

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Signed by its President: _____

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JEFFERSON COUNTY PLANNING GUIDE FOR A COUNTY FLOOD WARNING SYSTEM

SECTION ONE

General Information

INTRODUCTION

Flash floods have doubled their destructiveness in the last twenty years and now rank first among weather-related disasters in the United States.

A recent example of flash flooding occurred in West Virginia in 1985. Historically, the Appalachia area has had a high frequency of flash floods. Narrow valleys, flanked by steep hillsides, produce fast overflows from heavy rains. It has been the increased use of these valleys that has caused such a dramatic upsurge in damage. The lure of these usually peaceful flood plains is likely to continue, and with it, the continued rise in the potential loss of life and property.

This planning guide for a County Flood Warning System was developed to assist in the establishing of local flood warning systems. The system as outlined herein is intended to complement, through voluntary help, the existing warning system of the National Weather Service.

The forecast programs outlined in this guide maximizes warning time since it is based primarily on rainfall rather than stream flow. With cooperation of the Jefferson County Office of Emergency Management and cooperation with the National Weather Service and the West Virginia Division of Homeland Security and Emergency Management, a flood warning system can be developed that will substantially reduce the threat to life and potential property damage from intense, highly localized rainstorms.

WARNING SYSTEM LIMITATIONS

There are limitations to the county flood warning system. Thunderstorms can produce intermittent rainfall with varying intensity; therefore, it is difficult to determine when the highest rates of runoff will occur, and when the flood crest might reach an area. There is also the possibility of having one, two or more flood crests during a flash floods situation.

Stream flows during a flash flood are unpredictable. A blocked bridge or culvert can divert or change water flow both upstream and downstream of where the blockage occurs. Rapid flood flows can create new channels and new directions of water flow. Recent developments, a new road, a new house, extensive logging or land clearance, and other construction can cause changes in water runoff behavior not previously experienced. Early observation of heavy rainfall, followed immediately by on-scene personnel to observe the effect of the rainfall runoff, is the only practical method of warning of potential flooding along small flashy streams.

Citizens who are voluntarily committing their time and property as a service to their community operate this program. Their obligation to fulfill their assigned functions does not rest upon any legally imposed duty, but upon a sense of moral obligation. Dangers are ever present in flooding situations and volunteers are not asked or expected to expose their lives or property to potential harm.

These comments about the limitations of a flood warning system are not intended to lessen the importance of such a system. They are mentioned to emphasize to the operators of this system and the general public that there are restraints, which must be considered.

There also should be a distinction made that this system does not replace National Weather Service flood warnings for the general area or for rivers and major tributary waterways in the area. The self-help flooding warning system is intended as supplement to other warning systems.

FLASH FLOODS - CAUSES AND EFFECTS

Flash floods are aptly described as the "Killer from the Hills." Flash flood waves, moving at incredible speeds, can roll boulders, tear out trees, destroy buildings and bridges, and scour out new channels. Killing walls of water can reach 10 to 20 feet.

Flash flooding is caused by interrelated factors: heavy rainfall; geological and topographic features which facilitate rapid runoff; and human development placed in surface runoff pathways. Property damage and loss of life have increased due mainly to the spread of residential and commercial development of land within the flood risk zones of small waterways.

Throughout much of West Virginia, the topography and geology within drainage areas is very conducive to flash flooding. Over much of the area, the land rises rather sharply from the valley floors into a series of rolling hills interspersed with narrow, steeply sloping valleys. This condition sets the stage for rapid runoff during periods of intense rainfall. Small streams quickly reach bank full stage, and with extended heavy precipitation, flood follows. Forest and other debris, much of which finds its way into stream courses, compounds the flooding problem by blocking narrow channels and man-made obstructions (culverts and bridges) and forces the water to higher stages, thereby increasing the area affected by flood flows.

Intensity and duration of rainfall are the key elements involved in flash flooding. Intensity is the rate of rainfall or how much rain a storm drops in a given period of time. Duration is how long a storm affects a given area.

Meteorological skills are low in forecasting the amount of rainfall and locations of centers of heavy rainfall. However, there is some skill in recognizing rather large areas in which some portions might receive heavy rain. This is not accurate enough for stream forecasting but can serve as an alerting mechanism - as is used in issuing a "Flash Flood Watch."

Flash floods can occur during any month but they are rare during the cold months. The frequency is greatest from May through September. On the average, July is the month of greatest flash flood activity in West Virginia.

Stationary or very slow moving thunderstorms are the usual flood producers. Faster moving storms that move in rapid succession over the same area can also produce the volume of rain necessary to cause flash flooding. Taking into account the innumerable possibilities of rainstorms in terms of: intensity and duration of rainfall; the variability of physical features between watersheds; the limitations of the existing flood warning system; and the inherent short warning time with flash flooding; a program of voluntary, local rainfall observation and rapid action is the best means of providing an effective warning to residents and developments along small streams.

GENERAL PROCEDURES

The following are general procedural steps in establishing the Jefferson County Flood Warning System:

1. National Weather Service briefs Jefferson County Office of Emergency Management Director on the development of Flood Warning System.
2. Jefferson County Office of Emergency Management signs Memorandum of Understanding (MOU) for Flood Warning System and forwards to National Weather Service.
3. Jefferson County Office of Emergency Management identifies observation points that are staffed around the clock and volunteers who are willing to participate in the program by making rainfall observations and reports (police headquarters, fire houses, hospitals, industrial plants, etc.).
4. Jefferson County Office of Emergency Management Director designates a County Flood Warning Coordinator.
5. County Flood Warning Coordinator identifies, on stream map, those locations where flooding has occurred in the past and sites of possible future flooding.
6. National Weather Service reviews with the County Flood Warning Coordinator locations of proposed rain and stream gauges. National Weather Service determines need for remote reporting gauges.
7. Based on 5 and 6 above, the County Flood Warning Coordinator recruits volunteer rainfall observers and stream gauge observers.
8. National Weather Service and the Jefferson County Office of Emergency Management will provide gauges.

9. Jefferson County Office of Emergency Management will install stream gauges and distributes rain gauges.
10. National Weather Service and Jefferson County Office of Emergency Management will conduct training for the County Flood Warning Coordinator and all observers. Advises on establishing:
 - a. Alerting system (communications);
 - b. Record keeping system;
 - c. Information analysis system;
 - d. Reporting system; and
 - e. Warning system.

SECTION TWO

Organization

SYSTEM OUTLINE

The Jefferson County Flood Warning System, to be successful, will require establishing an organization that includes functions and elements as outlined below:

1. A County Flood Warning Coordinator is a volunteer member of the Office of Emergency Management staff.
2. Detailed mapping of flood-prone areas to identify areas that have high flood susceptibility.
3. Coordination of all existing emergency radio systems.
4. Volunteer stream gauge and rainfall observers.
5. An information exchange system between National Weather Service and the County Flood Warning Coordinator.
6. An alerting and mobilization system for rainfall and stream gauge observers.
7. A prearranged system for rainfall and stream gauge observers to alert the coordinator.
8. An information analysis system to evaluate possible flood conditions.

9. A record keeping system to record rainfall and stream gauge readings during each storm.
10. An alerting system, which provides methods for the coordinator to communicate to, prearranged locations; flash flood watches, flash flood warnings, flood predictions and evacuation warnings.
11. Emergency communications systems.
12. Emergency action procedures organized to respond to the flood warning system to include stream and road patrols and evacuation.

PLANNING THE SYSTEM

The following steps are to be taken by the Jefferson County Flood Warning Coordinator in the organization of a flood warning system:

1. Maps and Sources of Information
 - a. A map of the county which shows streams, water courses and the road system will be needed to begin the planning of the system. Most county highway maps meet this need. Other maps that are useful for study and planning are as follows:
 - (1) State Gazetteer of Streams.
 - (2) U.S. Geological Survey contour quadrangle maps for study in detail.
 - (3) Aerial photos at various scales for additional detailed study.
 - (4) Detailed flood plain maps are available for communities participating in the Flood Insurance Program (NFIP). This shows the floodway and 50 to 100 year flood contours.
 - b. There are other sources of information, which may be useful in organizing the system.
 - (1) Corps of Engineers studies and projects.
 - (2) Soil Conservation Service studies or projects. (Check with the County Soil and Water Conservation Office).
 - (3) National Weather Service records and studies.
2. Identification of Flood-Prone Areas

The next step in the organization of the system is the identification of points or areas, which are subject to flash flooding. Mark areas or point on the county map where flash flooding has occurred in the past. Make a list with the name of the stream, and the locations of the areas or communities that have had flash flood damage, they identify the locations along these streams where substantial damage has occurred in the past.

A record of the number of homes or kind of damage that occurred should be added if available. If available a list of the number of times and dates that streams have flooded would also be valuable. Identify where there are steep watersheds or streams and areas where development has occurred in low-lying areas where flash flooding is possible. Remember that just because an area has not had a flash flood does not mean it will never have one.

Changes in land use, relocation of roads; new residential and commercial development may be located within the flood risk zones of small waterways.

3. Assistance from National Weather Services

The first step in obtaining assistance from the National Weather Service is signing the Memorandum of Understanding (MOU) between the county and the National Weather Service (see Attachment "A"). This agreement establishes a working arrangement whereby the National Weather Service can provide assistance and the county in turn agrees to operate a flood warning system. After the initiation of the memorandum, a representative from the National Weather Service will visit the county to make recommendations for the installation of the necessary equipment and provide technical flood warning procedures.

4. Coordination of the System

The key person in the operation of the flood warning system is the coordinator. The Office of Emergency Management Director may wish to delegate someone to act as the coordinator for the system but should still assume overall responsibility and authority for the operation of the system. The coordinator should know what to do to initiate warning and action systems at the county and community level. (See Section IV and V).

5. Training Program

A training program for the participants in the flood warning system should be developed to insure understanding of how the system is to operate. Inspection and training exercises of the system should be held at least once each year.

SECTION III

Forecasting System

INFORMATION NEEDED

The following types of information are used in the Jefferson County Flood Warning System for each storm or flood situation:

1. Precipitation (rainfall, snowfall, sleet, etc.) as measured by rain gauges.
 - a. Total amounts during a storm.
 - b. Intensity or rate of accumulation.
 - c. Snow cover and the rate of melting.
2. Precipitation runoff.
3. Stream height as measured at stream gauges.
4. Time of travel of flood crests.
5. Time of crest in hours after end of heavy rain.

All of this information must be considered to develop a flood forecasting procedure and must be available in order to provide flood warnings. Most watersheds have such a variable pattern of rainfall during a flood that only estimations of actual stream flows are possible. Collection of data over many years will permit more accurate predictions.

PRECIPITATION CONSIDERATION

Several factors are considered in evaluating the effects of precipitation in each storm. These include: the form of the precipitation such as rain, snow or sleet. The most important parameter to consider in evaluating the effects of a storm is the total rainfall. Snow cover can have two opposite effects - if it is deep and very cold, it can decrease the runoff by freezing the rain and holding it in the snow pack - if the snow is melting, it will add liquid water to the rain and increase the stream flow. The National Weather Service should be consulted when snow cover is present during a rainstorm.

RUNOFF ESTIMATION

The National Weather Service River Forecasting Center (Harrisburg, PA) monitors many factors which are used to estimate the amount of rainfall that is infiltrating or soaking into the soil and Index (See Attachment "B"). This Index can be used by the County Flood Warning Coordinator to interpret observed rainfall in the watershed and then estimate the amount of runoff and stream levels.

RAINFALL GAUGES

A network of manned rainfall observation stations must be established to monitor precipitation in the county. Each station must be provided with a rain gauge for making observations. The National Weather Service should make selection of these observer stations following review. They should be located so that they can provide observations of rainfall in each of the problem watersheds in the county. Wherever possible, there should be rainfall observation stations located at public facilities where 24-hour surveillance is possible. Instructions for installation, operation and maintenance of rainfall gauges are shown at Attachment "C".

RAINFALL RECORDS

Each rainfall observer should record rainfall amounts daily. During periods of heavy rainfall, accumulations should be observed more often. They may require making observations as frequently as once an hour or less. The intensity and duration of rainfall determines flash flood conditions, therefore, frequent and timely observations and reporting during a storm are important.

Instructions for recording observations are contained at Attachment "D". A sample flood warning computation sheet is shown at Attachment "E". A documentation sheet would be filled out when the rain gauge observers started calling in.

STREAM GAUGES

Criteria for determining the need for stream gauges are outlined at Attachment "F". Stream gauges are normally placed at several locations in a watershed. These gauges are placed along the major tributary streams, often above and below the junction of two streams, in major flood-prone areas, and in areas that will increase understanding of water movement of the entire stream system. Procedures to follow during a site survey to determine location of stream gauges are outlined at Attachment "G".

A series of stream gauges up and down a river provide a linking record of what happens during a particular storm. By using several gauges, the relationship between recorded rainfall and the runoff amounts for each tributary or segment of the stream can be established. Careful observation of how rapidly the stream increases its flow or stage height with a given amount of rainfall is used to make future flood stage predictions. A sample care and maintenance checklist for stream gauges is at Attachment "I".

FLOOD STAGE TIME OF TRAVEL CONSIDERATION

Observations of several stream gauges along a stream or watershed provide a means of estimating the average time it will take for a flood crest or maximum flood level to travel down the stream. This is usually complicated by the fact that no two storms are exactly alike. A particular tributary may receive more rain or may have more rapid runoff with respect to the rest of the watershed in different storms. Therefore, records are maintained over a period of years. Attachment J is a sample Stream Gauge Worksheet and Attachment "K" contains instructions for Stream Gauge Observers. From this recorded history, increasingly accurate predictions can be made for the time of travel of the flood stage.

SUMMARY

Assembling all of the information on rainfall duration and intensity, rainfall/runoff conditions, stream gauge measurements, flood crest time of travel, and maintaining records of this information provides the basis for the county flood warning system. This data is assembled into tables, which will make it possible for an organized flood warning system to operate.

SECTION IV**Warning System**CENTRAL WARNING POINT

The Jefferson County Emergency Communications Center will be the primary County Warning Point and the West Virginia State Police – Troop 2 Communications Center will be the alternate County Warning Point which both are manned 24/7, where all rainfall reports can be initially received. Personnel at the Emergency Communications Center or State Police will be knowledgeable of the conditions under which they notify the County Flood Warning Coordinator who will then operate the flood warning system.

COUNTY FLOOD WARNING COORDINATOR

The County Flood Warning Coordinator is the focal point for the flood warning system. Rapid preplanned action will be needed to make the flood warning system operate successfully and accomplish what is designed to do - to reduce the threat to the general public of flooding and flood damage.

There should be a backup person who is trained to operate the system in case the coordinator is not available for any reason. There should be an assigned order of succession of these backup persons so that each knows when they are responsible to assume their role.

Specific tasks of the Jefferson County Flood Warning Coordinator or backup persons are:

1. Directs and coordinates the continuous operation of the Jefferson County Flood Warning Program.
2. Develops standard operating procedures for the operation of the flood program.
3. Recruits, organizes and trains rainfall observers, stream gauge observers.
4. Coordinates location of communications equipment for flood warning program and trains operators.
5. Alerts and maintains contact with rain and stream gauge observers.

6. Coordinates the placement of rain and stream gauges.
7. Maintains contact with the assigned Office of the National Weather Service.
8. Contacts and disseminates pertinent weather/flood information, conditions, and actions, to the Office of Emergency Management Director, and the County Public Safety Agencies.
9. Alerts key personnel when flood watches, alerts or warnings are issued.
10. Collects and maintains rainfall and stream level reports from observers.
11. Establishes and maintains a record keeping system of the amount or rainfall, snowfall and heights of streams and rivers.
12. From review of records determines flood risk areas.
13. Reviews weather situations with the National Weather Service and jointly select flood stage predictions and forecasts.
14. Disseminates flood stage predictions and alerts in the county.
15. Assists in the issuance of evacuation orders as necessary.
16. Advises on the necessity of activating the Emergency Broadcast System if conditions warrant such action.
17. Establishes inter-county radio/telephone communications with adjacent counties and coordinates and disseminates flood information.
18. Evaluates the flood warning system after each flood and takes remedial action to correct weaknesses.

RAINFALL OBSERVERS

Rainfall information is needed to supplement information obtained from stream gauges. This is especially true of tributary -streams or upper reaches of the watershed. In these locations, observations of rapid changes in water levels at stream locations would be too late to provide adequate flood warning for many areas. Therefore, rainfall observers should be organized at selected locations around the watershed where additional information would greatly increase the flood forecasting capability of the system. These observers must communicate with the flood coordination center by telephone and/or radio.

STREAM GAUGE OBSERVERS

Stream staff gauges and crest gauges may be placed in various locations on tributary streams. Volunteers are required to personally observe and report stream levels to the County Flood Warning Coordinator as a storm progresses. Communications will be by telephone and/or radio.

SELECTION OF OBSERVERS

The following is a suggested guideline to be used in selecting volunteer stream gauge and rainfall observers:

1. Live or work near a stream gauge or in an area where rainfall information is needed.
2. Home is not located in a floodway or flood fringe area. Observers should not be in a conflicting situation wherein personal safety or property is in jeopardy while simultaneously having the responsibility to read a stream or rain gauge during a flood.
3. The person is motivated to help others, will do the job over a long period of time, will attend training sessions and stick to the job during a crisis.
4. Must have access to a telephone 24 hours a day. A private telephone line, which has a trouble free record during inclement weather, is preferred.
5. Rainfall and stream observers should have access to radio communications in case telephones become inoperable. Mobile radios should be used at most stream gauges (if available).
6. Stream gauge observers should have binoculars and a flashlight or spotlight to read stream gauges at night or from remote locations.
7. Observation stations should be located, wherever possible, at public facilities such as police stations, fire stations, and hospitals where 24-hour surveillance is possible.
8. A backup observer should be designated for each observation station.

STREAM AND ROAD PATROLS

Flash Flood causes damage and risk to life because of the rapid rise in stream levels. Voluntary stream and road patrols can serve to monitor conditions, observe development of unexpected problems and identify areas needing the earliest warning and evacuation assistance. Stream and road patrols should be organized so that separate patrols operate independently on both sides of a stream, if practical, and areas

that might be isolated because of flooded roads and bridges. These patrols should be instructed not to attempt to ford flooded roads and bridges. They should not place themselves in a situation where they become part of the problem.

Upon receipt of a flood watch, the stream and road patrol should be alerted. If heavy rains begin or are reported, patrols should survey the streams and roads in the area to watch for local flooding conditions, blockages or stream channels from mud slides, trees and other obstructions. Special attention should be given to all bridges and culverts. All roads should be patrolled to identify local flood situations and to monitor road access to low-lying areas subject to flooding. Any unusual or dangerous conditions should be reported to the County Flood Warning Coordinator. Adequate manpower should be planned to carry out these patrols on short notice.

EFFECT OF WARNING TIME

The time required carrying out various actions like warning dissemination and evacuation depends on the size, population and characteristics of the affected area and the resources, which will be required. Impracticable attempts to salvage property to take other actions may cause unnecessary risks to property owners, those assisting them, and ultimately to the rescuers. Realistic assessment of the time required for execution of each step should be made to eliminate those, which are impractical.

SECTION V

Alerting System

COMMUNICATIONS

The means by which flood warning can be communicated depends on the means generally required to reach all warning recipients. Particular attention should be given to reliability in establishing communications procedures. Electrical power and telephone services frequently fail during floods or severe weather preceding floods. Alternative means of communications, primarily radio, must be considered.

EMERGENCY OPERATIONS CENTER

An Emergency Operations Center is the key to coordination of the flood warning system. The center brings together the necessary facilities, personnel and information that will result in the most effective decisions and actions.

Procedures for the operation of the center needs to be carefully developed and should include:

1. Procedures for activation of the center. (There should be a designation of individuals assigned to staff the center including designation of backups to those individuals).
2. Identification of responsibilities to be assigned to the center.

3. Operational procedures to carry out the assigned responsibilities.

An outline of procedures that could be used during a flood threat is shown at Attachment "L". This outline is not a plan for operating the Emergency Operations Center. A more detailed plan is needed that describes individual specific duties in a chronological sequence.

PUBLIC INFORMATION

There are two types of public information, which should be used. One is an information program designed to acquaint the public with the flood warning system. The other is an information system that will be used during an emergency.

1. Community Awareness Program

It is necessary to develop community awareness and understanding of the flood hazard and of the measures being taken to mitigate that hazard. Information about the organization and operation of the flood warning systems should be systematically disseminated to area newspapers, radio and television stations.

A continuing public information program to increase community awareness of floods, warning methods and evacuation procedures should be established encompassing the following elements:

- a. The source, nature, frequency and potential severity of floods.
- b. The county's system for flood recognition and dissemination of warnings to the public.
- c. The meaning of various types of warning announcements, siren signals and evacuation notices.
- d. The areas likely to be inundated or evacuated at each level of expected flooding.
- e. Procedures for evacuation including preparations for evacuation, routes, safe destinations and identification of reception centers.
- f. Actions, which can be taken by property owners to reduce damages including movement of furniture and valuables.
- g. Safety and remedial actions to be taken when returning to flood damaged buildings.

More detailed arrangements and direct contact must be made with hotels, motels, hospitals, nursing homes and other public facilities to establish guidelines and criteria for warning announcements and evacuation notices.

Emergency Information

Pre-planned systematic methods of communicating to the public must be developed. Methods used during a flood emergency will depend upon warning time, the duration of the storm, the type of flooding, and the expected extent of flooding downstream. The three generally accepted methods are:

- a. Mass media (television, radio, newspapers).
- b. Warning systems (sirens, mobile public address units).
- c. Personal contact (telephone, door-to-door).

During flood situations, radio and television may be the only quick method of reaching the public.

In planning an emergency information program, consideration should be given to preparing warning announcements in advance for use in various potential circumstances. The purpose of the precautionary measure is to:

- a. Identify the types of emergency information to be conveyed to the public in the period prior to, during and immediately following a flood to include watches, warnings and evacuation notices.
- b. Provide information on actions to be taken, locations of safe areas and areas to be avoided, location of reception centers, and ways of obtaining emergency assistance.
- c. Identify actions being taken or to be taken to deal with the flood.
- d. Identify sources of labor, equipment, or other types of assistance needed for evacuation, damage reduction and rescue operations.
- e. Identify the form and content of each type of message.
- f. Identify the method and procedures used in communicating each type of emergency information message.

SECTION VI

Information Analysis System

ANALYZING - DECISION MAKING

The County Flood Warning System will not function properly unless there is adequate information, a method of analysis, a system of making decisions, and a plan for the dissemination of information. The analysis and decision making role should be carried

out by the coordinator of the system. There should be a backup person pre-designated and trained who is capable of doing the job in case of vacations, sickness, etc., as mentioned previously.

In order to be effective in the analyzing and decision making role, the County Flood Warning Coordinator must attain a familiarity with the following essential elements of the system:

1. Attain a personal knowledge of county watersheds and streams, including the geographic and hydrological peculiarities of each flood-prone area.
2. Enjoy a personal acquaintance with observers and other volunteers involved in the system. This personal knowledge will enable a more effective understanding of the capabilities of the individuals and the system for operation in an emergency.
3. Understand how the information gathering system operates; who is to do what and what alternative methods there are during a crisis.
4. Know what decisions need to be made based on assembled information and be capable of making them. The following are examples of events that will require evaluations and decisions:
 - a. Warning of potential heavy rain or possible flood problems. This information could be received from rainfall reporters, stream gauge reports or an alert from the National Weather Service. During this phase, individual contact all rainfall and stream gauge observers and instruct them to observe and report situation at predetermined intervals.
 - b. Evaluate all information and determine the state of potential flood problems.
 - c. Relay flood watches and warnings issued by the National Weather Service. Special attention should be made to upstream or headwater areas with a history of flood problems.
 - d. As storm or flood progresses, determine flood crest situation and make initial estimates of the time and height of flood crest. Coordinate all information with National Weather Service.
 - e. Continual reevaluation to determine path of storm and potentials for flood conditions. Make appropriate warning announcements.
 - f. Issue flood predictions.
 - g. As a flood develops, coordinate with appropriate National Weather Service offices and issue periodic reports to other agencies, public officials, and local press.

ROLE OF FLOOD WARNING COORDINATOR

Pre-planned action will be needed to make the flood warning system effective. For this reason, a County Flood Warning Coordinator must be designate who is knowledgeable of the system and who can make informed decisions based on the situation. In addition to the coordinator, two backup persons should be designated who are trained to operate the system when the Coordinator is not available. There should also be an assigned order of succession of the backup personnel so that each knows when they are responsible to assume control. Specific tasks of the County Flood Warning Coordinator or backup person are listed in Section IV.

SECTION VII

Post-Flood Evaluation

EVALUATION PROCESS

The flood warning system should be thoroughly evaluated following each flood event. Revisions should be made and tested where necessary. The following list suggests some activities, which should be completed as part of the evaluation after a flood:

1. Identify high water marks. Painting of high water marks on bridges, utility poles and other markers can be used for later compilation of detailed flood stage damage maps. These maps show at what stage or elevation a particular area is flooded. The maps should be made available to all emergency organizations for use during the next flood.
2. Hold a post-mortem meeting with all the volunteers, organizations and agencies that participated in the warning system. This meeting should be a positive effort to obtain increased support from those participating in the system and recognition of the benefits attained from participation in and contributing to the actions taken during the flood. Evaluate what worked and what didn't work during operation of the system. Recommendations for improvements should be immediately evaluated and, if warranted, incorporated into a revised plan. Prepare a summary report for elected officials, news media, cooperating local, state and federal agencies and organizations and concerned individuals.
3. Carry out a simulation exercise on the revised plan to determine if it operates as intended.
4. Carry out a damage reduction survey. Evaluate the value of structures and contents of personal property and business damages reduced, and disruption alleviated, through implementation of the flood warning (and response) system.

SYSTEM CONTINUITY

A challenge to the continued effective operation of the county flood warning system will be the maintenance of a viable organization. Maintaining interest in and knowledge of how the system operates will not be easy. Volunteers who serve, as rainfall and stream gauge observers will need recognition for what they are doing.

There also will be a need to maintain close communications with other organizations who will participate in the system. Since close cooperation is essential, a series of continued contacts with these organizations and their leaders would be needed. Leadership of organizations change, with changes in leadership there will be a need to make contact with new leaders to inform them of the system and to obtain their cooperation. Contact should be maintained with emergency services, fire, police, and other organizations that are needed to make the system function. The longer the period since the last flood, the greater the chance for loss of interest.

SECTION VIII**Training Program**GENERAL

The West Virginia Division of Homeland Security and Emergency Management and the National Weather Service will provide initial training on the organization of the county flood warning system. This training will normally be provided to the Jefferson County Office of Emergency Management Director and his designated County Flood Warning Coordinator. Initial and ongoing training of the flood program observers will be the responsibility of the National Weather Service and the West Virginia Division of Homeland Security and Emergency Management and the Jefferson County Office of Emergency Management.

TRAINING PROGRAM OUTLINE

A training program for the participants of the county flood warning system should be organized to ensure an understanding of how the system is to operate. Inspection and test exercises of the system should be held at least semi-annually.

Suggested areas of instruction, by function, that should be included in the training program are listed below:

1. County Flood Warning Coordinator
 - a. General rainfall/runoff relationships of the county should be understood to enable effective selection of locations for rainfall observers, assignment of stream and road patrols, and to make other pertinent decisions about possible flooding conditions. The National Weather Service and the County Flood Warning Coordinator's experience in the county should base this background rainfall/runoff information on recommendation.

- b. Alternative and backup communications systems. There must be a clear understanding of what alternatives to telephone communications are available. Each system must be planned and tested before being adopted as all alternative and its limitations identified and understood.
- c. Awareness of the capabilities of community Public Safety organizations and how to contact them if necessary.
- d. Understand the need for and methods to be used in recording each storm. Record keeping should include rainfall amounts, stream levels, rate of streams rise and crest times.
- e. Methods of recruiting, training and maintaining the necessary personnel to man the rainfall stations, stream and road patrols and telephone call systems should be understood.
- f. Understand methods of training and procedures for testing the system.
- g. Importance of updating:
 - Address, Telephone numbers and names of key participants.
 - Assignments of responsibility.
 - Changes in flood potential.

2. Rainfall Observers

- a. Proper location of rain gauges.
- b. How to read and maintain the gauges.
- c. Procedures to be used in reporting and recording rainfall observations.

3. Stream and Road Patrol

- a. Understanding of primary mission to monitor changing streams conditions and report observations promptly.
- b. Clear understanding of the exact road and stream areas to be monitored, potential problems of these areas and alternate travel routes to and from affected areas.
- c. Communications methods to use, who to call and what type of information to be transmitted. If CB or RACES radio is used, radio procedures and methods need to be understood. If radio is not available, telephone use

arrangements should be made at or near critical flooding points to enable prompt contact with the County Flood Warning Coordinator.

- d. An understanding of the dangers involved. Avoid driving through flowing water, look out for clogged bridges and culverts, and low spots that flood easily.

4. Stream Gauge Observers

- a. How to read the gauges.
- b. Procedures to be used in recording and reporting stream gauge observations.
- c. Need for proper equipment - flashlight for night observation, binoculars for when observation cannot be made close in due to rising waters.

ATTACHMENT "A"**MEMORANDUM OF UNDERSTANDING FOR FLASH FLOOD WARNING SYSTEM**

This Memorandum of Understanding (MOU) between the National Weather Service, National Oceanic and Atmospheric Administration (NOAA), and the Jefferson County Office of Emergency Management (JCOEM) is undertaken for the purpose of defining a mutual assistance program designed to develop a Flash Flood Warning System for Jefferson County, West Virginia.

1. Authority

The National Weather Service, NOAA, undertakes this Memorandum of Understanding pursuant to its authority in 15 U.S.C. 313 and 7 U.S.C. 45Gb, in order to carry out its functions relating to flood warnings.

2. Nature of Agreement

The National Weather Service, NOAA and the Jefferson County Office of Emergency Management will cooperate to accomplish the installation and operation of a flash flood warning system to help provide advance flood warning for the Shenandoah River, Potomac River and the Opeqoun Creek and other small streams of Jefferson County, West Virginia.

3. Responsibilities of the National Weather Service, NOAA

The National Weather Service, NOAA will:

- a. In cooperation with other agencies as necessary, obtain available appropriate records of storms and floods in the area of concern, to develop a flood forecasting procedure and to acquire and use future data to modify or improve such a procedure.
- b. Develop a County Flash Flood Forecasting procedure for specific drainage basins and provide a copy of a designated representative of _____ with instructions on its use.
- c. Provide river and rainfall gages and instruct volunteer observers in the measurement, recordings of the data.
- d. Issue, according to the severity of the hydro meteorological threat, Flash Flood Watch, Flash Flood Warning, Flood Warning or Local Statements.

4. Responsibilities of the Community

- a. Designate a local flash flood representative by name(s) or title(s), trained in and responsible for the operation of a Local Preparedness Plan. The Plan should detail the necessary responsive actions to be taken when collected river and rainfall data indicate the need to issue the required statements and warnings.

- b. Recruit and manage a network of volunteer observers suitably distributed over the attributing area who will remain ready to furnish the required data.
- c. Establish an Emergency Operations Center (EOC), to operate continuously or as required for the purpose of:
 - 1) Receiving and recording all reports of rainfall and flood conditions.
 - 2) Promptly relaying or making available all such reports to the designated local flash flood representative.
 - 3) Serving as the official distribution point for all Warnings and Statements issued by or for the designated local representative.
 - 4) Ensuring, in addition to general public distribution that the warnings or statements reach warning action points as listed in the Local Preparedness Plan. (List of warning contacts is given in the Appendix).
 - 5) Relaying flood data and warnings to the National Weather Service office as soon as practicable after local requirements have been satisfied.

5. Amendments or Modifications

This Memorandum of Understanding may be amended or modified by mutual agreement of the National Weather Service, NOAA and the Jefferson County Office of Emergency Management.

6. Termination

This Memorandum of Understanding may be terminated by either party upon thirty (30) days written notice to the other party, notice to begin with date of mailing.

**UNITED STATES DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION**

By: _____

Title: _____

NATIONAL WEATHER SERVICE – STERLING VIRGINIA OFFICE

By: _____

Title: _____

**JEFFERSON COUNTY OFFICE OF EMERGENCY MANAGEMENT – CHARLES TOWN
WEST VIRGINIA**

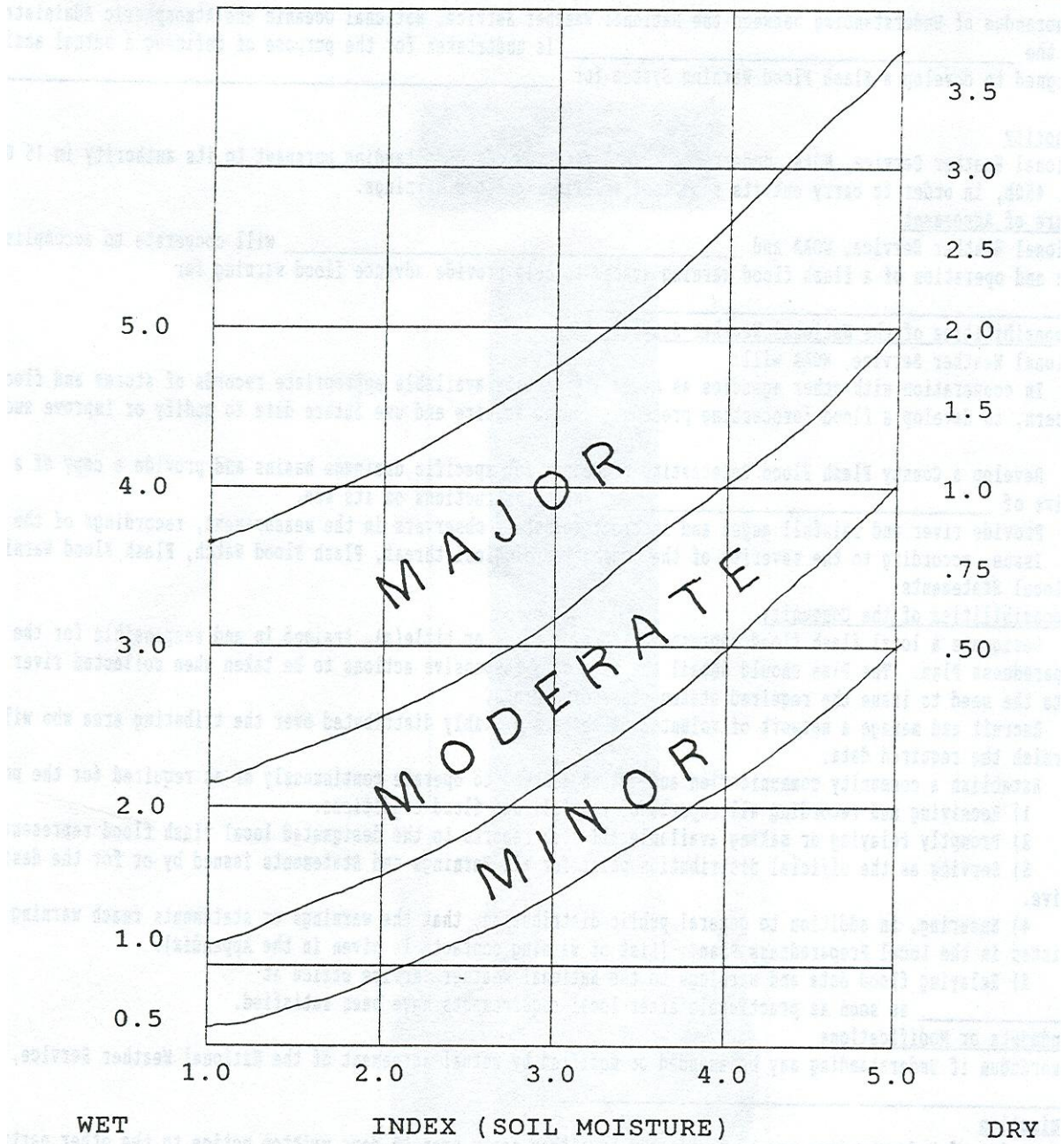
By: _____

Title: _____

ATTACHMENT "B"
CATEGORICAL FORECAST GRAPH

Average
Basin
Rainfall

Runoff



DIRECTIONS:

1. Enter with Index.
2. Estimate average basin rainfall
3. Approximate degree of flooding

ATTACHMENT "C"

INSTALLATION, OPERATION AND MAINTENANCE OF RAINFALL GAUGES**A. Installation**

1. Select an open space to allow unobstructed catch of rain. (Rule of thumb: Gauge should be as far from obstruction as height of obstruction. Example: 20 feet away from a 20' tree).
2. Mount base plate on well-anchored 2X4 or 4X4 plank (or post). Ideal height is eye level.
3. Attach rain gauge to base plate.

B. Operation

1. Read and empty rain gauge at the same time each day. (Note: This is the only time gauge is emptied).
2. Record rain gauge reading. (Note: See page 31 for instructions on use of NWS Form E-16).
3. Make a phone call report to the County Flood Warning Coordinator or the Emergency Operations Center whenever more than 1" of precipitation is observed in the summer (May 1 thru October 31) or 0.50" in the winter (November 1 thru April 30). Do not empty gauge, but keep reporting each additional 1" of rainfall during the storm. The number for your County is 728-3290; number for the National Weather Service is (703) 260-0909. (Latter to be used in the event local coordinator cannot be reached).
4. Remove gauge and store indoors during extended periods of absence. (Record "M" for missing on record sheet for each day's absence).
5. Place funnel and inner cylinder indoors during winter or periods of predicted freeze. (Outer cylinder along will serve to collect rain, sleet, and snow during these periods. Amounts are determined by melting contents).

Maintenance

1. Wash and clean with mild soap or detergent. (Solvents, abrasives or dishwashers should not be used, as damage will result).
2. Periodically, check for leaks in outer and inner cylinders, check other parts for cracks.
3. For replacement of gauge (or parts thereof) contact your County Flood Coordinator.

ANNEX D**INSTRUCTIONS TO RAINFALL OBSERVERS**

1. A regular daily observation should be taken about the same time each day. Empty rain gauge after each daily observation. Special observations are taken during heavy rain periods. Observations are recorded as shown on Form NWS Form E-16.

RECORD OF OBSERVATIONS

1. All special observations will be entered in the remarks section of the form provided for this purpose.
2. Snow should be melted and water content of the snow recorded in the 24 hour precipitation column. Total snow depth on the ground may be entered in the remarks section.
3. At the end of the month, forward one copy of the precipitation form to the County Flood Warning Coordinator.

WHEN TO REPORT BY TELEPHONE

1. When 0.50 of an inch of rain (or more) has fallen in 24 hours or less, during winter months (November 1 thru April 30) or when 1 inch of rain (or more) has fallen in 24 hours or less during the summer months (May 1 thru October 31) make an initial telephone report immediately to the County Flood Warning Coordinator (or his alternate) regardless of the time of day.
2. If rainfall continues, report again when another 1 inch occurs or as directed by your Flood Warning Coordinator until the rainfall has ended.

WHAT TO REPORT

1. Always report to total accumulation in the gauge at the time the report is made. If the report is made at the time of the regular observation, the amount reported will be the 24 hour accumulation. If a report is made at other times, the amount reported would be the amount that has fallen into the gauge since the daily observation, or a 2 to 3 hour accumulation. EMPTY only ONCE a DAY at the daily observation; therefore each additional report will be for the actual amount in the gauge at the time of the report.

HOW TO REPORT

1. Use NWS Form E-16 (which will be provided) to record daily observations. Mail forms for each month to the County Flood Warning Coordinator in envelopes provide. A sample filled-in NWS Form E-16 is appended hereto. Note the explanation of all terms on the reverse side thereof.

2. Use telephone (collect call on number provided) to make special reports. If telephones are inoperative, attempt to make report by any other means (CB, shortwave radio, in person, etc.) without jeopardizing, in any way, personal safety.

Rainfall Recorder

RECORD OF RAINFALL RECORDER				Station: <u>Millville</u>	
Type of Rain Gauge: <u>11" Clear Vue</u>				River Drainage: <u>Shenandoah River</u>	
Month: <u>January</u>		Year: <u>2005</u>		Time of Observation: _____	
PRECIPITATION				REMARKS	
DAY	BEGAN A	ENDED B	24 HOUR AMOUNT C	CHARACTER D	SPECIAL OBSERVATION, ETC. E
01			0.12		
02			T		
03			T		
04			0		
05			0		
06			M		
07			0.26		Two (2) Day Total
08			0.06		
09			0		
10			2.91		1.25" 9/6PM - 9PM called Coordinator
11			0		
12			0		
13			0		
14			0.76		1/4" Hail
15			T		
16			0		
17			T		
18			0		
19			0		
20			T		
21			0		Evitts Run Flood 10AM Advise Coordinator
22			0		
23			M		
24			0		
25			T		
26			Y		
27			M		
28			M		
29			M		
30			0		
31			0		
SUPERVISING OFFICE: <u>Jefferson County Office of Emergency Management</u>					
NAME OF REPORTER: _____					

RECORD OF RAINFALL REPORTER (NWS E-16)

Station – Name of the community you are reporting.

River Drainage – Stream for which warnings are issued based on your rainfall reports. If so particular stream – leave blank.

Month, Year – Be sure to enter these.

Time of observation – Time you actually take daily reading.

Type of Rain Gauge – Most are the plastic 11” Clear Vue.

Began and Ended – The time precipitation began and ended is not required and is difficult to keep track of. If you know the times, especially of heavy rainfall, you may enter then here or in remarks.

24-Hour Amount – The amount of precipitation that fell in the 24-hour period ending with your observation time. For example, the entry of 8AM on the 6th would cover the 24 hours for 8AM on the 5th of 8 AM on the 6th. In the winter, any snow, sleet. Etc. must be melted and figured in with any rain that fell. Enter precipitation in inches and hundredths – 0.07, .0.26, 1.09, 2.67. Use the following:

“0” – No precipitation in the last 24 hours.

“T” – Trace – it rained but there was too little to measure – less than 0.01.

“M” – Missing – you could not read the gauge that day.

**** Make an entry every day.**

Character – Not required. If you wish to enter rain, snow, hail, etc.

Remarks – Special readings and those called to the Flood Coordinator are important. Unusual or severe weather and flooding should be reported.

Supervising Office – Always the Jefferson County Office of Emergency Management

Reporter – The name of the individual making the documentation.

Keep a copy of your records and at the end of each month send the required numbers of copies of your County Flood Warning Coordinator.

ATTACHMENT “E”

RAINFALL TABULATION SHEET

Date: _____

#	LOCATION	TIME	TIME	TIME	REMARKS
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
	Total Rainfall				
	Average Basin Rainfall				

Average Basin Rainfall = $\frac{\text{Total Rainfall}}{\text{Total \# Observations}}$ = _____ =

Index (furnished by the National Weather Service)

Degree of flooding: _____

TELEPHONE INSTRUCTIONS:

County: Jefferson County Office of Emergency Management (304) 728-3290

INSTRUCTIONS FOR THE FLOOD COORDINATOR

The County Flood Coordinator must determine the potential for flooding is imminent, the approximate degree of flooding. The first step is to estimate average basin rainfall using observed rainfall reported by local observers within the gauge network. The next step is to obtain the Index supplied by the National Weather Service. The Index is derived from a history of storms and takes into account soil moisture and meteorological parameters. The average basin rainfall and the Index are then used together to determine the degree of flooding, if any, using a graphical procedure derived by the National Weather Service. In short, the lower the Index the greater the degree of flooding for a given average basin rainfall and the higher the average basin rainfall the greater the degree of flooding for a given Index.

EXAMPLE RAINFALL TABULATION

Date: _____

#	LOCATION	TIME 0700	TIME	TIME	REMARKS
1		3.10			
2		2.88			
3		3.24			
4		2.95			
5		3.01			
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
	Total Rainfall	15.18			
	Average Basin Rainfall	3.04			

$$\text{Average Basin Rainfall} = \frac{\text{Total Rainfall}}{\text{Total \# Observations}} = \frac{15.18}{5} = 3.04$$

Index (furnished by the National Weather Service) = 1.4

Degree of flooding: MAJOR

ATTACHMENT "F"

CRITERIA TO DETERMINE NEED FOR A STREAM GAUGE

- A. Is the location where the public meets and looks at the stream during high water?
- B. Will the knowledge of the rate of rise or fall be a value at the site? Further downstream?
- C. Would the knowledge of what is happening upstream be of enough value to find a location further upstream for a gauge?
- D. Does someone live nearby who would be a dependable reader?
- E. Could you dispatch someone to read the gauges in unpopulated areas?
- F. Do roads and communications in the area lead themselves to access during very high water?
- G. If gauges of another agency in the area are present, would a key giving access to their gauge need your need, and eliminate installing a staff gauge?

PROCEDURES IN A SITE SURVEY

After it is determined a stream gauge is needed or desired at a site, some of the things that need to be done are:

1. Visit the proposed site.
2. Check for any existing painted high water marks or any gauges owned by another agency.
3. Ask local people in the area how high water was in recent floods.
4. Insect path of main currents of stream to determine the movements of ice or debris.
5. Determine a reasonable depth of stream at this time (number of feet of flow over a riffle, outside of deep pools). Tie in proposed gauge to this level.
6. See if only a high water section is needed or a full gauge, starting at or near the current water level.
7. Look for access to gauge reading area during a flood. Will roads be covered?
8. If they will be, can it be read at a distance with binoculars? Consider this in placing upper sections of gauge.
9. In most places, bridges give best access and protection for mounting and reading the gauge.
10. On a bridge:
 - a. Is there a place where it is protected - generally downstream side and out of the direction current?
 - b. Is a wing-wall or pier available for mounting?
 - c. Are the sides vertical (straight - not slanted)?
 - d. If needed above top of pier or wing-wall, look for protected section higher on bridge structure.
 - e. Determine where to start gauge and at what reading.
 - f. Determine how high to go - preferably a few feet above flood of record..
 - g. Determine if gauge can be continuous or will it need to be offset, due to going above top of pier or perhaps an offset on the pier.

- h. Determine where offsets are located and how much overlap is needed. The various sections must be leveled so they all agree.
 - i. Adequate notes must be taken in order to develop installation instructions.
 - j. Amount of numerals and what gauge section lengths will be needed must also be determined from the notes.
 - k. Written permission must be obtained from the owner of the bridge before installation begins.
11. Minimum tools for site survey:
- a. Consider a large straight tree in flood plain - preferably upstream from the bridge so it can be read from the bridge area.
 - b. Buildings or other man-made structures in flood plain that would provide protection from debris.
 - c. Utility poles in the flood plain.
 - d. Consider installing an old utility pole as a mount for gauge if nothing else is available.
12. Engineering levels must be run before or at time the gauge is installed if there is an existing gauge in the area - they must agree. If there is no other gauge, the levels can be run later, so there will be history maintained in case the new gauge should be torn down or destroyed.
13. Examine the bridge structure for possible bench mark to aid in the survey.
14. Photos may be taken, if needed, to show site of desired gauge, or after gauge is completed to describe its location.

INSTALLATION OF A STREAM GAUGE

1. Determine if using "Criteria to Determine Need for a Stream Gauge" needs a stream gauge
2. Plans should be made to follow the information obtained during the site survey. Use "Procedures in a Site Survey" as a guide.
3. In all cases, permission for access to, and for construction of the gauge must be obtained in advance, and should be in writing. This is the case for all gauges, whether on private property, highway bridges or public property. The Department of Highways may require an occupancy permit.
4. Modern concrete bridge structures are the easiest to install gauges on; stone piers are much harder to drill and harder to get a solid mount.
5. Materials needed to construct the gauges:

2" X 12" Planks, Creosote, Scale and Numerals 5/8" or 3/8" x 5" Lag Screws, 5/8" or 3/8" Washers, 5/8" or 3/8" Lead Shields, #8 x 1/2" Brass or Stainless Steel Screws for mounting scales and numerals, Silicone Sealer, Angle Irons or Protective Shields if debris or ice is serious problem.
6. Tools needed to assemble stream gauges:

Electric Drill with bits, Box and Ratchet Wrenches, Chalk Line, 8-Point Saw, Square, Brushes for creosote, Carpenters Level and pencils.
7. Equipment needed to install stream gauges:

Electric Generator, Hammer Drill with masonry bits, Extension Ladder, Ladder Jacks, Planking, "Men Working" signs. Rental of Roto Hammer and Nail Stud Gun speeds the installation process.
8. Care must be taken that all safety precautions are followed. The ladder should be in good condition and properly placed. Jacks should be properly mounted and supported with the planking in good condition. The "Men Working" signs should be properly displayed to slow and/or caution traffic.
9. Pre-treated or pressure treated planks for waterproofing is easier to handle but, if not available, three coats of creosote should be adequate.
10. Additional protection of gauges by shields or angle iron may not be needed if a protected site away from debris is available.

11. Cut planks to desired lengths in accordance with information obtained in site survey. It should go a little higher than the known flood of record. If untreated, creosote the plank after it is cut.
12. After drying, a chalk line is struck to center the scale and numerals on the board. Individual numerals and scale should not quite touch to allow for slight expansion.
13. Fasten scale and numerals securely with #8 x 12" roundhead brass or stainless steel wood screws. Numerals are placed at footmarks.
14. Drill holes in the plank to accommodate the lag screws. Two holes are drilled 3" from the bottom and 3" from the top of the gauge while others are staggered.
15. Position the gauge and check for vertical alignment with a carpenter's level. A pencil mark is made through each pre-drilled hole in the gauge for placement of lag shields.
16. Remove the gauge so holes can be put in the concrete or stone. They should be no deeper than to length of the lag shield, than the shield is positioned.
17. Silicon spray is applied to each hole to retard water seepage.
18. Reposition the gauge; lag screws with washers are pushed through the gauge and into the shields.
19. Complete the installation by tightening all screws with ratchet wrench to insure flush and sturdy mount. Remember, any loose piece will be much easier for water or debris to damage or destroy. Counter sink, only where necessary, it weakens the plank.
20. The County Flood Coordinator should make a final inspection and it may also be necessary for the highway department to inspect before final approval. Your gauge reader should be taught how to read it.
21. If gauge is not installed in one continuous strip (high section of staff at another site), care must be taken that the two gauges are level so readings will be compatible in going from one to the other.
22. If the new gauge is at the same site or general area of another where history is available, then levels must be run before or preferably at the time of installation to make sure the two gauges are at the same Zero Datum and readings from the two will agree.
23. Levels should be run sometime after the new gauge is installed anyway. In case the gauge is destroyed, another could be mounted at the same datum and records obtained from the two gauges would be compatible.

24. These instructions are geared toward a bridge installation, but the same general rules would apply if it is mounted to a utility pole, large tree, retaining wall or building. The plank mounting would involve different fasteners however.
25. Cut or trim brush from the installation site so the gauge will be visible.
26. Care must be taken not to chip the enamel from the numerals or scales during installation as rust starts and causes deterioration.
27. Remove all scraps of lumber and other waste material from the installation site before departing the scene.

ATTACHMENT "I"**STREAM GAUGE MAINTENANCE CHECKLIST**

- A. A properly mounted stream gauge should require very little routine care.
- B. Infrequent checks should be made to see if weeds or brush are obscuring the gauge during the summer season.
- C. Mud or oily residue on a stream may cause difficult reading in a certain section of gauge. This can generally be removed by washing with a mild detergent and water.
- D. Checks should be made after the ice season and each flood to see if any damage has occurred to the scales or numerals. Also, damage can occur from vandalism.
- E. Needed replacement scales or numerals can be obtained through the County Office of Emergency Management.
- F. Problems that render the gauge unreadable should be reported immediately to the County Flood Warning Coordinator or County Emergency Management Director.

ATTACHMENT "J"

STREAM GAUGE OBSERVATION WORK SHEET

STREAM GAUGE NUMBER	TIME OF REPORTS							CREST INFORMATION
								Crested @ ___ Feet @ ___ Hrs
								Crested @ ___ Feet @ ___ Hrs
								Crested @ ___ Feet @ ___ Hrs
								Crested @ ___ Feet @ ___ Hrs
								Crested @ ___ Feet @ ___ Hrs
								Crested @ ___ Feet @ ___ Hrs
								Crested @ ___ Feet @ ___ Hrs
								Crested @ ___ Feet @ ___ Hrs

Remarks and other Pertinent Information:

Prepared by: _____ Date: _____

ATTACHMENT "K"**INSTRUCTION TO STREAM GAUGE OBSERVERS****I. INTRODUCTION**

The prompt reports of creek and river stages are extremely important on all streams and your service will be inestimable value to the Jefferson County Flood Warning System if reports are made promptly.

II. TIME OF OBSERVATIONS

- A. A regular daily observation should be taken (if needed).
- B. Special observations are taken at other times of the day only when reports are needed in accordance with instructions entitled "When to Report".

III. RECORD OF OBSERVATIONS

- A. Enter the record of the daily observation (stage in feet and tenths), and also all special observations under remarks on OES Form E-16.
- B. Enter the tendency (rising, falling, and stationary) for all observations.
- C. Mail original form at the end of each month to the Jefferson County Flood Warning Coordinator.

IV. WHEN TO REPORT BY TELEPHONE

- A. Whenever the stage reaches ___ feet (half bank-full), a report should be telephoned immediately to the County Flood Warning Coordinator.
- B. Continue telephone reports at 3 hour intervals until the stream is within its banks shows a falling tendency and reads 1.0 foot lower than the previous reading:

Example:

0700 Stage 5.5 ft. rising; previous 0700 2.1 rising 1000 Stage 8.0 ft. falling; crested 0900 8.5 feet 1300 stage 6.8 ft. falling.

A call should be made immediately if a rapid rise is noted, or if a road or bridge is flooded or washed out.

V. WHAT TO REPORT

- A. The present stage (feet and tenths) and tendency (rising, falling or stationary).
- B. The present initial reading should be given with the initial report. (This holds true regardless of the time of day the initial report is made).
- C. If the time limit of the telephone call allows, the following remarks would be helpful:
 - 1. Ground condition (very dry, saturated, frozen, etc.)
 - 2. If snow present (snow depth, melting rapidly, slowly, etc.)

**ATTACHMENT “L”
OUTLINE OF OPERATIONAL PROCEDURES**

PHASES	PERSONNEL	ACTION
Flash Flood Watch from NWS or rain reported by observers	Coordinator and Backup	<ul style="list-style-type: none"> • Remain near telephone • Obtain forecast from NWS latest index. • Alert the rainfall observer’s rainfall possibility.
Flash Flood Watch with continued local heavy rain	Coordinator and Backup	<ul style="list-style-type: none"> • Go to Emergency Operations Center (EOC) • Call and assemble first key EOC staff • Alert Stream Observers • Contact OEM Director • Start stream and road patrol
Flash Flood Warning local flooding occurring	EOC Partially staffed	<ul style="list-style-type: none"> • Assemble full EOC Staff • Order alert for communications systems • Begin hourly plotting of rainfall and stream data • Alert key staff of other agencies of possible problems
Main Stream flood levels expected	EOC fully staffed	<ul style="list-style-type: none"> • Activate backup radio to rain and stream observers • Establish inter-county radio communications. • Contact NWS Office • Obtain latest weather forecast • Report rainfall data and discuss expected flood levels
Flood Warning (Streams rising, peak not reached)	EOC fully staffed, county and community staff fully activated	<ul style="list-style-type: none"> • Update rainfall evaluation • Review situation with NWS • Jointly select flood stage prediction and statement • Issue flood stage prediction • Keep County OEM Director updated on areas that might need evacuated
Flood Condition (upstream flood peaks reached)	EOC, County and community staff fully operational	<ul style="list-style-type: none"> • Revise flood prediction and public statement as needed • Coordinate with area public safety agencies
Flooding Continues (Crest moving downstream)	EOC, county and community emergency units fully operational	<ul style="list-style-type: none"> • Revise flood crest predictions if needed • Continue evaluation of evacuation needs

ATTACHMENT "M"

FLOODING INFORMATION OF THE
SHENANDOAH RIVER, POTOMAC RIVER AND THE OPEQUON CREEKSHENANDOAH RIVER AT MILLVILLE

A *hydrograph* shows how the river level changes over time at a specific location. Forecast hydrographs are displayed when flooding is expected, otherwise the hydrograph for the past few days is provided, if the data are available. At key river gages, such as along navigable rivers, daily forecast hydrographs are provided, whether or not flooding is anticipated. For some locations, probabilistic outlooks for extended periods of up to 90 days are provided.

In cold regions, the hydrograph may seasonally show the effects of the formation of an ice cover. Gauges may either malfunction due to cold weather and/or show sporadic readings due to formation of ice cover on a river or movement of ice. The amount of ice effects can be determined at a site by comparing the gauge forecasts (which is based on open water flow) to the observed stages.

Links to past and forecast precipitation, river level impact and historical flood information are also included on this page.

The following terminology is used when describing floods:

The term **Minor Flooding** is used to indicate minimal or no property damage. However, some public inconvenience is possible.

The term **Moderate Flooding** is used to indicate the inundation of secondary roads. Transfer to higher elevation may be necessary to save property. Some evacuation may be required.

The term **Major Flooding** is used to indicate extensive inundation and property damage, usually characterized by the evacuation of people and livestock, and the closure of both primary and secondary roads.

Information

Top 5 Historical Crests

- (1) 32.40 ft on 10/16/1942
- (2) 26.84 ft on 09/08/1996
- (3) 26.40 ft on 10/01/1870
- (4) 26.36 ft on 03/18/1936
- (5) 25.60 ft on 11/06/1985



Impacts

- 42.0 water overflows the old molar steel mill dike.
- 17.0 water begins to flood the town of Riverton VA, upstream from Millville.
- 9.0 water will begin to inundate parts of Bloomery Road near Bloomery West Virginia. Campers should move away from the river.
- 4.0 the river is at hazardous levels for recreational use.

POTOMAC RIVER at SHEPHERDSTOWN

**(NOTE: As of March 2005, USGS discontinued the Shepherdstown Gauge)
(Following data is for information only)**

A *hydrograph* shows how the river level changes over time at a specific location. Forecast hydrographs are displayed when flooding is expected, otherwise the hydrograph for the past few days is provided, if the data are available. At key river gages, such as along navigable rivers, daily forecast hydrographs are provided, whether or not flooding is anticipated. For some locations, probabilistic outlooks for extended periods of up to 90 days are provided.

In cold regions, the hydrograph may seasonally show the effects of the formation of an ice cover. Gauges may either malfunction due to cold weather and/or show sporadic readings due to formation of ice cover on a river or movement of ice. The amount of ice effects can be determined at a site by comparing the gauge forecasts (which is based on open water flow) to the observed stages.

Links to past and forecast precipitation, river level impact and historical flood information are also included on this page.

The following terminology is used when describing floods:

The term **Minor Flooding** is used to indicate minimal or no property damage. However, some public inconvenience is possible.

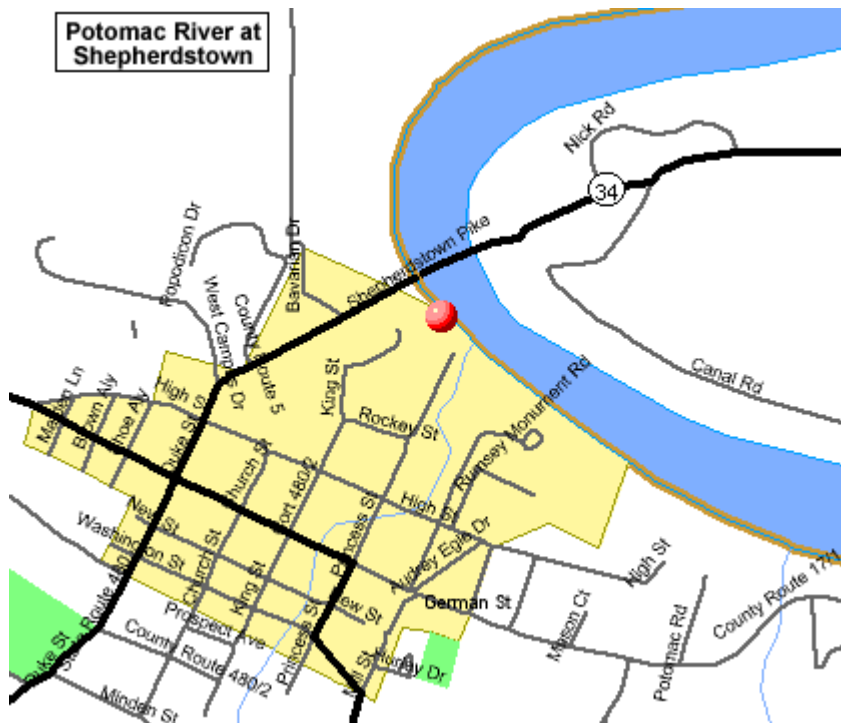
The term **Moderate Flooding** is used to indicate the inundation of secondary roads. Transfer to higher elevation may be necessary to save property. Some evacuation may be required.

The term **Major Flooding** is used to indicate extensive inundation and property damage, usually characterized by the evacuation of people and livestock, and the closure of both primary and secondary roads.

Information**Top 5 Historical Crests**

- (1) 42.07 ft on 03/19/1936
- (2) 39.20 ft on 06/01/1889
- (3) 33.20 ft on 04/27/1937
- (4) 32.68 ft on 10/16/1942
- (5) 32.50 ft on 01/21/1996

[Crest Flow Information](#)

**Impacts**

- 18.0 water approaches the C&O Canal Towpath.
- 15.0 river overflow low lying areas just downstream from Shepherdstown.
- 11.0 water begins to overflow low lying areas and the adjacent road just upstream from the Shepherdstown water plant.
- 5.1 the river is at hazardous levels for recreational use.

General Information

STATION.--01618000 POTOMAC RIVER AT SHEPHERDSTOWN, WV

LOCATION.--Lat 39°26'05.0", long 77°48'05.0", Jefferson County, Hydrologic Unit 02070004, on right bank, 0.1 mi downstream from Rumsey Bridge at Shepherdstown, 3.3 mi upstream from Antietam Creek, and at mile 184.

DRAINAGE AREA.--5,929 mi².

PERIOD OF RECORD.--August 1928 to September 1953. Annual maximums, water years 1954-64. July 1964 to September 1993. Gage-height record and estimated discharges October 1953 to June 1964 available in files of the Maryland/Delaware/DC district office.

REVISED RECORDS.--WSP 756: Drainage area. WSP 781: 1929(M). OFR 95-0292: Drainage area.

GAGE.--Water-stage recorder. Datum of gage is 281.00 ft above National Geodetic Vertical Datum of 1929.

REMARKS.--Some regulation at low flow by power plants upstream from station, prior to July 1981 by Stony River Reservoir, since December 1950 by Savage River Reservoir (see station 01597500), and since July 1981 by Jennings Randolph Lake. National Weather Service gage-height telemeter at station. Water-quality records for some prior periods have been collected at this location.

EXTREMES FOR PERIOD OF RECORD.--Maximum discharge, 335,000 ft³/s, Mar. 19, 1936, gage height, 42.10 ft; minimum discharge, 170 ft³/s, Aug. 1, 1966.

EXTREMES OUTSIDE PERIOD OF RECORD.--Floods in June 1889 and May 1924 reached stages of 39.2 and 29.8 ft respectively, from floodmarks, discharges, about 290,000 ft³/s and 168,000 ft³/s.

COOPERATION.--Funding for the operation of this station **WAS** provided by the U.S. Geological Survey.

POTOMAC RIVER AT HARPERS FERRY

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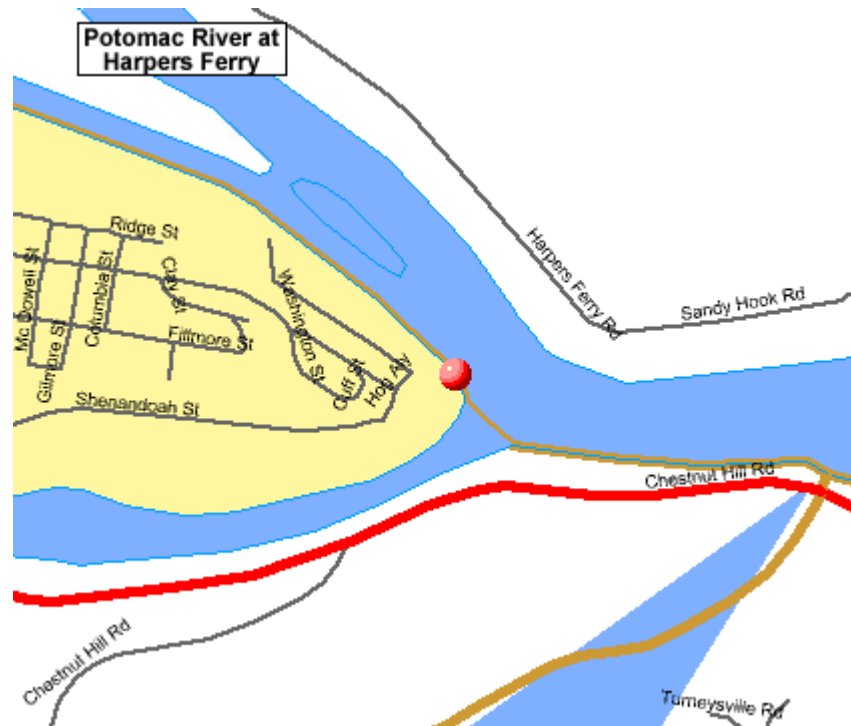
Information

Photos

- Looking upstream at gage
- Looking from right bank to left bank just below gage
- Looking downstream at confluence of Potomac/Shenandoah Rivers
- Looking downstream on left bank just above confluence

Top 5 Historical Crests

- (1) 36.50 ft on 03/19/1936
- (2) 34.80 ft on 06/01/1889
- (3) 33.80 ft on 10/16/1942
- (4) 33.00 ft on 10/01/1896
- (5) 30.10 ft on 11/06/1985



Impacts

- 43.5 water approaches the lowest point on Potomac Avenue downriver in Brunswick Maryland.
- 40.0 water inundates the platform and depot of the MARC Railway Station at Harpers Ferry.
- 33.5 water reaches the railroad yards downriver in Brunswick Maryland.
- 32.0 water begins to inundate 2 to 3 dwellings on the low edge of the town of Harpers Ferry WV.
- 29.0 all buildings along Shenandoah Street are flooded in Historic Harpers Ferry.
- 25.5 water floods National Park Service buildings 34,35,43 and 44. Shenandoah Street is completely covered as water approaches buildings 6 and 7 on Potomac Street in Historic Harpers Ferry.
- 24.5 water floods National Park Service buildings 32,33,33A and 63. Water approaches the front of buildings 8 and 11 on Shenandoah Street in Historic Harpers Ferry.
- 23.5 water begins to inundate National Park Service building number 45 and 34A in Historic Harpers Ferry.
- 22.5 water covers Shenandoah Street to the edge of the business district and standing water in low sections of the roads adjacent to the intersections between Potomac and Shenandoah Streets in Historic Harpers Ferry.

- 21.5 water begins to reach Shenandoah Street and adjacent shuttle bus pavilion in Historic Harpers Ferry.
- 20.5 water begins to flow through the open tunnel between the Potomac River and historic Harpers Ferry. Water reaches the lower edge of town, inundating half of Main Street and half of the shuttle bus parking lot.
- 19.5 water approaches Bruce and Hamilton Streets in Historic Harpers Ferry.
- 18.0 water begins to inundate low lying service roads on the Shenandoah River side of Historic Harpers Ferry, due to backwater effects.
- 16.0 the river begins to overflow onto the C&O Canal Towpath on the Maryland side of the river across from Harpers Ferry WV.

OPEQUON CREEK NEAR MARTINSBURG

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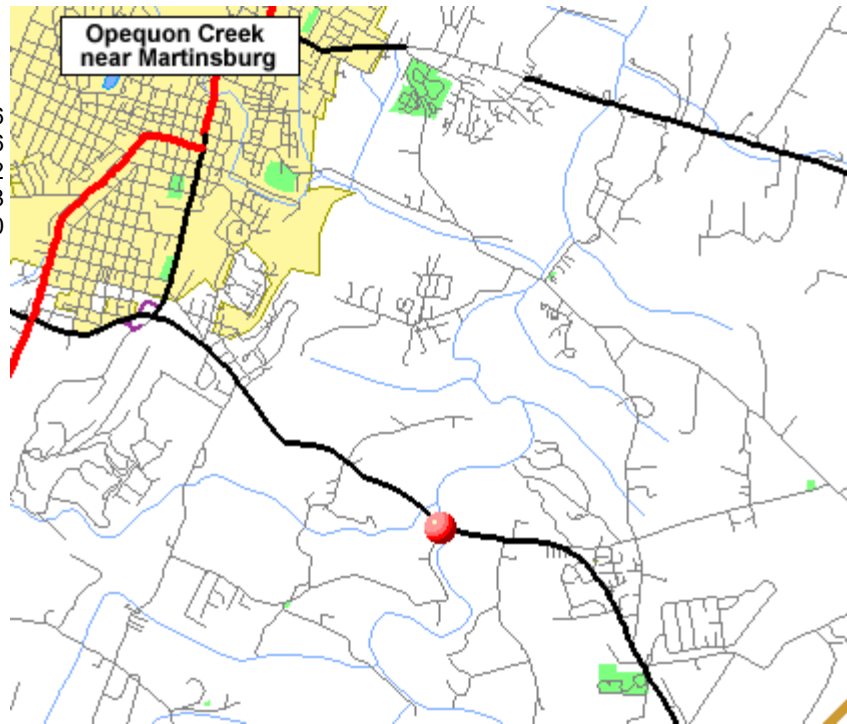
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Information

Top 5 Historical Crests

- (1) 18.76 ft on 01/20/1996
- (2) 17.50 ft on 03/18/1936
- (3) 17.45 ft on 06/22/1972
- (4) 16.29 ft on 05/19/1988
- (5) 15.81 ft on 11/13/1970

[Crest Flow Information](#)



Impacts

10.0 water begins to overflow low lying area.

ATTACHMENT "N"

OTHER STREAMS FOR OBSERVERS

Place	County	State	Type	Elevation*	USGS Quad	Lat	Lon
Bullskin Run	Jefferson	WV	stream	unknown	Round Hill	39.210°N	77.829°W
Cattail Run	Jefferson	WV	stream	unknown	Charles Town	39.277°N	77.789°W
Dry Run	Jefferson	WV	stream	unknown	Middleway	39.370°N	77.943°W
Elk Branch	Jefferson	WV	stream	unknown	Charles Town	39.337°N	77.775°W
Elks Run	Jefferson	WV	stream	unknown	Charles Town	39.335°N	77.758°W
Evitts Run	Jefferson	WV	stream	unknown	Charles Town	39.254°N	77.818°W
Flowing Springs Run	Jefferson	WV	stream	unknown	Charles Town	39.292°N	77.786°W
Forge Run	Jefferson	WV	stream	unknown	Charles Town	39.258°N	77.784°W
Furnace Run	Jefferson	WV	stream	unknown	Round Hill	39.226°N	77.817°W
Hog Run	Jefferson	WV	stream	unknown	Round Hill	39.164°N	77.854°W
Hopewell Run	Jefferson	WV	stream	unknown	Middleway	39.374°N	77.943°W
Long Marsh Run	Jefferson	WV	stream	unknown	Round Hill	39.184°N	77.852°W
North Fork Bullskin Run	Jefferson	WV	stream	unknown	Berryville	39.230°N	77.879°W
Rattlesnake Run	Jefferson	WV	stream	unknown	Shepherdstown	39.419°N	77.752°W
Rocky Branch	Jefferson	WV	stream	unknown	Round Hill	39.151°N	77.861°W
Shaw Run	Jefferson	WV	stream	unknown	Martinsburg	39.406°N	77.930°W
Town Run	Jefferson	WV	stream	unknown	Shepherdstown	39.434°N	77.801°W
Turkey Run	Jefferson	WV	stream	unknown	Inwood	39.309°N	78.003°W

ATTACHMENT "O"

SPRINGS TO BE OBSERVED TO CAUSE FLOODING

Place	County	State	Type	Elevation*	USGS Quad	Lat	Lon
Adams Farm Spring	Jefferson	WV	spring	465 feet	Berryville	39.206°N	77.901°W
Aldridge Spring	Jefferson	WV	spring	560 feet	Middleway	39.301°N	77.919°W
Baker Farm Spring	Jefferson	WV	spring	500 feet	Berryville	39.241°N	77.910°W
Balch Spring	Jefferson	WV	spring	460 feet	Middleway	39.353°N	77.931°W
Barr Spring	Jefferson	WV	spring	470 feet	Harpers Ferry	39.325°N	77.738°W
Beasley Spring	Jefferson	WV	spring	450 feet	Shepherdstown	39.421°N	77.813°W
Billmeyer Farm Spring	Jefferson	WV	spring	440 feet	Shepherdstown	39.417°N	77.825°W
Byrd Spring	Jefferson	WV	spring	510 feet	Middleway	39.263°N	77.903°W
Cammack Spring	Jefferson	WV	spring	420 feet	Charles Town	39.288°N	77.838°W
Capper Farm Spring	Jefferson	WV	spring	440 feet	Middleway	39.298°N	78.000°W
Claymont Court Spring	Jefferson	WV	spring	510 feet	Middleway	39.263°N	77.909°W
Claymont Court Spring	Jefferson	WV	spring	510 feet	Middleway	39.263°N	77.903°W
Claymont Paige Spring	Jefferson	WV	spring	520 feet	Middleway	39.263°N	77.903°W
Claymont Springs	Jefferson	WV	spring	520 feet	Middleway	39.263°N	77.909°W
Clipp Spring	Jefferson	WV	spring	395 feet	Charles Town	39.251°N	77.839°W
Cool Spring	Jefferson	WV	spring	unknown	Middleway	39.250°N	77.937°W
Dailey Farm Spring	Jefferson	WV	spring	400 feet	Charles Town	39.259°N	77.823°W
Downs Farm Spring	Jefferson	WV	spring	460 feet	Shepherdstown	39.427°N	77.836°W
Dr Boyd Farm Spring	Jefferson	WV	spring	440 feet	Berryville	39.177°N	77.894°W
Dr Frey Farm Spring	Jefferson	WV	spring	450 feet	Berryville	39.198°N	77.898°W
Dr Langdon Farm Spring	Jefferson	WV	spring	420 feet	Berryville	39.184°N	77.876°W
Elmwood Farm Spring	Jefferson	WV	spring	460 feet	Shepherdstown	39.395°N	77.814°W
Engle Spring	Jefferson	WV	spring	520 feet	Middleway	39.298°N	77.899°W
Fairfax Grant Farm Springs	Jefferson	WV	spring	460 feet	Berryville	39.244°N	77.928°W
Falling Spring	Jefferson	WV	spring	420 feet	Shepherdstown	39.419°N	77.811°W
Flowering Springs	Jefferson	WV	spring	460 feet	Charles Town	39.311°N	77.844°W
General Darkes Home Spring	Jefferson	WV	spring	460 feet	Charles Town	39.362°N	77.821°W
General Horace Gates Farm Spring	Jefferson	WV	spring	500 feet	Martinsburg	39.386°N	77.902°W
George Washington Cavern Pool...	Jefferson	WV	spring	475 feet	Charles Town	39.255°N	77.858°W
Grey Spring	Jefferson	WV	spring	480 feet	Middleway	39.344°N	77.930°W
Harpers Ferry Spring	Jefferson	WV	spring	320 feet	Charles Town	39.336°N	77.769°W
Harrison Farm Spring	Jefferson	WV	spring	585 feet	Berryville	39.249°N	77.938°W
Head Spring	Jefferson	WV	spring	600 feet	Berryville	39.239°N	77.958°W
Henry Baker Farm Spring	Jefferson	WV	spring	480 feet	Berryville	39.239°N	77.903°W
Hostler Spring	Jefferson	WV	spring	480 feet	Charles Town	39.257°N	77.780°W
John Bayles Farm Spring	Jefferson	WV	spring	600 feet	Round Hill	39.198°N	77.818°W
Johnson Springs	Jefferson	WV	spring	520 feet	Charles Town	39.250°N	77.807°W
Joseph Bell Farm Spring	Jefferson	WV	spring	500 feet	Berryville	39.236°N	77.898°W
Keller and Lackey Farms Springs	Jefferson	WV	spring	440 feet	Berryville	39.243°N	77.920°W

JEFFERSON COUNTY FLOOD WARNING PLAN & OPERATIONS

May 2005

Klein Spring	Jefferson	WV	spring	620 feet	Harpers Ferry	39.308°N	77.747°W
Lippett Springs	Jefferson	WV	spring	500 feet	Berryville	39.201°N	77.918°W
Locust Hill Farm Spring	Jefferson	WV	spring	500 feet	Berryville	39.239°N	77.916°W
Maisie Ware Farm Spring	Jefferson	WV	spring	400 feet	Round Hill	39.186°N	77.869°W
Maple Shade Farm Spring	Jefferson	WV	spring	380 feet	Shepherdstown	39.484°N	77.811°W
Marist College Camp Spring	Jefferson	WV	spring	340 feet	Charles Town	39.364°N	77.750°W
Marlow Farm Spring	Jefferson	WV	spring	400 feet	Charles Town	39.293°N	77.812°W
McQuilkin Farm Spring	Jefferson	WV	spring	460 feet	Shepherdstown	39.432°N	77.845°W
Melvin Farm Spring	Jefferson	WV	spring	500 feet	Charles Town	39.362°N	77.833°W
Meyer Spring	Jefferson	WV	spring	340 feet	Charles Town	39.333°N	77.766°W
Meyers Farm Spring	Jefferson	WV	spring	600 feet	Round Hill	39.195°N	77.819°W
Meyersdale Farm Spring	Jefferson	WV	spring	480 feet	Charles Town	39.341°N	77.829°W
Morgan Spring	Jefferson	WV	spring	440 feet	Shepherdstown	39.420°N	77.822°W
Mountain Mission Spring	Jefferson	WV	spring	580 feet	Round Hill	39.250°N	77.798°W
Opequon Spring	Jefferson	WV	spring	460 feet	Inwood	39.300°N	78.010°W
Owens Farm Spring	Jefferson	WV	spring	500 feet	Middleway	39.336°N	77.938°W
Piedmont Farm Spring	Jefferson	WV	spring	540 feet	Middleway	39.298°N	77.885°W
Rippling Spring	Jefferson	WV	spring	300 feet	Shepherdstown	39.384°N	77.753°W
Robert Smith Farm Spring	Jefferson	WV	spring	440 feet	Round Hill	39.202°N	77.875°W
Rock Spring	Jefferson	WV	spring	440 feet	Shepherdstown	39.435°N	77.848°W
Rock Spring	Jefferson	WV	spring	520 feet	Berryville	39.244°N	77.916°W
Russel Spring	Jefferson	WV	spring	480 feet	Inwood	39.271°N	78.021°W
Schlack Farm Spring	Jefferson	WV	spring	480 feet	Middleway	39.301°N	77.998°W
Shannon Hill Spring	Jefferson	WV	spring	390 feet	Round Hill	39.231°N	77.845°W
Shannondale Blue Sulphur Spring	Jefferson	WV	spring	350 feet	Round Hill	39.230°N	77.837°W
Shannondale Red Sulphur Spring	Jefferson	WV	spring	350 feet	Round Hill	39.230°N	77.837°W
Shannondale White Sulphur Spring	Jefferson	WV	spring	350 feet	Round Hill	39.230°N	77.837°W
Southwood Spring	Jefferson	WV	spring	460 feet	Shepherdstown	39.417°N	77.870°W
Spring Hill Farm Spring	Jefferson	WV	spring	440 feet	Shepherdstown	39.467°N	77.836°W
Springdale Farm Spring	Jefferson	WV	spring	400 feet	Shepherdstown	39.473°N	77.834°W
Springdale Farm Spring	Jefferson	WV	spring	520 feet	Middleway	39.343°N	77.911°W
Stonefield Spring	Jefferson	WV	spring	400 feet	Charles Town	39.281°N	77.826°W
Tom Painter Farm Spring	Jefferson	WV	spring	560 feet	Round Hill	39.242°N	77.793°W
Turkey Run Spring	Jefferson	WV	spring	500 feet	Middleway	39.300°N	77.969°W
Van Meter Farm Spring	Jefferson	WV	spring	500 feet	Shepherdstown	39.413°N	77.846°W
Walker Spring	Jefferson	WV	spring	580 feet	Harpers Ferry	39.303°N	77.750°W
Walker and Vine Springs	Jefferson	WV	spring	580 feet	Charles Town	39.300°N	77.752°W
Warner Spring	Jefferson	WV	spring	740 feet	Harpers Ferry	39.308°N	77.746°W
Washington Spring	Jefferson	WV	spring	560 feet	Middleway	39.300°N	77.909°W
White House Spring	Jefferson	WV	spring	600 feet	Middleway	39.250°N	77.946°W
Wilt Farm Spring	Jefferson	WV	spring	400 feet	Charles Town	39.257°N	77.794°W
Wynkoop Farm Spring	Jefferson	WV	spring	480 feet	Charles Town	39.254°N	77.778°W
Wysong Spring	Jefferson	WV	spring	520 feet	Middleway	39.293°N	77.881°W