

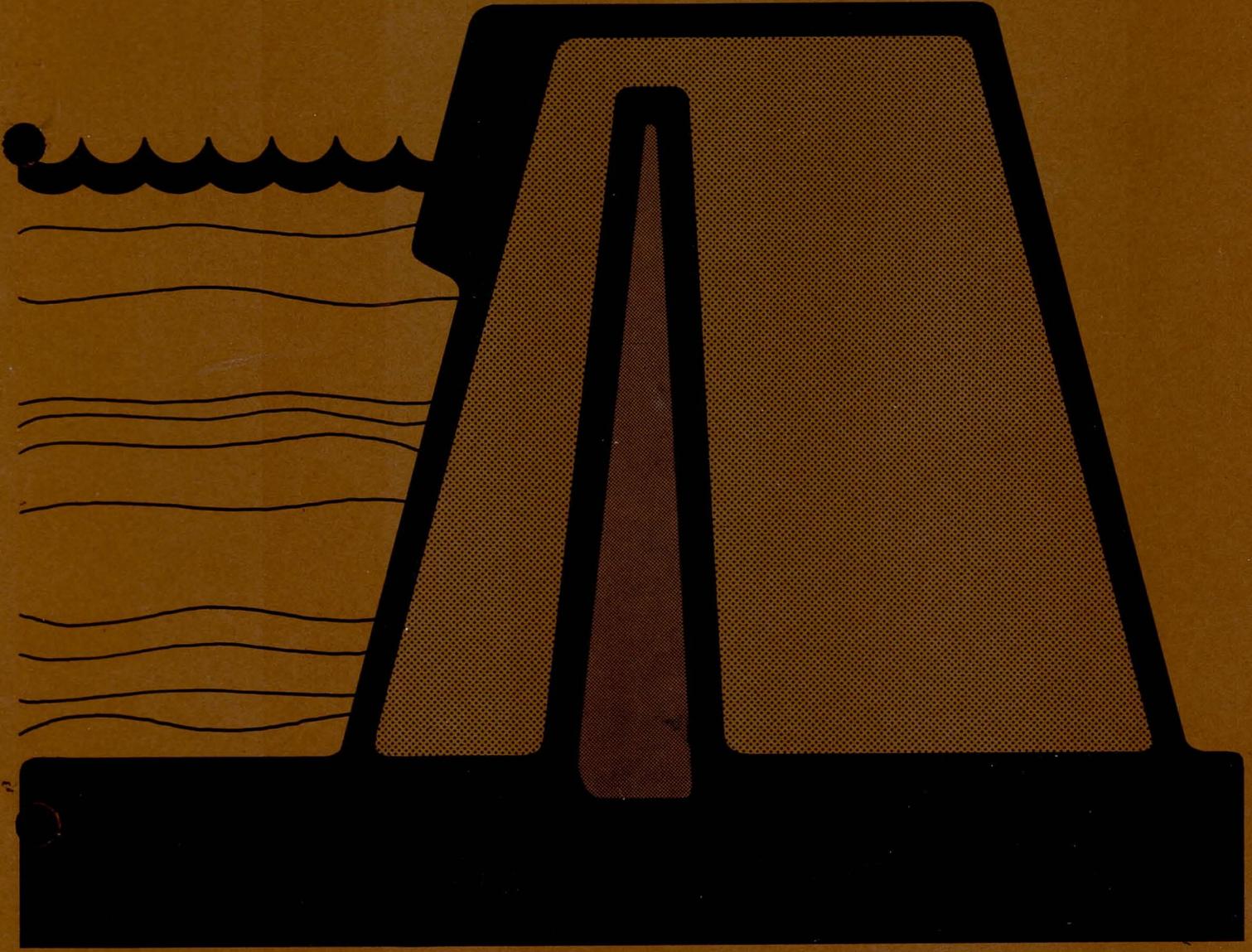
Emergency Action Planning Guidelines for Dams

FEMA 64/ February 1985



FEDERAL EMERGENCY
MANAGEMENT AGENCY

Property of
Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85009



Property of
Flood Control District of MC Library
Please Return to
2801 W. Durango
Phoenix, AZ 85009

EMERGENCY ACTION PLANNING GUIDELINES
FOR DAMS

By

Subcommittee on Emergency Action Planning
of
Interagency Committee on Dam Safety

February 1985

MEMBERSHIP LIST
ICODS SUBCOMMITTEE ON EMERGENCY ACTION PLANNING

Vernon K. Hagen, Chairman
U.S. Army Corps of Engineers

Joseph S. Haugh
Soil Conservation Service

Jerry M. Schaack
U.S. Bureau of Reclamation

W. Glen O'Neal
Tennessee Valley Authority

Harry E. Thomas
Federal Energy Regulatory Commission

Samuel D. Fischer
Forest Service

George Lear
Nuclear Regulatory Commission

David L. Sveum
U.S. Bureau of Reclamation

John Odell
Mine Safety & Health Administration

Wayne J. Graham
U.S. Bureau of Reclamation

Brian Cowan
Federal Emergency Management Agency

Brian R. Mrazik
Federal Emergency Management Agency

OTHERS CONTRIBUTING TO GUIDELINES REPORT

Sears Y. Coker
Federal Energy Regulatory Commission

Walt Furen
Forest Service

Edgar C. Roper
U.S. Bureau of Reclamation

Don W. Newton
Tennessee Valley Authority

Robert A. Shelton
Tennessee Valley Authority

Jerrold W. Gotzmer
Federal Energy Regulatory Commission

James L. Gottesman
U.S. Army Corps of Engineers

Bill Opfer
Forest Service

Larry Chapman
Tennessee Valley Authority

James A. Wolfe
Forest Service

John F. King
Tennessee Valley Authority

Harold W. Andress, Jr.
Federal Emergency Management Agency

Bill Gersch
U.S. Bureau of Reclamation

James G. Dalton
U.S. Army Corps of Engineers

CONTENTS

- I. Basic Considerations for Preparing Emergency Action Plans
 - A. Purpose 1
 - 1. General 1
 - 2. Emergency Potential 1
 - 3. Supplementation of Information 1
 - 4. Uniformity of Plans 1
 - B. Background. 1
 - 1. Federal Guidelines for Dam Safety 1
 - 2. Non-Federal Dam Inspection Program. 1
 - 3. National Research Council Committee 2
 - 4. American Society of Civil Engineers (ASCE). 2
 - 5. Waterpower '81 International Conference on Hydropower . . . 2
 - C. Scope 2
 - D. Inundation Associated with Dam Failure and Large Releases . . . 2
 - 1. General 2
 - 2. Critical Conditions 2
 - 3. Dam Break Hydrograph and Routing Procedures 3
 - 4. Flooding Information and Inundation Maps. 3
 - E. Emergency Action Plan Outline 5
 - F. Mechanisms to Ensure Effective Plans. 6
 - 1. Identification of Emergency 6
 - 2. Notification. 7
 - 3. Coordination 7
 - 4. Training of Personnel 8
 - 5. Periodic Testing 8
 - 6. Preparation and Posting of Plans 8
 - 7. Review and Revisions. 9
- II. Outline of an Emergency Action Plan
 - A. Introduction 10
 - 1. Purpose and Scope 10
 - 2. Description of Dam 10
 - 3. Hazard Area 10
 - 4. Responsibility and Authority 10
 - 5. Periodic Review, Testing and Updating 10
 - 6. Approval 10
 - B. Identification of Emergency 11
 - C. Preventive Action 11

D.	Notification and Coordination	12
	1. General	12
	2. Emergency Notification and Methods.	12
	3. Responsibility	12
	4. Use of News Media	13
	5. Alert	13
	6. Warning	13
	7. Continuing Conditions	13
E.	Evacuation	14
	1. General	14
	2. Evaluation of Existing Emergency Plans.	14
	3. Local Government Organization	14
	4. Factors to be Considered	14
F.	Emergency Termination and Follow-up	14
	1. Termination	14
	2. Security and Entry	15
	3. Critique and After-Action Report	15
	4. Other	15
G.	Hazard Area	15
	1. Description	15
	2. Conditions Assumed	15
	3. Inundation Maps	16
	4. Narrative Description	16
	Glossary	17
	Appendices	27

a - d. Examples

LIST OF FIGURES

Figure

1	Inundation Information, Urban Areas.	19
2	Inundation Information, Rural Areas.	20
3	Checklist for Dam Emergency Plans.	21

EMERGENCY ACTION PLANNING GUIDELINES
FOR DAMS

I. Basic Considerations for Preparing Emergency Action Plans

A. Purpose.

1. General. The general purpose of these guidelines is to encourage thorough and consistent emergency action planning for levels of preparedness which may save lives and reduce property damage in areas affected by dam operation or failure.

2. Emergency Potential. Whenever human habitation is located in an area that could be flooded by the operation or failure of a dam, an emergency potential is assumed to exist.

3. Supplementation of Information. The Federal Guidelines for Dam Safety defines the need for and provides general guidance on emergency action plans. However, the guidance is not specific enough for many dams owners and communities to develop meaningful emergency plans without supplemental information and guidance. This document provides specific guidance on the development of emergency action plans. It does not address the adequacy of design, construction, maintenance, or operation of dams.

4. Uniformity of Plans. The effectiveness of emergency action plans can be enhanced by promoting a uniform format which ensures that all aspects of emergency planning are covered in each plan. Uniform emergency action plans and advance coordination with local and State officials should enhance the integration of the dam owner's plans with actions of impacted communities. This is particularly important where a community is exposed to the consequences of more than one dam failing and the dams are owned by different persons or organizations.

B. Background. The following information provides various Federal and non-Federal views on the need for and content of emergency action plans.

1. Federal Guidelines for Dam Safety. An ad hoc interagency committee on dam safety of the Federal Coordinating Council for Science, Engineering, and Technology prepared, "Federal Guidelines for Dam Safety" which was published June 25, 1979. This activity was directed by Presidential Memorandum dated April 23, 1977. A second Presidential Memorandum dated October 4, 1979 directed Federal agencies to adopt and implement the Federal Guidelines. Part D3 of the guidelines outlines the need for and the essential elements of emergency action planning.

2. Non-Federal Dam Inspection Program. In 1981 the U.S. Army Corps of Engineers completed inspection of nearly 9,000 non-Federal dams. This national inspection program was carried out in accordance with Public Law 92-367. The dams inspected were those located where loss of life and major

property damage would likely occur in the event of dam failure. Results of the inspection indicated that about one-third of the dams inspected were unsafe. This determination was made from criteria established by the Corps of Engineers. Wherever a dam was designated as unsafe, the Corps of Engineers generally recommended the immediate preparation of an emergency action plan. However, all dams which could cause adverse consequences in the event of failure need emergency action plans. As indicated in the Federal Guidelines, sound integrity of the dam is not a basis to avoid preparation of emergency plans.

3. National Research Council Committee. In keeping with its role as the lead Federal agency in coordinating Federal dam safety activities, the Federal Emergency Management Agency (FEMA) contracted with the National Research Council (NRC) to provide recommendations regarding the Federal role in safety assurance of non-Federal dams. The NRC committee completed its first phase assessment and provided FEMA with the following recommendations related to emergency action planning:

(a) Federal Involvement in Non-Federal Dams. Prepare guidelines for emergency preparedness plans for non-Federal dams initially engineered and constructed with Federal assistance;

(b) Imperative Needs. Developing guidance for emergency preparedness planning;

(c) Second Phase Study. Emergency preparedness planning; develop a model plan for voluntary use by the states.

4. American Society of Civil Engineers (ASCE). The Subcommittee on Dam Safety of the ASCE National Water Policy Committee prepared a position paper on responsibility for dam safety. This paper was adopted by the ASCE Board of Directors on May 9, 1981. A portion of the position paper reads as follows:

"For a dam that represents a significant or high potential hazard to downstream areas, detailed standard project operations plans to protect public safety should be developed, particularly for operations during extreme flood conditions, when primary communications systems may not function. In addition, contingency plans for emergency project operations, notifications to civil authorities, and warning of need for evacuation should be developed for use when the safety of the dam is threatened. The plan should define areas that could be inundated and should be coordinated with local law enforcement and civil defense authorities."

5. Waterpower '81 International Conference on Hydropower. In a paper titled, "Mitigation of Impacts-Emergency Action Plans," which was presented at the Waterpower Conference, Messrs. Dresdner and Stachle discuss the private sector views on needs for emergency action plans. They point out that in the event of a project emergency, there are two emergency plans to be implemented. The emergency action plan of the dam owner must be augmented by a local response plan. The authors conclude: "To assure maximum safety, the two plans must function as one coordinated plan when implemented during an actual emergency. Warning and response cannot be separated; neither can emergency

actions internal and external to the facility be performed in isolation of each other."

C. Scope. This document contains guidelines for preparing emergency action plans for those dams which, if they were to fail, would be likely to cause loss of life or extensive property damage. Development of the flood plain downstream from dams varies, therefore, the potential loss of life from each dam failure is different. A greater level of detail should be used in the preparation of emergency action plans when the potential for loss is large than when it is small.

Emergency action plans generally contain six basic elements. The elements are identification of emergency, preventive action, notification and coordination, hazard area delineation, evacuation, and termination and follow-up. All of these items are discussed. The dam owner is responsible for much of the plan development; however, the impacted communities need to prepare and implement the evacuation plan element. Coordination is essential between the dam owner and communities involved as well as with appropriate local, county, state, and federal entities.

The purposes of these guidelines are more likely to be achieved if methods are readily available for predicting and detecting dam failures. Early discovery of hazardous situations allows the initiation of efforts to prevent or delay dam failure and provides additional time for issuing warnings to flood plain occupants. Many lives may be saved when dam failure is predicted or detected early in the failure process. Conversely, large numbers of lives may be lost when a dam failure occurs without advance knowledge of the pending failure. Although the importance and need for prediction/detection systems or processes are identified, the development and presentation of such information is beyond the scope of these guidelines.

D. Inundation Associated with Dam Failures and Large Releases

1. General. Information on flooded areas and warning times are essential to the development of notification and evacuation plans. This information may be obtained from evaluations of a postulated dam failure or major flood and subsequent routing of the resulting flows downstream.

2. Critical Conditions. Several different assumptions could be made regarding the appropriate condition prevailing at the time of a dam break. A "fair weather" dam break is generally considered to have the most potential for loss of life. Therefore, the "fair weather" dam break is selected as the minimum condition to be used in these guidelines. The normal full pool (top of flood control storage or other active storage, excluding surcharge) should be the reservoir level assumed for the dam break flood. Failures at other higher pool level situations such as a flood overtopping the dam should be considered and should be used if they are critical in terms of potential loss of life. This is particularly important for some mine tailings dams.

In addition to the failure condition, information regarding the inflow design flood or other large flood should be included to depict both upstream and downstream flood levels for the nonfailure condition. Generally, the flood

selected should be sufficiently large to cause significant discharge through the spillway and associated significant downstream flooding without a failure. The flood selected should be shown in the plan, such as, probable maximum flood (PMF), 1/2 PMF, or 18" rainfall in 24 hours.

The differences in flooded areas may be large enough to warrant identifying different evacuation areas for different flood or failure conditions. If appropriate, these areas should be identified in the EAP.

3. Dam Break Hydrograph and Routing Procedures. Several factors usually have to be evaluated whenever dam failures are postulated. The type of dam and the mechanism which could cause failure require careful consideration if a realistic breach is to be assumed. Size and shape of the breach, time of breach formation, hydraulic head, and storage in the reservoir contribute to the dam failure hydrograph. Most of the methods for estimating dam break hydrographs require the choice of size, shape, and time of dam breach. However, simplified techniques do not require an estimate of the size and shape of the breach or the time of breach formation. There are also several available procedures for routing dam failure hydrographs to determine information on areas inundated by the flood as it travels downstream. To avoid unnecessary study and costs, the routing should cease at a point where real-time flood warning information can be provided on a pre-planned basis.

Many methods for developing the dam failure hydrograph and routing dam break flows downstream are available and equally acceptable. Regardless of the method used, all emergency action plans for communities and other affected areas in a watershed should be developed to the extent practicable using the same computational procedures to ensure coordination, compatibility, and acceptance. Many Federal agencies have developed procedures that are available upon request. They may be obtained from the National Weather Service, Bureau of Reclamation, Soil Conservation Service, Corps of Engineers, Tennessee Valley Authority, Geological Survey and Federal Emergency Management Agency. Procedures developed by the National Weather Service (NWS) are the most widely used. Simplified NWS procedures are readily available from the nearest FEMA office. However, considerations for using the detailed procedure should be coordinated with NWS.

4. Flooding Information and Inundation Maps.

(a) Mapping. Whenever communities or significant numbers of dwellings are located in the flood plain downstream of a dam, an inundation map is usually needed to develop an adequate evacuation plan. These maps should show an outline of the area covered by the dam break flood in enough detail to identify dwellings and other significant features that are likely to be directly affected. This is generally accomplished by superimposing the flood outline on a existing map. Additional data included on the maps are estimated flood travel time and depth at selected locations. The maps should be of sufficient scale and detail to identify clearly the areas which would be flooded if large flows occur from dam failure, misoperation, or extreme storms. Clarity and simplicity are important. Therefore, the map scale should be such that all important features can be identified. A typical

example of an inundation map for an urban area is shown in Figure 1. These same maps may be used to show planned evacuation routes. However, the limitations of the map should be identified.

Generally, an inundation map depicting both the breach and large flood condition should be included in the plan. Although additional conditions could be used, caution should be used to keep the map from becoming cluttered and to keep the plan simple enough to be clear and understandable. Generalized breach inundation maps may be used in the plan if sufficient for clearly depicting the inundated areas. Generalized maps may need to be supplemented with larger scale and more detailed maps in some areas. The mapping and the number of different flooded areas should be coordinated with local officials who are developing evacuation plans. It may be appropriate to supplement the inundation maps with water surface profiles in critical areas.

For detailed maps, it is recommended that the best available maps for evacuation planning should be used. This may be topographic or orthographic mapping or street maps. The lines delineating the inundated area should be drawn in such thickness or form (solid line, dashed line, dotted line) as to identify the inundation limits as the main features of the map but not bold enough to obliterate features which would be inundated by the flood waters. When plotting inundation limits between cross sections used for the analysis, the lines should reasonably reflect the change in water levels caused by topographic patterns and man-made features.

When inundation lines enter the area of an existing lake or reservoir, they should represent an increase in the water level of such lake or reservoir. Should this increased water level overtop the dam, the appropriate inundation lines should extend downstream of such dam.

For dams not in series but which affect a common downstream area, it is usually adequate to consider the breach condition for each dam individually unless special conditions would warrant multiple failure considerations. Breach inundation lines of such dams then should consist of a line enveloping the lines for the individual breaches when common areas would be inundated.

(b) Other Methods. Development of the flood plain below some dams is sparse and the expense of preparing inundation maps may not be warranted. Flooding information can be readily provided by vicinity maps with pertinent information at the key locations. Individuals living between key locations can estimate their vulnerability by interpolating data from locations upstream and downstream of their site. Information on depth of flooding and time of travel for floods to reach specific locations is also provided as illustrated in Figure 2.

E. Emergency Action Plan Outline. Chapter II provides a suggested outline for an emergency action plan (EAP).

An emergency action plan should be tailored to the specific dam or system of dams. The amount of detail for a specific dam may be more or less than that shown in this outline. Thus, the outline is not intended to be all inclusive, but rather to guide the user and to provide a uniform format. Dams

affecting a small population may have brief, simple emergency plans with due considerations given to the need for redundant features if only a short warning time is available. Dams affecting large populations may require more elaborate plans. Therefore, flexibility is provided for individual decisions regarding format and other decisions.

Emergency action plans must be very specific for the following reasons:

- o Emergency action plans are subject to testing, but not under conditions approaching those likely to prevail in the event they must be put to actual use. The only way to assure their workability is through careful consideration of each important detail.
- o Plans are expected to be activated only under hurried and stressful conditions. Consequently, plans which are vague or which require significant interpretation to decide appropriate action may lead to serious adverse consequences.
- o Plans contain some portions which are made up largely of interorganizational arrangements subject to a number of complex legal, institutional, sociological, and other influences. Coordination efforts must be well planned and agreed on.

Plans which identify only what is to be done conceptually under various circumstances are inadequate. Plans must identify emergency situations that require action, designate prescribed actions and who is responsible for taking those actions, identify sources of equipment, material and labor to accomplish the prescribed actions, and other similar details.

The word "dam" as used in this basic outline should also be interpreted to include "a system of dams" in those situations where more than one dam affects a common area.

In the event that a plan for emergencies already exists for the affected area, particularly for flood related emergencies, it may be appropriate for the EAP, addressing those items specific to the dam emergency, to be added as an annex or addendum to the existing plan.

F. Mechanisms to Ensure Effective Plans. Emergency action plans are dynamic and require constant attention to changes and updating. They also require participation by individuals fully knowledgeable about the plan and its implementation. The following paragraphs describe how this is accomplished.

1. Identification of Emergency. Procedures and means for assuring timely and reliable identification and evaluation of existing or potential emergencies are a primary concern. Major elements of these procedures are:

- o Listing of the conditions or events which could lead to or indicate an existing or potential emergency. Include situations involving flood emergencies due to a breach as well as a major flood without a breach. Breach conditions could occur as a result of piping, floods, earthquake or sabotage;

o Description of the means by which potential emergencies will be identified including data and information collection system, monitoring arrangements, surveillance, inspection procedures and other provisions for early detection of conditions indicating an existing or potential emergency;

o Procedures, aids, instructions, and other provisions for interpreting information and data to assess the severity and magnitude of any existing or potential emergency; and

o Designation of the person responsible for evaluating the emergency. Normally, this would be the owner or employee of the owner. However, if the owner does not have the proper technical expertise available, this responsibility may need to be assigned to another individual. Ensure that continuous coverage is provided by designating appropriate alternates.

At unattended dams, special consideration should be given to the need for surveillance. Since any emergency action plan has little value unless it can be implemented in a timely manner, the surveillance should be evaluated to ensure that the greatest practicable time will be available for necessary notification of responsible officials and warning the public. An audible/visual alarm could enhance the reliability of any warning system that is based on instrumentation since it would quickly bring to attention the existence of a potential problem. The operation of any such electronic surveillance system in adverse conditions should be evaluated in advance. Because false alarms could occur, consideration should be given to the time required to travel to the dam to conduct an inspection of the dam to verify the emergency once the alarm is received. The advisability of inspecting the dam prior to evacuation will depend on the condition causing the alarm and the time required to evaluate the condition. If the time required for a visual check is unacceptably long, then backup instrumentation or other measures should be considered.

2. Notification. For an emergency action plan to be effective, all persons having a role in correcting potentially dangerous conditions at the dam or evacuating persons endangered by the dam failure must be aware of their role and notified in an emergency. Communication links, both primary and backup, should be established which will operate reliably in the extreme flood and earthquake conditions which could cause dam failure. All critical positions in the notification network should be covered 24 hours a day, 7 days a week. Chapter II which outlines the elements to an effective flood warning plan identifies persons and agencies to be notified in sections II C, Preventive Action, and D, Notification and Coordination. Order of notification must be prioritized.

3. Coordination. Coordination with State and local officials responsible for warning and evacuation of the public is essential to ensure that there is agreement on their individual and group responsibilities. Participation in the preparation of the plan will enhance their confidence in the plan and in the accuracy of its components. Coordination will provide opportunities for discussion and determination of the order in which public officials would be notified, backup personnel, alternate means of communication, and special

procedures for nighttime, holidays, weekends, etc. Differences in procedures for notification in the event of a slowly developing emergency, a rapidly developing emergency, and an almost instantaneous emergency, as in an earthquake, should also be coordinated prior to finalizing the notification plan(s).

4. Training of Personnel. Training of personnel involved in the emergency action plan should be conducted to ensure that they are thoroughly familiar with all elements of the plan, availability of equipment and their duties thereunder. Technically qualified project personnel should be trained in problem detection, evaluation, and appropriate remedial (emergency and non-emergency) measures. This is essential for proper evaluation of developing situations at all levels of responsibility which, initially, must be based on onsite observations. A sufficient number of personnel should be trained to assure adequate coverage at all times. A training plan could be included in an appendix to the emergency action plan. Exercises simulating dam failures are excellent training mechanisms for assuring readiness. Cross-training in more than one responsible position for each individual is advisable in order to provide alternates. A careful record by roster should be kept of training completed and refresher training conducted.

5. Periodic Testing. The dam owner should prepare scenarios for slowly developing, rapidly developing, and instantaneous emergencies and test the state of training and readiness of key personnel responsible for actions during an emergency, to assure that they know and understand the procedures to be followed and actions required. Any special procedures required for nighttime, weekends, and holidays should also be included. The tests should include a drill simulating emergency conditions. Coordination and consultation with local government, law enforcement officials, and other organizations involved is desirable in order to enhance the realism of the test. Their involvement will perfect the close coordination with agencies necessary for a successful execution of the plan in an actual emergency. The tests should be critiqued in writing and the plan should be revised to correct any deficiencies noted.

6. Preparation and Posting of Plan(s). Notification plan(s) should include a list of individual names and position titles; location; office and home telephone numbers; and radio communication frequencies and call signals, if available, for owner personnel, public officials, and other personnel, including alternates, who should be notified as soon as emergency situations develop. The list should clearly indicate, for each developing condition, who is responsible for the notification of which owner representative(s) and/or public official(s), and in what priority.

The number of persons to be notified by each responsible individual in the notification plan should be governed by what other responsibilities the person has been assigned. No one person should be required to notify more than three or four (preferably three or less) individuals, since that would take too long and leave no time for effective mitigation activities.

Each notification plan should be brief, simple, and easy to implement under emergency conditions. The list of critical personnel to be notified by

dam owner representative(s) should be limited normally to one page for each failure followed by such supplementing information as may be necessary.

A copy of each notification plan should be posted in a prominent location readily accessible at the project site near a telephone and/or radio transmitter. Copies of the notification plans should also be available at the home and office of each person involved. All personnel involved should be familiar with the plans and the procedures they are to follow in the event of an emergency.

7. Review and Revisions. Plans should be updated promptly after each change in involved personnel or their telephone numbers. The dam owner and local governmental officials should conduct a comprehensive review of the adequacy of the emergency action plan at intervals not to exceed 1 year. In this review, a determination of any new developments in guidelines or changes in human habitation downstream or in the reservoir area should be made to determine whether any revisions to the current plan are necessary. These revisions will be in consultation with the appropriate public agencies involved. Reviews should be conducted on the same date each review period. If no revision is necessary, a statement that the review was made and no revision to the plan was necessary should be provided to each recipient of the original plan. Figure 3 provides a suggested checklist developed by the General Accounting Office for use in reviewing the adequacy of an Emergency Action Plan.

Copies of the revisions resulting from updating the plans, annual tests, and reviews should be furnished to all individuals to whom the original plan was distributed. A procedure should be established to ensure that all copies of the plan are revised.

II. Outline of an Emergency Action Plan

A. Introduction.

1. Purpose and Scope. The Emergency Action Plan (EAP) should provide a brief statement of purpose and scope such as: "The purpose of this emergency action plan (EAP) is primarily to safeguard the lives and secondarily to reduce property damage of the citizens of Adams County, living along Spring Creek in the event of flooding caused by large runoff or failure of the Stoney Creek Dam."

2. Description of Dam. Provide a brief description of the dam including location, purpose, name of owner, date built. If more detail is needed, such as height, maximum storage capacity or other physical data, include an Appendix.

3. Hazard Area. Provide a brief description of the area that would be impacted by a breach or major flooding. Inclusion of a sketch or schematic may be appropriate here although detailed inundation maps and descriptions would generally be included in Section II G.

4. Responsibility and Authority. Indicate the person or organization responsible for the maintenance and operation of the dam and the persons or groups responsible for implementing various phases of the EAP. The basic authority for carrying out the various components of the EAP should also be cited.

5. Periodic Review, Testing, and Updating. This section should provide the basis to update, extend, and improve the emergency action plan and to ensure readiness for executing the plan.

Include a schedule for carrying out periodic reviews of the plan by the participants at intervals not to exceed 1 year with updating for changes in telephone numbers and personnel as they occur.

Include procedures and schedules for periodic testing of the plan. Special procedures for those aspects of the plan not susceptible to direct testing should be established and periodic exercises simulating emergencies carried out. Consideration should be given to updating (such as use of "controlled copies"), whereby plan holders are advised of any changes.

6. Approval. This section should provide the means by which all parties to the plan agree to their responsibilities. The following is an example of a format that could be used:

We, the undersigned, this date acknowledge this (Annex or Plan) as a part of the emergency operation procedure to protect life and reduce property damage in case of an emergency at the Stoney Creek Dam.

Signature, I.M. Damowner

Date

Signature, County Sheriff, Adams County

Date

Signature, Mayor, City of Springfield

Date

Signature, Director, Springfield
Civil Defense

Date

Signature, Chief, Springfield Police
Department

Date

B. Identification of Emergency.

The procedures and means for assuring timely and reliable identification and evaluation of potential or existing emergencies should be included. These would normally explain the events or conditions which indicate an emergency; describe the data and information collection system; describe the analysis process; designate the responsible person(s); and ensure continuous coverage through designation of appropriate alternatives. (See Section I-F1.)

For unattended dams, the surveillance and warning system should be described along with the expected reliability and backup system in place to assure that warning is given in the event of failure in the primary system.

C. Preventive Action.

This section should discuss those preventive actions that need to be taken at the dam to prevent or delay failure after an emergency is first discovered. Because of uncertainties about their effectiveness, preventive actions usually would be carried out simultaneously with appropriate notification of an alert situation or warning situation (see Section II D).

The dam owner should designate a person who has the authority to make needed decisions and authorize immediate expenditures so that repair work will not be delayed.

This section should identify sources of repair equipment, materials, and labor; engineering expertise; and underwater examiners for use during an emergency. The materials portion should include sources for clay, sand, gravel, stone, riprap, sandbags, cement, plastic sheeting, etc. The anticipated need for the above items (equipment, materials, etc.) should be evaluated for each dam and the specific needs and the exact location of each of these items should be stated.

At some dams, it is desirable to stockpile suitable construction materials for emergency use. The amounts and type of construction materials needed for emergency repairs should be determined on the basis of the structural, foundation, and other characteristics of the dam, design and construction history, and history of prior problems.

Prior arrangements for use of materials, labor, and equipment should be made if they will not be at the dam site.

D. Notification and Coordination

1. General. A mandatory first step in the entire notification chain of events is the first identification that there is or could be a problem at the dam as stated in Section II B. The chain of events usually proceeds from the owner, to a local or state government, who, in turn, contacts local police and/or civil defense groups. They may contact local news media, and finally the public who are expected to take some specific actions such as evacuation. The National Weather Service (NWS) has the general responsibility for issuing flood warnings. Therefore, the plan should include its notification of any pending or actual dam failure so that NWS facilities could be used to help disseminate the warnings. The details of the specific steps and responsibilities of each member in this chain of notification and the expected response must be clearly defined in the plan and should be prioritized. (See Sections I-F2 and I-F3.)

2. Emergency Notification and Methods. The responsibility for notifying officials of a dam emergency should be determined. For a slowly developing failure, the owner may wish to reserve this responsibility for management. For an imminent or actual failure, this responsibility may have to be delegated to the dam operator or local official who can quickly evaluate the seriousness of the problem. The responsibility should be clearly outlined in the plan. The method of notification should ensure that the message can be delivered. Primary and backup communication links should be established which offer reliable operation in the extreme flood, and earthquake situation which could cause dam failure.

3. Responsibility. Responsibility for the decision to proceed with the warning and evacuation of affected occupants generally rests with local and State authorities. In addition to residents, affected area occupants may also

include operators of water-related facilities (including resort owners, boat rental concessionaires, and campground operators), users of recreation facilities, and other people who could be endangered.

To the extent possible, emergency situations that would require immediate notification of public officials in time to allow evacuation of the potentially affected areas should be predefined and documented. If sufficient time is available, the decision to notify public officials of an emergency can be made by the owner or by a predetermined employee in the dam owner organization. If failure is imminent or has already occurred, project personnel at the damsite should be directed to notify the public officials. The urgency of the situation should be made clear so that public officials will take positive action immediately.

4. Use of News Media. The news media, including radio, television, and newspapers, should be utilized to the extent available and appropriate. Use of news media should be preplanned to the extent possible by the dam owner or public officials. Notification to the news media may be by the dam owner or public officials depending on the type of emergency. Notification plans should define emergency situations for which each medium will be utilized and should include an example of a news release that would be the most effective for each possible emergency. Information for media ordinarily should not be relied upon as the primary means of warning.

5. Alert. An ALERT situation is used to provide notice that although failure or flooding is not imminent, a more serious situation could occur unless conditions improve. Local officials and residents in affected areas should be alerted that an unsafe situation could be developing. Examples would be: a full reservoir with additional rainfall or snowmelt in the forecast that could cause discharge through auxiliary spillways or over-topping; or a dam that is leaking excessively but is not yet a hazardous situation.

6. Warning. A WARNING situation is to indicate that flooding is imminent either as a result of high runoff or an impending failure of the dam. It would normally include an order for evacuation of delineated inundation areas.

Wherever possible, the warning and evacuation procedures for a dam emergency should follow any standard operational procedure already established. The difference in dam emergency events may be the elements of time and size or dimension of hazard. The warning for a dam emergency must be specific and address these elements. When possible, more than one means of communicating warnings should be planned and repetitively issued. Consideration should be given to disseminating the warning to any non-English speaking populace in their language.

7. Continuing Conditions. The person responsible for monitoring the dam should keep local authorities informed of developing conditions at the dam from the time of initial determination that an emergency exists until the emergency has been terminated. The emergency action plan should delineate responsibility for, and the frequency of, conducting and reporting the results

of the continued onsite examination and evaluation of conditions until the emergency is terminated. It should also contain procedures for the initiation of preventive action, as indicated in Section II-C.

E. Evacuation.

1. General. Evacuation planning and implementation are the responsibility of the State(s) and local officials having responsibility in areas that would be inundated by flood releases or failure of a dam.

2. Evaluation of Existing Emergency Plans. A review of any existing emergency action plan should be made prior to the development of an evacuation portion of the EAP. This review should be coordinated with state and local officials responsible for evacuation and the dam owner. The addition of an annex to an existing plan may be sufficient. Where such a plan already exists, an assessment of the adequacy of several aspects of the plan should be made before the community decides to adopt an annex and determines what the annex needs to include.

3. Local Government Organization. This portion of the plan should discuss the various aspects and considerations of evacuating the affected public by the state and local authorities. It is based on the particular local government organization. For example, a small community with a less complex organization and a few affected flood plain residents would need only an abbreviated plan. However, even then, the action to be taken must be stated very specifically.

4. Factors to be Addressed. The following factors should be addressed in the evacuation section:

(a) Transportation. Evacuation procedures should assure that the planned routes and modes of transportation will be usable during the dam emergency. Make provisions for any necessary special assistance to evacuees such as transportation and aid to invalids or the elderly. It is possible that an existing plan supplemented by maps showing the extent of inundation, routes for evacuation, and reception centers, is all that is needed. Special care may be needed to prevent accidental travel into dangerous areas.

(b) Reception and Care. The plan should provide specific arrangement for shelter, feeding, and other care for evacuees. The community may want to indicate not only the location of centers and the care to be provided, but also what cannot be provided and what individuals should (or should not) bring with them.

F. Emergency Termination and Follow-up. An emergency action plan needs to address who and how a declared emergency will be terminated, security at the dam and downstream disaster areas, and a follow-up critique and report.

1. Termination. There are two conditions requiring a termination of the emergency. One has to do with emergency conditions at the dam and the other is related to the evacuation and disaster response. The dam owner is responsible for making the decision that an emergency condition no longer exists at the

dam. The applicable state or local emergency officials are responsible for termination of the evacuation or disaster response activities.

The owner and/or responsible state or local officials should agree upon and prepare a news release in advance which can be used by radio or television announcers to broadcast to the general public immediately. Such news releases are used to supplement other methods of notifying the public that the emergency has been terminated. News releases should be developed so that the audience will know precisely what to do when reentering or approaching the affected area.

2. Security and Entry. An emergency action plan should consider security provisions within the affected area during an emergency to protect the public and permit effective execution of emergency response actions and, following an emergency, to protect the public and ensure entry to the disaster areas.

3. Critique and After-Action Report. Following an emergency a critique should be conducted including all participants. This should discuss and evaluate the events prior to, during, and following the emergency; significant actions taken by each participant, and what improvements would be practicable for future emergencies; and all deficiencies found in procedures, materials, equipment, manpower, leadership, and funding. The results of the critique should be documented in an after-action report and used as a basis for revising the emergency action plan.

4. Other. Include arrangements addressing any other evacuation aspects as required for reoccupancy of the affected areas.

G. Hazard Area.

1. Description. The description of the area subject to inundation should be clear and concise and may be by maps and/or narrative descriptions. It should describe the specific area threatened and it should be easily read and easily understood. It should include information on the size of the expected flood relating it to known landmarks and historical flood heights.

Information on estimated flood stages, or increases in water surface elevation above normal levels should be listed for well known locations. For these same locations, an estimate of the maximum flood width, or the distance flooding will extend from the watercourse, should be provided. An estimate of the travel time of the flood wave to various locations should also be listed.

Whenever possible, major streets, railroads, or other prominent and well known features or distances from such features, should be used in developing the description.

2. Conditions Assumed. The conditions assumed in determining the hazard area for mapping should be explained since an actual emergency may portend greater or less consequence than assumed. (See Sections I-D2 and I-D3.)

3. Inundation Maps. Generally, an inundation map depicting the hazard areas determined for the assumed breach condition and the large flood without breach condition should be included with the plan.

Describe the methods used to determine inundation boundaries, maximum water surface elevations and travel times of the flood wave to significant locations.

The maps should be developed at a scale sufficient to identify features within the area subject to inundation or possible danger related to the flood. However, the accuracy and limitations of the information presented on the maps should be discussed. It may be appropriate to supplement the inundation maps with water surface profiles at critical areas. (See Section I-D4.)

4. Narrative Description. Development of the flood plain below some dams is sparse and the expense of preparing detailed inundation maps is not warranted. A narrative description of the potential flooding can be provided and supplemented by vicinity maps with pertinent information at key locations. Individuals living between key locations can estimate their vulnerability by interpolating data from locations upstream and downstream of their site. Information on depth of flooding and travel for floods to reach specific locations can also be provided.

Glossary

For the purpose of these guidelines the following definitions apply.

CONSEQUENCES. Potential loss of life or property damage downstream of a dam caused by floodwaters released at the dam or by waters released by partial or complete failure of dam. Includes effects of land slides upstream of the dam on property located around the reservoir.

DAM OR PROJECT. Any artificial barrier, including appurtenant works, which impounds or diverts water, and which (1) is twenty-five feet or more in height from the natural bed of the stream or watercourse measured at the downstream toe of the barrier or from the lowest elevation of the outside limit of the barrier if it is not across a stream channel or watercourse, to the maximum water storage elevation or (2) has an impounding capacity at maximum water storage elevation of fifty acre-feet or more. Definition does not apply to any such barrier which is not in excess of six feet in height regardless of storage capacity, or which has a storage capacity at maximum water storage elevation not in excess of fifteen acre-feet regardless of height. This lower size limitation should be waived if there is significant downstream development.

DAM FAILURE. Catastrophic type of failure characterized by the sudden, rapid, and uncontrolled release of impounded water. It is recognized that there are lesser degrees of failure and that any malfunction or abnormality outside the design assumptions and parameters which adversely affect a dam's primary function of impounding water is properly considered a failure. Such lesser degrees of failure can progressively lead to or heighten the risk of a catastrophic failure. They are, however, normally amenable to corrective action.

DAM FAILURE HYDROGRAPH. A flood hydrograph resulting from a dam breach at a specific location downstream from the dam.

EMERGENCY. A condition of serious nature which develops unexpectedly and endangers the structural integrity of a dam or endangers downstream property and human life and requires immediate action.

EMERGENCY ACTION PLAN. Formal plan of procedures to alleviate risk during construction of or after completion of a dam, or to reduce the consequences if conditions develop in which dam failure is likely or unpreventable.

FLOOD HYDROGRAPH. A graph showing, for a given point on a stream, the discharge, height or other characteristic of a flood with respect to time.

FLOOD ROUTING. A process of determining progressively over time the amplitude of a flood wave as it moves past a dam or downstream to successive points along a river or stream.

FREEBOARD. Vertical distance between a specified stillwater surface elevation and the top of the dam, without camber.

HAZARD. A situation which creates the potential for adverse consequences such as loss of life, property damage, and adverse social and environmental impacts. Impacts may be for a defined area downstream of a dam from floodwaters released through spillways and outlet works of the dam or waters released by partial or complete failure of the dam. They may also be for an area upstream of the dam from effects of backwater flooding or effects of landslides around the reservoir perimeter.

HYDROGRAPH. A graphical representation of the stage or discharge as a function of time at a particular point on a watercourse.

INFLOW DESIGN FLOOD. The flood hydrograph used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works and for determining maximum temporary storage and height of dam requirements.

MAINTENANCE. Maintaining structures and equipment in intended operating condition, equipment repair, and minor structure repair.

NOTIFICATION. To inform appropriate individuals about an emergency condition so they can take appropriate action.

RESERVOIR. An artificial lake, basin, or tank in which water can be stored.

SPILLWAY. A waterway used to convey water from a reservoir which may be either gated or ungated. Definition of specific types of spillways follows:

SERVICE SPILLWAY. A spillway that is designed to provide continuous or frequent regulated or unregulated releases from a reservoir without significant damage to either the dam or its appurtenant structures.

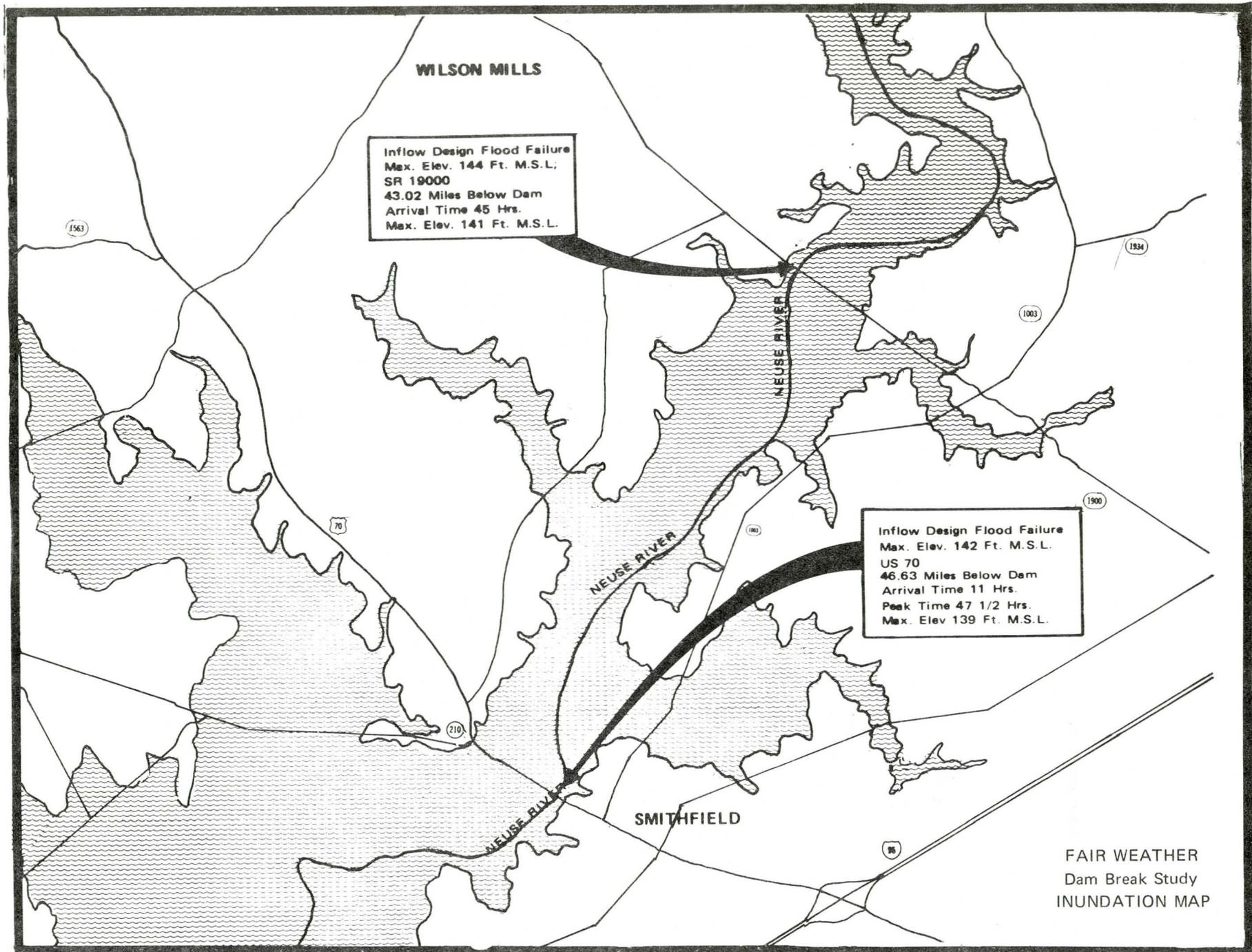
AUXILIARY SPILLWAY. Any secondary spillway which is designed to be operated very infrequently and possibly in anticipation of some degree of structural damage or erosion to the spillway during operation.

EMERGENCY SPILLWAY. A spillway that is designed to provide additional protection against overtopping of dams and is intended for use under extreme conditions such as misoperation or malfunction of the service spillway or other emergency conditions.

SAMPLE

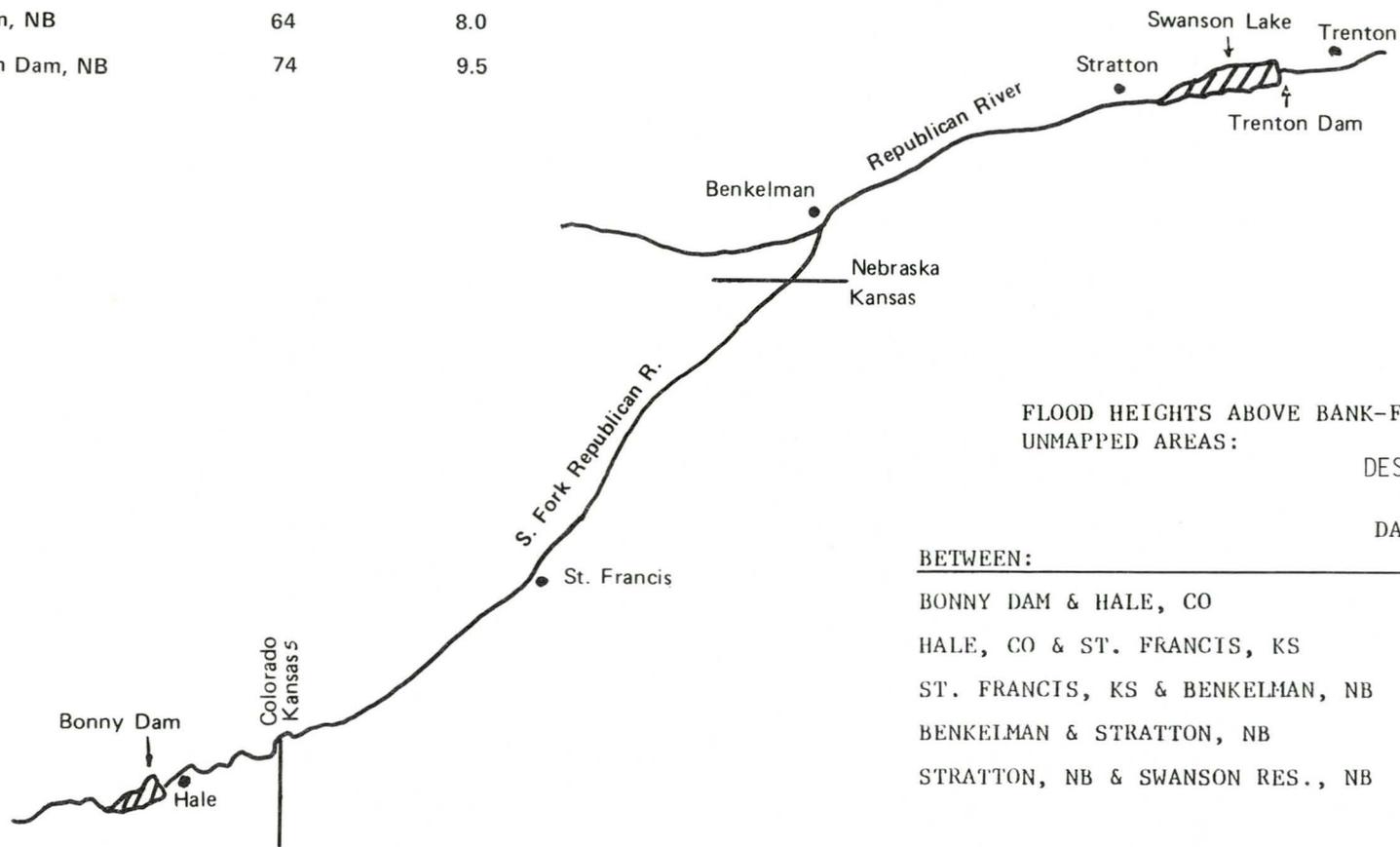
19

FIGURE 1



FAIR WEATHER
Dam Break Study
INUNDATION MAP

Location	Distance Downstream From Bonny Dam (Miles)	Flooding Begins Travel Time Dam Failure (Hours)
Hale, Co.	2	.1
St. Francis, KS	23	2.5
Benkelman, NB	48	6.0
Stratton, NB	64	8.0
Trenton Dam, NB	74	9.5



TRENTON DAM WILL NOT FAIL AS A RESULT OF BONNY DAM FAILING

FLOOD HEIGHTS ABOVE BANK-FULL STAGE IN UNMAPPED AREAS:

BETWEEN:	INFLOW DESIGN FLOOD SUDDEN DAM FAILURE (FEET)	FAIR WEATHER SUDDEN DAM FAILURE (FEET)
BONNY DAM & HALE, CO	25	22
HALE, CO & ST. FRANCIS, KS	20	18
ST. FRANCIS, KS & BENKELMAN, NB	15	13
BENKELMAN & STRATTON, NB	15	13
STRATTON, NB & SWANSON RES., NB	12	10

NOTE:

THE FLOODING DEFINED IN THE SUMMARY TABLES AND ON THE MAP SHEETS IS FOR FLOOD EVENTS WITH AN EXTREMELY RARE CHANCE OF OCCURRENCE. PUBLICATION OF THE TABLE AND MAPS DOES NOT REFLECT UPON THE SAFETY OF BONNY DAM.

BONNY DAM
COLORADO

SUMMARY TABLES AND INDEX MAP

SAMPLE

Figure 3

CHECKLIST FOR DAM EMERGENCY PLANS

I. Development of Plan

A. Overview

1. Are reporting procedures clear enough in showing what data must be collected and what information should be reported?
2. Are terms in the plan defined so that users will have no questions about the nature of the situation?
 - a. failure vs. impending failure
 - b. an emergency situation vs. a potential problem
 - c. a rapidly vs. slowly developing situation
 - d. how much time before a crisis occurs

B. Problem Identification

1. Are all potential indicators of potential failure covered in the plan?
 - a. slumping/sloughing
 - b. erosion
 - c. riprap displacement
 - d. slides on dam or abutment
 - e. increased amount of seepage
 - f. cloudy seepage
 - g. boils
 - h. piping
 - i. whirlpool (vortices)
 - j. settlement
 - k. cracks
 - l. bogs
 - m. sinkholes
 - n. abnormal instrumentation
 - o. failure of operating equipment
 - p. water in the intake tower
 - q. other
2. Are all events which could cause either a dam failure or flooding covered in the Plan?
 - a. earthquake
 - b. flooding
 - c. storms
 - d. massive landslide
 - e. volcanic eruption
 - f. fire

- g. civil disturbance
 - h. hazardous substance spills
 - i. sudden water releases
 - j. other potential disasters
3. Does the problem identification show all the possible locations of the problem?
 4. Are the above elements, indicators and events sufficiently defined so that the user can understand them?
 5. Does the plan identify the cause of the problem?
 6. Can the user ascertain the seriousness of the problem? (i.e. when the problem becomes an emergency)
 7. Can the user determine what action is needed?
 8. Can the user ascertain exactly when to notify local officials and which local officials to notify depending on the nature of the problem?
 9. Can the user determine what equipment or supplies are needed for each type of problem?
 10. Does the format of the plan easily link problem identification with the action to take, notification to make, and equipment and supplies to use?
 11. Does the plan include a list of historical problems or a list of most common problems for that type of dam?

C. Notification

1. Does the plan contain a list of key agency personnel which shows:
 - a. their office and 24 hr telephone number
 - b. their field of expertise
 - c. the name of their alternate
 - d. which officials to call first
 - e. their responsibilities
2. Does the plan show the dam tender or project manager's responsibility in the event of a total loss of communications?
3. Does the plan's format allow the user to find the name of the primary contacts quickly? Has the order of notification been prioritized?
4. Does the plan's list of local officials in charge of evacuation include:

- a. office and 24 hr telephone number
 - b. name of alternates
 - c. which officials should be contacted first
 - d. at what point officials should be called
 - e. how messages should be worded
5. Does the plan describe the communication system?
- a. normal conditions
 - b. backup
 - c. are radio call numbers and frequencies included?
 _____ for own radios
 _____ for those to be notified
6. Does the plan include procedures for downstream warning?
- a. availability of equipment
 - b. levels of responsibility for the warning
 - c. downstream operators
 - d. other dams
 - e. industries
 - f. other agencies
 - g. recreational users

D. Local Coordination

1. Was the development of the plan coordinated with local officials during the planning phase?
- a. agency input into plan
 - b. integration into the local plan
2. Do the inundation maps provide sufficient information and explanation?
- a. is language understandable,
 - b. are terms explained,
 - c. is map usage explained,
 - d. are criteria explained,
 - e. is travel time shown,
 - f. are hazardous elevations shown,
 - g. is flood plain information available.

E. Resources

1. Are resources adequately identified
- a. equipment and sources specifically described including the contact name and telephone number
 - b. supplies and suppliers specifically described including the name of the contact and telephone number

- c. repair material and erosion protection material described
- d. arrangements to share with government entities described

F. Review

1. Is there a comprehensive review of the plan at the time it is developed?
 - a. technically accurate
 - b. workable
 - c. complies with criteria
 - d. comprehensive as a whole
 - e. presented effectively

II. Implementation of Plan

A. Local Coordination

1. Were emergency plans (including notification lists and inundation maps) sent to all appropriate officials. Is a list maintained?
2. Have local officials had a briefing or other explanation of the plan? Is a record maintained?
 - a. basic project data
 - b. maps explained
 - c. communication network explained
 - d. point of contacts exchanged
 - e. notification procedures clarified
3. Have effective lines of communication for crisis conditions been set up?
4. Has agreement between dam owner and local officials been reached in relationship to roles and responsibilities during a dam crisis? Is it in writing?
5. Has the dam owner reviewed local evacuation plans and provided feedback to local officials?

B. Testing

1. Has a plan for testing plans been developed?
2. Have tests been conducted? Is a schedule of tests maintained?
3. Have the following elements of the plan been tested?
 - a. problem identification
 - b. emergency scenarios
 - c. notification of dam owner and operating staff

- d. notification of others
- e. communication system
- f. equipment

4. Were all appropriate personnel involved in the test?

- a. owner's personnel
- b. dam safety personnel
- c. maintenance personnel
- d. support staff
- e. local officials
- f. contractors and suppliers

G. Personnel and Resource Readiness

1. Are all appropriate employees familiar with the emergency plan?

2. Do all appropriate employees have access to the plan?

3. Have all appropriate personnel received training in:

- a. how to use the plan
- b. identifying a problem
- c. identifying the severity of a problem
- d. using the communication equipment
- e. using the notification subplan
- f. overall dam safety

4. Is dam attendance appropriate?

5. Are key personnel available 24 hours per day?

6. Is the division of personnel into emergency response teams appropriate?

7. Do employees understand their roles during emergencies?

8. Do key employees have access to the dam during emergencies?

9. Are resources ready?

- a. equipment available and up to date
- b. list of contractors up to date
- c. supplies on hand or readily available

H. Updating and Reviewing

1. Are plans reviewed at least annually? Periodically?

2. Are notification procedures regularly updated?

- a. names and telephone numbers of key staff

- b. names and telephone numbers of local officials
 - c. names and telephone numbers of contractors
3. Are plans reviewed for the following:
- a. tests conducted
 - b. personnel trained
 - c. communication equipment operational
 - d. other equipment operational
 - e. access to dam is clear
 - f. downstream warning system in place and operational
 - g. any new problems have been included
 - h. inundation maps are still current

APPENDICES

Appendices should be added as appropriate to supplement material in the main body of the EAP. The following are examples of some appendices that may be helpful.

a. Description of Dam

The principal features of the dam could be summarized and a schematic (sketch and/or picture) of the dam and appurtenances provided.

b. Area Map

A detailed map could be provided which shows the region surrounding the dam and access routes to the dam which could be used in flood and other emergencies.

c. Training Procedures

A section on training could be provided identifying persons and/or organizations responsible for training personnel who have responsibilities under the plan to ensure that they are aware of and familiar with their responsibilities and that they have developed the detailed procedures necessary to carry out the plan.

d. Recording Emergency Conditions

A log could be developed for recording emergency conditions, facility failures, and actions initiated and carried out.