

CHAPTER VI
EMERGENCY ACTION PLANS

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CHAPTER VI EMERGENCY ACTION PLANS

6-1 PURPOSE AND SCOPE

This chapter of the Engineering Guidelines provides the following:

1. The Commission's requirements for Emergency Action Plan (EAP) submittals and scheduling EAP exercises.
2. A basis for preparing and maintaining an effective and workable EAP in a manner consistent with Federal Guidelines.
3. Procedures and criteria for performing and reviewing the analytical studies required for an EAP.
4. A basis for preparing, performing, and evaluating EAP exercises.

Every EAP should be site-specific with individual project features and potential impacts governing the content of the plan.

6-2 REQUIREMENTS FOR EAPS AND EXERCISES

6-2.1 General Requirements for Submitting EAPs

Part 12, Subpart C of the Commission's regulations provides general requirements for EAPs at hydropower projects under the Commission's jurisdiction. Section 12.20 (a) of the Commission's regulations requires every applicant for license, licensee, and exemptee (all of which are referred to as "licensee" in this chapter) to develop and file an EAP with the Regional Engineer unless granted a written exemption in accordance with Section 12.21 (a) of the regulations.

When a licensee is not the owner of the dam nor is otherwise responsible for the maintenance, operation and monitoring of the dam, the licensee should coordinate with the owner of the dam to develop an EAP. In the event that the owner refuses to cooperate, the licensee should prepare the EAP to the best of its ability with the information available to it and provide it to the owner. If the owner indicates that it will not implement the EAP in the event of an emergency, the licensee should provide a copy of the EAP to pertinent emergency management authorities and the State agency responsible for dam safety and explain the situation to these authorities. The licensee should also advise the Regional Engineer of the owner's lack of cooperation.

In the event of competing applications for a license of an existing dam, if one of the applicants is the owner of the dam, it is that applicant's responsibility to develop an EAP.

If none of the competing applicants is the owner of the dam, then it is the responsibility of the first applicant having its application on file to prepare the EAP.

The Commission has special provisions for EAPs at projects near nuclear power plants, located at federal dams, and under construction. These are discussed in Sections 6-7, 6-8, and 6-9, respectively.

6-2.2 Schedules for EAP Submittals and Exercises

The following sections describe the schedules for EAP submittals and exercise requirements:

6-2.2.1 EAPs

Filing requirements for EAPs are described in Part 12, Subpart C of the Commission's Regulations. A summary of the filing requirements is as follows:

1. *Unconstructed Projects* – At least 60 days before reservoir filling.
2. *Unlicensed Constructed Projects* – The earliest of: 6 months after the date of the license application, 6 months after the Commission issues an order determining a license is required, or the date specified by the Commission or its authorized representative.
3. *Licensed Constructed Projects* – The date specified by the Commission or its authorized representative.
4. *Temporary Construction EAPs* – At least 60 days before construction begins.

6-2.2.2 Annual Review

Licensees must conduct a comprehensive review of the adequacy of the EAP at least once a year in accordance Section 12.24 of the Commission's regulations. The EAP Status Report should indicate this review has taken place.

6-2.2.3 Agency Coordination and Exercises

The following is a summary of all requirements for agency coordination and exercises:

1. *Seminars* – Seminars should be performed each year for each EAP. Separate seminars do not need to be performed during years where tabletop, functional, or full-scale exercises are being performed. However, it is beneficial to discuss topics often covered in a seminar (e.g., project description, downstream impacts, and inundation maps) during the player briefing at the beginning of tabletop, functional, or full-scale exercises. A brief description of the seminar should be included in the EAP Status Report.

2. Drill – A training session and drill should be performed for each EAP annually (see Section 6-4.2.2). A separate training session and drill is not required in any year when a comprehensive (i.e. functional or full-scale) exercise takes place. The EAP Status Report should include a brief description and evaluation of the training session and drill, including a list of lessons learned. The EAP Status Report should also describe all site-specific emergency equipment (e.g., sirens, emergency generators, high water level sensors and alarms) and the date tested.
3. Tabletop – The Commission recommends that a tabletop exercise take place prior to a comprehensive exercise (see Section 6-4.2.3). It is beneficial to perform a tabletop exercise at least 30 days before the comprehensive exercise, so any changes to the EAP based on the tabletop exercise can be completed before the comprehensive exercise. Other options are holding a tabletop in the year before a comprehensive exercise will be held or on the same day of the comprehensive exercise if it is difficult to get all parties involved to participate in exercises on two separate days. Although having a tabletop and comprehensive exercise on the same day is possible, it is not recommended. Licensees can also consider performing tabletop exercises as part of annual seminars.

The Regional Engineer may require a tabletop exercise be performed for certain projects to enhance coordination with emergency management authorities. This is done on a case-by-case basis.

At least 90 days before performing a tabletop exercise, the licensee should submit a plan and schedule to the Regional Engineer explaining when and where the exercise will take place. Within 60 days of completing a tabletop exercise, the licensee should submit to the Regional Engineer an evaluation report of the exercise including comments from participants and any recommendations for modifications to the EAP. If both a tabletop and comprehensive exercise are being performed for a project within the same year, a single evaluation report can cover both exercises. Appendix 6-B contains a sample outline for an exercise evaluation report.

4. Functional or Full-Scale Exercise – The Commission tries to schedule at least one comprehensive exercise over a five year period in each river basin where there is a project required to have an EAP (see Sections 6-4.2.4 and 6-4.2.5).

At least 90 days before performing a comprehensive exercise, the licensee should submit a plan and schedule to the Regional Engineer explaining when and where the exercise will take place. Within 60 days of completing a

comprehensive exercise, the licensee should submit to the Regional Engineer an evaluation report of the exercise including comments from participants and any recommendations for modifications to the EAP. Appendix 6-B contains a sample outline for an exercise evaluation report.

6-2.2.4 EAP Reprints

A completely reprinted copy of the EAP should be redistributed to all participants, including three copies to the Regional Engineer, on a five year cycle (as a maximum). The reprinted copy of the EAP should include updated inundation maps showing any changes within the inundation zones since the last reprint. The reprint should be in three ring binders or similar form to allow for updates. Licensees should try to accommodate planholders who prefer electronic versions of the EAP in lieu of or in addition to a printed version.

The three copies provided to the Regional Engineer shall contain all information required under EAP format described in this chapter. It is acceptable and licensees are encouraged to submit reprints of EAPs on a more frequent basis.

The Regional Engineer will notify licensees of the date that reprints are due approximately one year prior to the deadline.

6-2.2.5 EAP Revisions/Annual Updates

Once notified of a significant discrepancy in the EAP that would have an adverse impact on the emergency response to a dam-safety incident (e.g., a change in how a first responder would be notified), the licensee is required to make the necessary changes to the EAP and issue revised pages, sections, maps, as appropriate, to all plan holders within 30 days. The licensee should mark all revised pages "Revised MO/DA/YEAR" and highlight the revised material.

It is beneficial to hand deliver revisions to high-priority emergency responders to ensure the changes are properly made to their EAPs. If it is not possible to hand deliver revisions within 30 days, licensees can send the revisions and follow-up that the revisions were incorporated into the EAPs during scheduled seminars or by phone (see Section 6-4.2.1). Any other changes to the EAP that would not have a significant adverse impact on the emergency response to a dam-safety incident can be distributed as an annual update by the end of each year.

6-2.2.6 EAP Status Reports

There are a number of annual requirements regarding EAPs. By December 31 of each year, licensees should submit an EAP Status Report regarding these requirements to the Regional Engineer. The report should include the following:

- The date(s) that the licensee performed an annual comprehensive review of the EAP.
- The date(s) annual updates to the EAP and, if applicable, the Radiological Emergency Response Plan was sent to planholders. It is acceptable for updates to be submitted to the FERC with the EAP Status Report. The annual updates should include any documentation of consultation between the licensee and emergency management authorities /responders which occurred during the year.
- The date of the last full reprint of the EAP for all planholders.
- The date(s) of the last annual seminar and a brief description of what was discussed.
- The date(s) of the last drill/training/call down test, including any lessons learned.
- A brief description of the project's emergency equipment and the date(s) tested.
- The date and results from the most current Sudden Failure Assessment (see Section 6.5). This should include an explanation of any response time enhancement implemented or changes in downstream population that would affect the Sudden Failure Assessment results.
- The date(s) and description of any public education that was provided during the year and who received it. This includes public education which was provided by local emergency management authorities (see Section 6-4.2.1).
- A table indicating all parties who: (1) received EAP revisions and/or annual updates, (2) participated in the annual seminar, and (3) participated in the annual drill and/or were contacted during the call down test.

Appendix 6-C contains a sample EAP Status Report format.

6-2.2.7 Verification of Projects Exempt from Filing an EAP

Licensees of projects exempt from filing an EAP must annually perform a field reconnaissance to verify if there were any changes to upstream and downstream conditions affecting the determination that no reasonably foreseeable project emergency would endanger life, health, or property (see Section 6-6.2). Licensees should also develop, maintain, post, and annually verify a contact list of people and organizations such as local emergency management authorities and upstream and downstream dam owners that will be called during flood events, if their dam is in danger of failing, or has failed (see Section 6-6.3).

In accordance with 18 C.F.R., Part 12, Subpart C, § 12.21, by December 31 of each year, licensees of projects exempt from filing an EAP should send a letter to the Regional Engineer: (1) discussing the results of the field reconnaissance, (2) if appropriate, requesting a continuation of the exemption from filing an EAP, and (3) including, as a separate enclosure, the contact list along with a statement that the information provided was verified to be accurate.

6-2.2.8 Part 12.10 Reporting

Part 12.10 of the Commission’s Regulations requires licensees to report safety-related incidents to the Regional Engineer. Any activation of the EAP, including activation of the Non-Failure and High Flow Conditions (see Section 6-3.2.2-2.E), is considered a safety-related incident. The licensee should report the incident by telephone to the Regional Engineer as soon as practicable. Afterwards the licensee should submit a written report describing the incident and emergency response according to the schedule specified by the Regional Engineer.

6-2.2.9 Table of Requirements

The following table describes the schedules for all EAP submittals and exercise requirements:

EXERCISE/SUBMITTAL	SCHEDULE	REPORTING DEADLINE
Seminar	Annual – except during the year of a tabletop, functional, or full-scale exercise.	Submit information in EAP Status Report.
Drill	Annual – separate training session and drill are not needed during the year of tabletop, functional, or full-scale exercise.	Submit information in EAP Status Report.
Tabletop Exercise	Recommend at least 30 days before comprehensive exercises or as required by the Regional Engineer.	Submit Plan & Schedule at least 90 days before exercise. Submit Evaluation Report within 60 days following exercise.
Functional/Full-Scale Exercise (Comprehensive Exercise)	Every 5 years within a river basin.	Submit Plan & Schedule at least 90 days before exercise. Submit Evaluation Report within 60 days following exercise.
EAP Reprint	Every 5 years.	Submit according to the schedule specified by the Regional Engineer.
EAP Status Report	Annual.	December 31.
EAP Revisions	Varies.	Submit revisions for significant discrepancies within 30 days of notification. Otherwise, submit revisions as the annual update with EAP Status Report.

EXERCISE/SUBMITTAL	SCHEDULE	REPORTING DEADLINE
Verification of Projects Exempt from Filing an EAP	Annual.	December 31.
Part 12.10 Notification	Following any activation of the EAP.	Provide oral report as soon as practicable after incident occurs. Submit written report as specified by the Regional Engineer.

6-3 PREPARING EMERGENCY ACTION PLANS

6-3.1 Basic Considerations for Preparing Emergency Action Plans

6-3.1.1 Purpose

1. General - There are many types of emergency events that could affect dams. Whenever people live in areas that could be impacted by a potential or actual flood caused by the failure or operation of a dam, there is a potential for loss of life and damage to property. The purpose of these Guidelines is to encourage comprehensive and consistent emergency action planning to protect lives and reduce property damage. This document provides guidance for the licensee and the emergency management authorities who work together to respond to dam safety emergencies.

An Emergency Action Plan (EAP) is a formal document that identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life. The EAP describes actions the licensee will take to moderate or alleviate a problem at the dam, as well as what actions the licensee, in coordination with emergency management authorities, should take to respond to incidents or emergencies related to the dam. It presents procedures and information to assist the licensee in issuing early warning and notification messages to responsible downstream emergency management authorities. The EAP also contains inundation maps to assist the licensee and emergency management authorities by identifying critical infrastructure and population-at-risk sites that may require protective measures, warning and evacuation planning. The EAP must clearly define the responsibilities of all those involved in managing the incident and how those responsibilities should be coordinated.

2. Addressing Incidents and Emergencies – In general, a dam safety incident is a malfunction/deviation of a project feature or some other unusual occurrence that could, if left unchecked, lead to an uncontrolled release or excessive controlled release of water from an impounding structure.

Whenever people live in an area that could be impacted by the operation or failure of a dam, there is potential for an emergency related to a dam safety incident. The National Incident Management System (NIMS) defines an emergency as “any incident, whether natural or manmade, that requires responsive action to protect life or property”. A dam

safety emergency is an impending or actual sudden release of water caused by an accident to, or failure of, a dam or other water retaining structure, or the result of an impending flood condition when the dam is not in danger of failure that requires responsive action to protect life or property.

3. Uniformity of Plans - The effectiveness of an EAP program can be enhanced by promoting a uniform format which ensures that all aspects of emergency planning are covered in each plan. Uniform EAPs and advance coordination with appropriate emergency management authorities should facilitate a timely response to a developing or actual emergency situation. Licensees responsible for the operation and maintenance of dams are encouraged to use these guidelines to develop, update, revise and exercise their EAPs.

4. National Incident Management System – The NIMS provides a systematic, proactive approach to guide all levels of governmental, nongovernmental and private sector organization to work seamlessly to respond to incidents. The NIMS approach is effective for any situation that involves coordination among multiple agencies or partners. The goal is to coordinate activities to reduce consequences (loss of life, property damages, and harm to the environment).

The Incident Command System (ICS) is a fundamental element of NIMS and consists of a standardized, on-scene, all-hazards incident management approach that:

- Allows for the integration of facilities, equipment, personnel, procedures and communications operating within a common organizational structure.
- Enables a coordinated response among various jurisdictions and functional agencies, both public and private.
- Establishes common processes for planning and managing resources.

As a system, ICS is extremely useful. The ICS provides an organizational structure for incident management and guides the process for planning, building and adapting that structure. Using ICS for every incident or planned event helps hone and maintain skills needed for the larger scale incidents. It is recommended that the licensee coordinate with appropriate emergency management authorities in an effort to incorporate ICS and NIMS concepts and structures.

A critical tool for promoting the nationwide implementation of NIMS is a well-developed training program. For further information on NIMS training courses, the licensee and emergency management authorities should contact appropriate state and/or local response agencies and refer to FEMA's web site at www.fema.gov.

6-3.1.2 Scope

These Guidelines are used for preparing or revising EAPs and apply to all dams unless exempted under Part 12, Subpart C, 12.21 (see Section 6-6 for exemption requirements). Ownership and development of the floodplain downstream from each dam varies; therefore, the potential for loss of life as a result of failure or operation of a dam will also vary. The level of detail presented in the EAP should be commensurate with the degree of hazard created by the potential impacts. A low-hazard potential dam that has little or no impact should not require an extensive evaluation or be subject to an extensive planning process. Conversely, high- and significant-hazard potential dams with an increased possibility for impacts may require a larger emergency planning effort. In addition, high- and significant-hazard potential dams tend to involve more entities that must coordinate responsibilities and efforts to effectively respond to an incident. Every EAP must be tailored to site-specific conditions.

Emergency Action Plans generally contain six basic elements:

- Notification Flowchart and Contact Information
- Emergency Detection, Evaluation, and Classification
- Responsibilities
- Preparedness Activities
- Inundation Maps
- Appendices

All elements should be included in a complete EAP. The requirements of these elements are discussed in detail in Section 6-3.2, which presents a format for uniformity among EAPs.

The licensee is responsible for the development of the EAP. However, the plan will not be effective unless it is developed and implemented in close coordination with all applicable emergency management authorities. Emergency management authorities will use the information in a licensee's EAP to facilitate the implementation of their responsibilities. State and local emergency management authorities will generally have some type of plan in place, either a local Emergency Operations Plan or a Warning and Evacuation Plan.

6-3.1.3 Coordination

It is vital that the development of the EAP be coordinated with all entities, jurisdictions, agencies, and authorities that would be involved with an incident at the dam or that have statutory responsibilities for warning, evacuation, and post-incident actions. Coordination with upstream and downstream owners is also important to determine what

could be done to mitigate effects resulting from an emergency. The finished product should clearly define the roles and responsibilities of each entity.

Coordination with emergency management authorities who are responsible for warning and evacuating the public is essential to ensure that there is agreement on their individual and group responsibilities. Participation in the preparation of the EAP will enhance their confidence in the EAP and in the accuracy of its components. Coordination will provide opportunities to discuss critical emergency planning concerns such as the order of public official notification; the use of backup personnel; alternate means of communication; and special procedures for nighttime, holidays and weekends.

The tasks and responsibilities of the licensee and the emergency management authorities that would be implemented during a dam emergency incident should be clearly stated and be as compatible as possible.

To ensure timely and accurate information exchange, coordination between the licensee, local emergency management authorities and the appropriate National Weather Service (NWS) Weather Forecast Office (WFO) is highly recommended. The NWS has a congressional mandate to issue official public warnings for all weather-related events, including dam breach and flooding. Through the planning process, a decision needs to be made on who will contact the NWS. The local NWS web sites (www.nws.gov) provide links to local WFOs, a description of NWS services and a list of NWS products.

Coordination with emergency management authorities is enhanced through a licensee's EAP exercise program. A detailed discussion of coordination through exercises is in Section 6.4.

Coordination with upstream and downstream dam owners is important to determine operational procedures for mitigating the effects of floods and dam safety emergencies. Dams that provide critical resources to a community should have a recovery plan. This recovery plan should be developed in coordination with local emergency management authorities. The loss of a dam that provides a key resource, such as power or drinking water, could significantly impact the recovery efforts of a community or region. Recovery and continuity of operations of critical infrastructure for these types of dams are discussed in the Department of Homeland Security (DHS) Dam Sector Crisis Management Handbook, 2008.

6-3.1.4 Evacuation

Evacuation planning and implementation is typically the responsibility of either state or local emergency management authorities. The licensee should not usurp the responsibility of the local emergency management authorities responsible for evacuation. However, there may be situations where recreational facilities, campgrounds, or

residences may be located below a dam where local emergency management authorities would not be able to issue a timely warning. In such cases, the licensee should coordinate with local emergency management authorities to determine who will warn these people and in what order. Evidence of coordination between the licensee and the alerting authorities should be provided in the EAP. Although the EAP does not need to include the actual evacuation plan, it should indicate who is responsible for evacuation, and what plan will be followed.

Inundation maps developed by the licensee must be shared with emergency management authorities and included in the EAP. These maps may help in the development of warning and evacuation plans. It is important for dam owners to coordinate with the appropriate emergency management authorities and provide information from dam inundation studies that can assist with evacuation planning.

The licensee should include procedures in the EAP for ensuring that emergency management authorities are provided with timely and accurate information on dam conditions during an incident. This will assist those authorities in making the appropriate decisions regarding evacuations

Dam emergency evacuation plans should be developed before an incident occurs. It is recommended that plans be based on a worst case scenario and address the following activities:

- Initiating emergency warning systems
- Pre-incident planning
- Identification of critical facilities and sheltering
- Specific evacuation procedures, including flood wave travel time considerations (e.g., evacuation of special needs populations and lifting evacuation orders)
- Distance and routes to high ground
- Traffic control measures and traffic routes
- Potential impact of weather or releases on evacuation routes, such as flooding of portion or the evacuation route before the dam incident occurs
- Vertical evacuation/sheltering in place
- Emergency transportation
- Safety and security measures for the perimeter and affected areas
- Re-entry into affected areas

6-3.1.5 Document Control and Protection of Critical Information

The licensee should develop an EAP distribution list for all those who would be involved in implementing the EAP. The list must be reviewed and updated as part of updates to the EAP. Each copy of the EAP that is distributed should be controlled by copy number and

a notice requesting that other copies of the EAP not be made. When outdated EAPs have been replaced in their entirety with new versions, the licensee should request that the outdated controlled copies be returned to the owner or otherwise ensure they are securely destroyed to prevent misuse. If EAPs are made available electronically, care should be taken to ensure that document control is maintained, such as through the use of a secure web portal accessible only to the entities on the established distribution list.

To protect critical information, it may be important to limit technical data and personal contact information provided to the public. Licensees should consider controlling the dissemination of technical information such as engineering details (text and drawings) specific to the dam, potential modes of failure, facility details, etc. This can be done by keeping specific engineering details in controlled EAP copies, while removing such details from copies distributed to outside agencies that have no specific need for the information.

With this process, it is possible to have different versions of the EAP. One version would contain the information described in these guidelines and be for the licensee's and Commission's use. Another version could be stream-lined for emergency management authorities to contain only information they need to respond to an emergency. The stream-lined version(s) should be coordinated with authorities to ensure they have enough information to perform their duties. For example, the National Weather Service may need additional information not required by other authorities, such as the dam breach analysis and engineering drawings of the structures. Licensees should go over the contents of the EAP with emergency response authorities during annual seminars or other meetings/exercises.

6-3.1.6 Maintaining an EAP

After the EAP has been developed, approved, and distributed, continual reviews and updates must be performed. Without periodic maintenance, the EAP will become outdated and ineffective. Requirements for updating the EAPs are in Section 6-2.2.5.

The EAP should be updated promptly to address changes in personnel and contact information, significant changes to the facility or emergency procedures. At least annually, a review of the adequacy of the EAP should be conducted and appropriate updates made. Even if no revision is necessary, the review should be formally documented.

The review should include an evaluation of any changes in flood inundation areas, downstream developments, or in the reservoir and a determination of whether any revisions, including updates to inundation maps, are necessary. Appendix 6-D contains an EAP review checklist.

The EAP should be updated promptly based on the outcome of any exercises, including periodic reviews and verifications of personnel and contact information from Notification Flowcharts and contact lists. Any changes to the dam and/or inundation zone should be reviewed because the changes may affect the inundation maps. Maps should be changed as soon as practicable and noted in the EAP.

Once the EAP has been revised, the updated version (or possibly only the affected pages for minor updates) should be promptly distributed to those designated on the EAP distribution list. The EAP is a living document and should be submitted in a loose-leaf binder which will simplify the process of removing and replacing outdated pages when updates are made. Including the date of the EAP or the date of the current revision on each page will help to ensure that users have the most current version. It is required that the entire EAP be reprinted and redistributed to all plan holders at least every five years.

6-3.2 EAP Outline and Contents

6-3.2.1 EAP Outline

An EAP outline is provided below that ensures all of the six EAP elements identified in Section 6-3.1.2 of these Guidelines are included. This provides uniform, comprehensive, and consistent dam emergency action planning for levels of preparedness that may save lives and reduce property damage in areas affected by dam operation or failure. It is important that the EAP satisfies both licensee and regulatory requirements.

It is necessary that all EAPs within a given jurisdiction be similar and consistent to eliminate confusion when activating any EAP. To the extent possible, an EAP should be organized in the format that is most useful for those involved in the plan. The EAP should be user-friendly so that it will actually be used during EAP exercises and actual emergency events. Development of an EAP should consider the elements described on the following pages to ensure all aspects of emergency action planning are covered. If there are deviations in the EAP format from what is described in these guidelines, the licensee should notify the Regional Engineer in the EAP Status Report that the changes were discussed and mutually agreed upon by the users of the EAP.

During annual seminars or other meetings/exercises, licensees should review the EAP with representatives of emergency management authorities. The parties can discuss what portions of the plan are necessary for the authorities and if any changes to the plan would improve the overall efficiency of the plan.

The outline for an EAP appears below:

EAP OUTLINE

Front Matter

Cover

Title Page

Table of Contents

EAP Signatures

Part I: EAP Information

A. Summary of EAP Responsibilities (Optional)

B. Notification Flowcharts

C. Statement of Purpose

D. Project Description

E. EAP Response Process

Step 1: Incident Detection, Evaluation, and Emergency Level Determination

Step 2: Notification and Communication

Step 3: Emergency Actions

Step 4: Termination and Follow-up

F. General Responsibilities

Licensee Responsibilities

Notification and Communication Responsibilities

Evacuation Responsibilities

Monitoring, Security, Termination, and Follow-up Responsibilities

EAP Coordinator Responsibilities

G. Preparedness

Surveillance and Monitoring

Evaluation of Detection and Response Timing

Access to the Site

Response during Periods of Darkness

Response during Weekends and Holidays Response during Adverse Weather

Alternative Sources of Power

Emergency Supplies and Information

Stockpiling Materials and Equipment

Coordination of Information

Training and Exercise

- Alternative Systems of Communication
- Public Awareness and Communication
- H. Inundation Maps

Part II: Appendices

- A. Investigation and Analyses of Dam Break Floods
- B. Plans for Training, Exercising, Updating, and Posting the EAP
- C. Site Specific Concerns
- D. Documentation

The suggested format separates the EAP into two parts: the basic EAP instructions (EAP Information) and supporting information (Appendices). The content and depth of detail in the EAP should be appropriate for the risk the dam poses.

A. Part I: EAP Information. Sections A through H contain information that is likely to be used by all parties (licensee and emergency management authorities) during an actual incident.

B. Part II: Appendices. The appendices should contain supplementary information. The appendices typically include material that was used to develop the EAP and information that can be used to assist with decision-making during an incident (e.g., detailed operation and maintenance requirements, dam break information and analyses, record of plan reviews and updates, plan distribution list, incident tracking forms).

When developing the appendices, dam owners, in coordination with emergency management authorities, should consider including supporting information that will help them respond rapidly and effectively to an incident.

However, the information contained in the Appendices is not necessarily needed by all parties during an actual emergency. They typically contain support materials used in the development of the basic EAP. More specifically, the Appendices focus on such important issues as those that specifically address maintenance requirements for the EAP and dam break investigations and analyses, among others. This information may be directly applicable to the actions of the licensee and possibly some of the emergency management parties, but may not be critical to the actions and activities of other parties during an actual emergency.

6-3.2.2 EAP Contents

This section follows the heading and numbering of the format and describes in detail each element of an EAP.

1. Front Matter

A. Title Page

The EAP title page identifies it as an Emergency Action Plan and specifies the dam for which it was developed. Both the dam and reservoir names should be included. To assist State and federal dam safety personnel, include the National Inventory of Dams (NID) number unique to each dam on the title page. A sample title page is included in Appendix 6-E.

B. Table of Contents

The table of contents should list all major sections of the EAP and the figures, tables, and maps.

C. EAP Signatures

The EAP should be signed by all parties involved in plan implementation to ensure that everyone is aware of the plan and understands the agreed-upon responsibilities.

A verification form should also be included. This form should be signed by the licensee and indicate that the licensee has read the document, knows the contents, and finds all statements to be true and correct. A sample verification form is included in Appendix 6-E.

2. Part I: EAP Information

A. Summary of EAP Responsibilities (Optional)

Part I, Section A of the EAP should summarize the critical responsibilities for responding to an incident and implementing the plan. Appendix 6-F, Table F-1, is an example of a table with the general responsibilities of those involved with implementation of an EAP. Appendix 6-F, Table F-2, is an example of a summary of licensee responsibilities. During an actual incident, these types of summaries can provide quick and easy references to critical activities involved with implementing the EAP.

B. Notification Flowcharts

A Notification Flowchart identifies who is to be notified of a dam safety incident, by whom, and in what order. An example Notification Flowchart is provided in Appendix 6-G. The information on the flowchart is critical for the timely notification of those responsible for taking emergency actions. For ease of use during an incident, the EAP should include Notification Flowcharts that clearly present the information listed below.

One chart or a set of charts may be needed depending on the complexity of the hazards associated with the dam and the potentially affected downstream areas.

- Emergency level of the Notification Flowchart if more than one flowchart is required
- Individuals who will notify licensee representatives and/or emergency management authorities
- Prioritization of notifications
- Individuals who will be notified

The Notification Flowchart should include appropriate contact information such as names, positions, telephone numbers, and radio call numbers. Supplemental contact information may be included in a list or table of emergency contacts. Supplemental contact information may include fax numbers, e-mail addresses, direct connect numbers, and alternate contacts. The Notification Flowchart may also be supplemented by NIMS ICS Forms, such as ICS Forms 205 and 205a, available at:

www.training.fema.gov/EMIWeb/is/ICSResource/icsforms.htm.

The number of persons to be notified by each responsible individual on the notification flow chart should be governed by what other responsibilities the person has been assigned. It is usually recommended that individuals not be responsible for contacting any more than three or four other parties.

At a minimum, the Notification Flowchart should designate who licensees will contact and who the local emergency management authorities will contact, as described below.

The Licensee will typically contact:

- Engineer/management staff/public affairs officer
- Local emergency management authorities or 911 centers
- State dam safety program representatives
- FERC Regional Office
- Upstream and downstream dam owners

Local emergency management authorities will typically contact:

- Other local responders such as police or fire
- State emergency management authorities
- Affected residents and businesses
- Appropriate NWS WFO

Deviations from the above list often occur, such as when a licensee directly contacts the NWS during high flows or when a licensee directly contacts a downstream campground that would immediately be impacted by a dam failure.

If an emergency dispatch center is on the flowchart, a direct contact number for the center should be included as it may be necessary to contact emergency response authorities directly. In addition, it is possible that the caller may be outside the dispatch center's call range. For example, 911 calls made from a dam owner's operations center may go to a different jurisdiction from where the dam is physically located.

Notification Flowcharts should be easy to follow for each emergency level and should allow for information to be exchanged upward and downward between the contacts. One flowchart that represents all emergency levels is preferred for simplicity. However, it may be necessary to develop a flowchart for each emergency level for clarity. Color coding may also be helpful. If necessary, narrative information supplementing the flowchart may be provided on the page following the flowchart. A sample Notification Flowchart is provided in Appendix 6-G.

If other forms of mass communication or notification are used, these may need to be incorporated into the Notification Flowchart and associated procedures. Examples include warning sirens, loud speakers, conference calling, mass auto e-mail notifications, mass auto-call outs, and text messaging.

C. Statement of Purpose

The EAP should include a brief statement describing the purpose of the EAP. Two examples are provided below.

Example 1: "This Emergency Action Plan defines responsibilities and provides procedures designed to identify unusual and unlikely conditions that may endanger Alpha Dam in time to take mitigating action and to notify the appropriate emergency management authorities of possible, impending, or actual failure of the dam. The plan may also be used to provide notification when flood releases can create major flooding."

Example 2: "The purpose of this EAP is to safeguard the lives and reduce damage to the property of the citizens of Alpha County living along Beta Creek, in the event of failure of the Beta Creek Dam or flooding caused by large runoff."

D. Project Description

Provide a description of the project its location, and the NID identification number. A dam vicinity map and a simple drawing showing the dam's features are recommended, along with a list of any significant upstream or downstream dams and downstream communities potentially affected by a dam failure or by flooding as a result of large operational releases. List and highlight critical site-specific concerns (i.e., critical

operating procedures and material stockpiles) and refer the reader to more specific information contained in Appendix C of the EAP document. The licensee should limit design information and site-specific concerns in EAP copies that are distributed to outside agencies if the agencies have no need for the information (see Section 6-3.1.5 on Document Control and Protection).

E. EAP Response Process

There are generally four steps that should be followed when an unusual or emergency incident is detected at a dam. These steps constitute the EAP response process. The steps are:

- Step 1: Incident detection, evaluation, and emergency level determination
- Step 2: Notification and communication
- Step 3: Emergency actions
- Step 4: Termination and follow-up

Early detection and evaluation of the condition(s) or triggering event(s) that initiate or require an emergency response action are crucial. It is important to develop procedures for reliable and timely determination of an emergency level to ensure that the appropriate response actions are taken based on the urgency of the situation. Procedures for early notification are required to allow all entities involved with plan implementation to respond appropriately. Preventive or mitigating actions can be taken to attempt to address conditions at the dam. Eventually, a determination will need to be made concerning termination of the incident. After the incident is over, follow-up activities may be required. All of these steps make up the general EAP response process and should be discussed in the plan.

Step 1: Incident Detection, Evaluation, and Emergency Level Determination

During Step 1, an unusual condition or incident is detected and confirmed. Unusual condition or incidents are unique to each dam and, to the extent possible, should be identified in the EAP. The following information should be considered for inclusion or reference in the plan to assist the licensee in this step:

- Measures for detecting existing or potential failures
- Operating information, such as normal and abnormal reservoir level data
- Description of monitoring equipment, such as water level sensors and early warning systems
- Monitoring and instrumentation plans
- Inspection procedures
- Process for analyzing and confirming incoming data

After an unusual condition or incident is detected and confirmed, the licensee will

categorize the condition of incident into one of the established emergency levels based on the severity of the initiating condition or triggering events. Both the licensee and emergency management authorities should understand the emergency levels and each other's expected responses. Consistency of the emergency level categories is recommended to eliminate confusion for emergency responders whose jurisdiction contains multiple dams and dam owners.

The four dam safety emergency level categories listed below are recommended. However, licensees, in coordination with emergency management authorities, should determine the number of emergency levels required for each dam on a case-by-case basis. If an EAP uses different levels than those described in these guidelines, the licensee should notify the Regional Engineer in the EAP Status Report that the changes were discussed and mutually agreed upon by the users of the EAP.

- High flow
- Non-failure
- Potential failure
- Imminent failure

The EAP should describe how each emergency level applies to the particular dam. Information to assist the licensee in determining the appropriate emergency level should be developed and included in the EAP. An example table describing emergency level for different incidents is included in Appendix 6-H. The four emergency levels are discussed below.

High Flow. The High Flow emergency level indicates that flooding is occurring on the river system, but there is no apparent threat to the integrity of the dam. The High Flow emergency level is used by the licensee to convey to outside agencies that downstream areas may be affected by the dam's release. Although the amount of flooding may be beyond the control of the licensee, information on the timing and amount of release from the dam may be helpful to authorities in making decisions regarding warnings and evacuations.

The EAP should include a High Flow Operations Table that identifies the following:

1. Essential operations at the project before, during and after flood flows reach the project.
2. A general overview tying project discharges to EAP notification procedures.
3. For remotely operated projects, a description of what triggers sending staff to the project and at what point personnel are to be physically present at the site.
4. Pre-flood coordination to include coordination with resource agencies on

anticipated or pre-emptive flow releases or reservoir drawdown.

Notifications should be predetermined based on correlations between releases and the timing of impacts to downstream areas. High Flow emergency level notifications are typically made to local jurisdictions that would be affected, the NWS, downstream dam owners, and other agencies, as necessary. Licensees should develop a table that correlates gate openings and/or reservoir levels to outflows, expected downstream impacts, and agencies that will be contacted. An example table is provided in Appendix 6-I.

If this emergency level is initiated, it is important that all parties are made to understand the dam is NOT in danger of failing.

Non-Failure. The Non-Failure emergency level is appropriate for an event at a dam that will not, by itself, lead to a failure, but requires investigation and notification of internal and/or external personnel. Examples are (1) new seepage or leakage on the downstream side of the dam, (2) presence of unauthorized personnel at the dam, and (3) malfunction of a gate.

Some incidents, such as new seepage, may only require an internal response from the dam owner. Others, such as a gate malfunction, may lead to unexpected high releases that could pose a hazard to the downstream public and would require the notification of outside agencies.

Potential Failure. The Potential Failure emergency level indicates that conditions are developing at the dam that could lead to a dam failure. Some examples are (1) rising reservoir levels that are approaching the top of the non-overflow section of the dam, (2) transverse cracking of an embankment, and (3) a verified bomb threat. Potential Failure should convey that time is available for analyses, decisions, and actions before the dam could fail. A failure may occur, but predetermined response actions may moderate or alleviate failure.

The licensee should assess the situation and determine the urgency of the emergency situation. Based on the licensee's assessment (and as a result of prior coordination with the appropriate authorities), the emergency management authorities should be placed on alert and it is up to the emergency management authorities to determine the appropriate course of action.

If it appears that a situation may take days or weeks before it could develop into a failure situation, the local emergency management authorities may decide on one course of action. Periodic status report updates from the licensee are important because when it appears that the situation is continuing to worsen at the dam, in spite of the actions being taken to moderate or alleviate failure, the local emergency management authorities may

decide to change their course of action. Depending on the location of downstream residents with respect to the dam and the estimated warning time available, the evacuating authorities should consider the prudence of early evacuation, or heightened awareness, of certain downstream areas until the emergency has passed.

To assist the evacuating authorities in selecting their appropriate course of action and to provide a proper transition from “potential failure” level to “imminent failure” level, the licensee should clearly communicate their assessment of the situation to the emergency management authorities. The licensee should consider placing the emergency management authorities on an initial alert and provide periodic updates on the situation as it develops so that the emergency management authorities can assess when they should implement their evacuation procedures.

Imminent Failure. The Imminent Failure emergency level indicates that time has run out, and the dam has failed, is failing, or is about to fail. Imminent Failure typically involves a continuing and progressive loss of material from the dam. It is not usually possible to determine how long a complete breach of a dam will take. Therefore, once a decision is made that there is no time to prevent failure, the Imminent Failure warning must be issued. For purposes of evacuation, emergency management authorities should assume the worst-case condition that failure has already occurred.

Step 2: Notification and Communication

After the emergency level at the dam has been determined, notifications are made in accordance with the EAP’s Notification Flowchart(s). Details on the use of the Notification Flowchart and any additional contact information should be provided in the EAP.

When developing notification and communication procedures, licensees should coordinate closely with emergency management authorities. All parties must understand that the formal declaration of public emergency by emergency management authorities can be a very difficult decision. During this step, the licensee should provide any information that will assist in that decision. An early decision and declaration are critical to maximizing available response time.

When performing notification and communication activities, it is important that people speak in clear, nontechnical terms to ensure that those being notified understand what is happening at the dam, what the current emergency level is, and which actions to take. To assist in this step, the EAP may include checklists and/or pre-scripted messages to help the caller adequately describe the emergency situation to emergency management authorities. Different messages can be developed for each emergency level. Examples of a notification checklist and pre-scripted messages are included in Appendix 6-J.

After initial notification, the licensee should make periodic status reports to the affected emergency authorities and other stakeholders in accordance with the Notification Flowcharts and associated procedures. If it appears that the situation is continuing to deteriorate despite actions being taken to moderate or alleviate failure, local authorities may decide to change their course of action. Depending on the location of downstream residents and the estimated time required to warn them, the evacuating authorities may consider early evacuation or continued warnings until the emergency has passed.

Step 3: Emergency Actions

After the initial notifications have been made, the licensee will act to save the dam and minimize impacts to life, property, and the environment. During this step, there is a continuous process of taking actions, assessing the status of the situation, and keeping others informed through communication channels established during the initial notifications. The EAP may go through multiple emergency levels during Steps 2 and 3 as the situation improves or deteriorates. The dam owner should develop tables that include specific actions for minimizing impacts of dam safety incidents. An example table is provided in Appendix 6-K. Additional information related to response actions may also be provided in the dam operating manuals and instructions.

During an incident, safety and security measures should be implemented to secure the affected operational areas at the dam to protect operations personnel and the public, and permit an effective performance of emergency response actions.

Step 4: Termination and Follow-up

The EAP should explain the expected termination and follow-up procedures for dam safety incidents and emergencies. This step should explain the process to follow and the criteria for determining that the incident at the dam has been resolved. A Dam Emergency Termination Log may be developed and used to document conditions and decisions. An example log form is provided in Appendix 6-L, Table L-4. Generally, the licensee or the licensee's chief dam safety engineer is responsible for notifying the authorities that the condition of the dam has been stabilized. Government officials are responsible for declaring an end to the public emergency response.

Following the termination of an incident, the licensee, in coordination with emergency management authorities, should conduct an evaluation that includes all affected participants. At a minimum, the following should be discussed and evaluated in an after-action review:

- Events or conditions leading up to, during, and following the incident
- Significant actions taken by each participant and improvements for future emergencies
- All strengths and deficiencies found in the incident management process,

- materials, equipment, staffing levels, and leadership
- Corrective actions identified and a planned course of action to implement recommendations

The results of the after-action review should be documented in an After Action Report (AAR) and used as a basis for revising the EAP. The licensee should participate in the after-action review and the development of the AAR.

F. General Responsibilities

A determination of responsibility for EAP-related tasks must be made during the development of the plan. Licensees are responsible for developing and maintaining the EAP. Licensees in coordination with emergency management authorities are responsible for implementing the EAP. Emergency management authorities with statutory obligations are responsible for warning and evacuation within affected areas. All entities involved with EAP implementation should document incident-related events. Appendix 6-L, Table L-1 includes an example Emergency Incident Log.

The EAP must clearly specify the responsibilities of all involved entities to ensure that effective and timely action is taken if an emergency at the dam occurs. The EAP must be site-specific because conditions at the dam and upstream and downstream of the dam are unique to every dam. Some responsibilities to be considered are discussed below. An example summary of EAP responsibilities is provided in Appendix 6-F, Table F-1.

Licensee's Responsibilities

The duties of the licensee or owner's designated representatives under the EAP should be clearly described. In general, the licensee is responsible for detecting and evaluating dam safety incidents, classifying the incident, notifying emergency management authorities, and taking appropriate response actions. Suggested information for this section includes, but is not limited to, the following:

The dam operator's duties should be described in the EAP, and operators should be trained on the importance and use of the plan. Examples of duties may include opening spillway gates per a required sequence and opening or closing water intakes, as appropriate. Instructions for the operation of the project during the anticipated emergency should be provided.

The chain of command in the licensee's organization should be clearly described. Officials and alternates that must be notified should be identified and priority of notification determined. Notification of supervisory personnel is recommended if time permits. Advice may be needed concerning predetermined remedial action to delay, moderate, or alleviate the severity of the emergency condition.

Responsibilities should be coordinated with appropriate levels of management to ensure

full awareness of organizational capabilities and responsibilities. An example summary table identifying actions that each member of the dam owner's organization will take during the incident or emergency is provided in Appendix 6-F, Table F-2.

Notification and Communication Responsibilities

The individuals authorized to notify emergency management authorities should be determined and clearly identified in the EAP. If time allows, onsite personnel should seek advice and assistance. However, under an Imminent Failure emergency level, the responsibility and authority for notification may have to be delegated to the dam operator or a local official. When developing the EAP, the licensee and emergency management authorities should discuss and determine the most efficient notification protocol to follow.

Throughout the United States, the NWS and/or other authorities have the primary responsibility for issuing flood warnings. It is highly recommended that the Notification Flowchart include the agency with this responsibility so that its facilities can enhance warnings being issued.

Once notified of an incident at the dam, local emergency management authorities may activate an Emergency Operations Center (EOC) to serve as a central coordination center for emergency response, warning, and evacuation activities. A representative of the dam owner should go to the EOC to help agency personnel understand the project-specific information and inundation maps.

Interaction with the media should be implemented through the local or State emergency management authority. These authorities should have a Public Information Officer (PIO) and/or a Joint Information Center for disseminating information and handling inquiries. It is highly recommended that the licensee and the appropriate incident or emergency management authority work in partnership to accomplish this task.

Proper coordination and communication among onsite technical personnel at the dam, PIOs, and emergency personnel at the EOC are of critical importance to the successful implementation of the EAP. These activities should be thoroughly tested during comprehensive EAP exercises and modified as necessary.

Evacuation Responsibilities

Warning and evacuation planning and implementation are responsibilities of local emergency management authorities with the legal authority to perform these actions. Under the EAP, the licensee is responsible for notifying the appropriate emergency management authority when an incident is anticipated, is imminent, or has occurred. Warning and evacuation protocols are key elements in an EAP exercise but are not

typically included in the EAP. The EAP should, however, clearly describe the notification, warning, and evacuation responsibilities of the licensee and the local emergency management authority.

Licensees should not assume or usurp the responsibility of government entities for evacuation of people. However, there may be situations in which routine notification and evacuation will not be sufficient, as in the case of a residence located immediately downstream of a dam or a campground that would be inundated within minutes of a dam failure. In some cases, licensees may arrange to notify the residence or campground directly. Such procedures should be coordinated with the appropriate authorities before an emergency situation develops.

Section 6-5 describes other procedures for dealing with high risk areas downstream of dams.

Monitoring, Security, Termination, and Follow-Up Responsibilities

A person should be designated as an onsite monitor from the beginning of a dam safety incident until the emergency has been terminated. This person should provide status updates to the dam owner so the owner can keep all those involved with the implementation of the EAP informed of developing conditions.

Provisions for security measures during the emergency should be specified in the EAP. For additional information on security measures, see *Dams Sector Security Awareness Guide: A Guide for Owners and Operators* (DHS, 2007), available at www.dhs.gov/xlibrary/assets/ip_dams_sector_security_awareness_guide.pdf.

Termination of a dam safety emergency is usually twofold. The entity that activates the EAP is usually responsible for determining when the dam safety situation has stabilized. This is typically the licensee in consultation with engineers and dam safety experts but may include other State and Federal regulatory entities. The applicable emergency management authorities, on the other hand, are responsible for termination of the emergency response activities, including termination of an evacuation. Both the licensee and the emergency response authorities should coordinate closely while making decisions to terminate both the dam safety event and response efforts.

Recovery activities will continue on different levels for all involved in the dam safety incident after the emergency has been terminated. Although not typically addressed in a dam EAP, recovery activities should be considered by all dam owners and particularly for those dams that can affect a critical public utility such as water supply or electricity.

The licensee should coordinate a follow-up evaluation after any emergency. All participants should be involved in this evaluation and should keep logs and records

during the incident. An example Emergency Incident Log and Emergency Termination Log are presented in Appendix 6-L. The results of the follow-up evaluation should be documented in a written report (After Action Report) and used to improve future response actions.

EAP Coordinator Responsibilities

The licensee should specify the designated EAP coordinator who will be responsible for EAP-related activities, including but not limited to preparing revisions to the EAP, establishing training seminars, coordinating exercises. This person should be the contact if any involved parties have questions about the plan.

G. Preparedness

Preparedness, as it relates to an EAP for a dam, typically consists of activities and actions taken before the development of an incident. Preparedness activities attempt to facilitate response to an incident as well as prevent, moderate, or alleviate the effects of the incident. This section of the EAP should describe preparedness actions already completed, as well as established preplanned actions that can be taken after the development of emergency conditions.

Examples of preparedness actions include conducting regular inspections or surveillance, installing monitoring equipment, installing warning sirens, developing emergency operating instructions, and planning for equipment, labor, and materials to be used in emergency situations.

At a minimum, the EAP should address the following categories related to preparedness:

- Surveillance and monitoring
- Evaluation of detection and response timing
- Access to the site
- Response during periods of darkness
- Response during weekends and holidays
- Response during periods of adverse weather
- Alternative sources of power
- Emergency Supplies and Information
- Training and exercising
- Alternative systems of communication

- Public awareness and communication

The following sections discuss these categories:

Surveillance and Monitoring

The EAP should contain provisions for surveillance and monitoring at the dam. Prompt detection and evaluation of information from instrumentation and physical monitoring is critical to the effectiveness of the EAP and timely emergency response. Consideration should be given to times when the dam is attended and unattended.

When a dam is not continuously attended and an incident could endanger life or cause significant property damage, it is imperative that instrumentation be installed and/or procedures developed to monitor conditions at the facility. To promptly identify and notify emergency management authorities of emergency conditions, a dam owner should be able to detect, confirm, and evaluate developing conditions. Monitoring systems must be able to deliver clear, concise, and reliable information so that emergency authorities with warning and evacuation responsibilities may be promptly alerted. While the EAP is being activated, personnel should visit the site to verify and continue to monitor conditions.

For an unattended dam, remote surveillance systems that include instrumentation for continuous monitoring of headwater and tailwater levels should be considered. If the dam owner has an operations center that is attended 24 hours a day, these systems should include monitoring for water level rate of change and alarms when prescribed limits or levels are exceeded. Monitoring system design must be site-specific and account for changes in headwater and tailwater that may occur during normal dam operations, floods, and maintenance activities.

Tailwater monitoring is generally more sensitive to a dam breach than headwater monitoring. Changes in tailwater will alert operators more quickly to site conditions and help determine whether the EAP should be implemented. If continuous readings of both the headwater and tailwater are available, the operator can obtain concurrent readings at any time and verify alarm conditions.

If automated monitoring systems are used, provisions should be made for indicating power interruptions and loss of communication with the monitoring instrumentation. When a dam operator lives close to a project, consideration may be given to installing an alarm at the operator's home. When power to, or communication with, the site is interrupted, the dam should be manned until conditions return to normal. Operation of the alarms should be checked periodically. Proper functioning of alarms should be confirmed by testing. For instance, annual testing of the EAP may be initiated by artificially tripping one of the alarms.

Reaction time must be minimized when inhabited structures are located immediately downstream of the dam. When these conditions exist, special procedures may need to be included in the EAP to notify the occupants involved. Local emergency management authorities should be fully involved in the development of these special procedures.

Procedures should be described for providing continuous surveillance for periods of actual or forecasted high flows. It may be necessary to send an observer to the dam during these periods and not rely on the instrumentation alone. It is very important that an observer be at the dam when flood conditions or signs of serious structural distress have been identified, provided that it is safe to do so.

If remote surveillance at the dam is not applicable, reasons to support that decision should be provided in this section of the EAP.

Backup systems and procedures should be developed to verify that instrumentation readings are correct. Camera systems that can be accessed from the command center or over the Internet can allow for quick verification of water level alarms and other dam safety conditions.

Evaluation of Detection and Response Timing

Total EAP implementation time from the initiation of an actual incident to determination of an emergency situation and notification of appropriate entities involved with implementation should be evaluated and understood. The impact of the timing should be considered when developing preparedness actions. Timely implementation of the EAP and coordination and communication with emergency management authorities are crucial elements in the effectiveness of the emergency response effort.

Access to the Site

The description of access should focus on primary and secondary routes for reaching the site using various access methods (e.g., foot, boat, helicopter, and snowmobile). The expected response time should also be discussed. If the main road to the dam crosses the downstream channel and could be impassable due to flood waters, this situation should be identified and alternate access options described.

Response during Periods of Darkness

Response to potential or actual emergency conditions during periods of darkness should be clearly addressed in the EAP and include any special instructions for the dam operator and/or emergency management authorities. Response times, if different from daylight, should also be included. Actions to be taken to illuminate the abutments, spillways,

operating decks, non-overflow sections, or other areas where failures could occur should be described. Other actions that may facilitate the operation of gates or other emergency equipment should be described if they are different during periods of darkness. Any special procedures during a power failure should be provided, including manual operation of electrically powered equipment and any additional notification requirements.

Response during Weekends and Holidays

Response during weekends or holidays should be clearly addressed in the EAP and include any special instructions for the dam operator and/or emergency management authorities. Response times, if different from non-holiday or weekdays, should also be included. The availability of the dam operator should be considered, and any special procedures for contacting or notifying personnel addressed.

Response during Adverse Weather

Response under adverse weather conditions should be included and any specific actions to be taken described in detail. Actions should be based on whether the dam is attended or unattended. Methods of access to the site (e.g., foot, boat, and snowmobile) should be described. The expected response time should be discussed in detail. Any other special instructions for the dam operators or emergency management authorities should be described.

Alternative Sources of Power

Alternative sources of power for spillway gate operation or other emergency needs should be identified in the EAP. The plan should list the location of each alternate power source, its mode of operation and, if portable, a means of transportation with routes to be followed.

Emergency Supplies and Information

Planning and organizational measures that can help the dam owner and emergency management authorities manage an emergency situation more safely and effectively include stockpiling materials and equipment for emergency use and coordinating information between organizations. The availability of local resources should be predetermined through discussions with local emergency management authorities and additional resource needs should be identified. The EAP should include the name and contact information (including backups) for suppliers, additional personnel, contractors, consultants, and any other entities who may be needed to assist the dam owner or emergency management authorities in responding to a dam emergency.

Stockpiling Materials and Equipment

Where applicable, the following should be documented:

- Materials needed for emergency repair, including source; materials should be as close as possible to the dam site
- Equipment needed for emergency response or repair, its location, and who will operate it
- Local contractors, vendors, and suppliers for dam-related equipment and supplies, including contact information and maps or directions to their locations
- Justification of decision not to stockpile materials and equipment if stocking is not warranted

Coordination of Information

Where applicable, the following should be described:

- The need for coordination of information on flows based on weather, runoff forecasts, dam failure, and other emergency conditions, including how coordination is achieved and the chain of communication, including names and contact information for responsible parties. Coordination with the NWS or other appropriate agency is recommended to monitor storms, river stages, and flood waves resulting from a dam break. The NWS or other appropriate agency may also be able to supplement the warnings being issued by using its own communication system. If coordination of information on flows is not applicable, this decision should be documented in the EAP.
- Actions to be taken to lower the reservoir water surface elevation, if applicable, including when and how this action should be taken. If not applicable, this should be documented in the EAP.
- Actions to be taken to reduce inflow to the reservoir from upstream dams or control structures. The EAP should provide instructions for contacting operators of these structures and how these actions should be taken. If such actions do not apply, this should be documented in the EAP.
- Actions to be taken to reduce downstream flows, such as increasing or decreasing outflows from downstream dams or control structures on the waterway on which the dam is located or its tributaries. The EAP should provide instructions for contacting operators of these structures and how these actions should be taken. If such actions do not apply, this should be documented in the EAP.

Training and Exercise

Results of training and exercise programs are critical components in evaluating the

effectiveness of an EAP. Training and exercise plans should be designed and developed by those entities with responsibilities identified in the EAP. Since many emergency management authorities follow the FEMA Homeland Security Exercise and Evaluation Program (HSEEP) framework, HSEEP should be considered by the dam owner and other entities involved with the EAP when developing training and exercise activities. More information on the HSEEP can be found at hseep.dhs.gov.

Training. The people involved in the implementation of the EAP should be receive training at least annually to ensure that they are thoroughly familiar with all elements of the plan, the available equipment, and their responsibilities and duties under the plan.

Technically qualified personnel should be trained in the incident management process, including detection, evaluation, notification, and appropriate response actions during all emergency level determinations. A sufficient number of people should be trained to ensure adequate coverage at all times. Cross-training in more than one responsible position for each individual is advisable in order to provide alternates. New personnel should be trained immediately when they become responsible for EAP activities. A brief description of the training performed at the dam, the participants, and how often it is performed should be included in the EAP.

Local emergency management authorities may want to consider developing evacuation and shelter-in-place training materials for people who would be affected by a dam failure in their jurisdiction. This is particularly important when a dam is categorized as unsafe or the population immediately downstream of a dam would be inundated within a short time frame.

Exercise. If the EAP action items and procedures are not exercised periodically, those involved in its implementation may lose familiarity with their roles and responsibilities. A proposed exercise schedule and plans for an EAP exercise program should be included in the EAP. Plans for conducting an evaluation of the exercise and for updating the EAP based on the outcome of the evaluation should be discussed. The exercises should consider any special procedures required for night time, weekend, or holiday response. See Section 6-4 for a discussion of the types of EAP exercises, frequency of exercises, and procedures for evaluation.

Alternative Systems of Communication

The availability of alternative communications systems at the dam site should be identified in the EAP. These may include, but are not limited to, emergency sirens, cellular phones, direct connect, e-mail, intranet, radios, social media, and couriers. Operating procedures and special instructions for the use of these systems should be described. Consideration should be given to the target audience involved and the best means for communicating with them.

Public Awareness and Communication

Dams that are immediately upstream of residences, recreation areas, and campgrounds pose unique challenges. It may be necessary for the dam owner to assist emergency management authorities in developing public awareness measures. These measures typically explain the proximity of the dam, how people will be informed of an emergency, and the actions people should take during an emergency. The EAP should include a brief description of any public awareness measures that are performed. Emergency management authorities may consider the use of social media for both primary and alternate systems of communication with the public.

H. Inundation Maps

The primary purpose of an inundation map is to convey the hazards associated with a dam failure usually assumed to occur during both fair weather (sunny day) and flood conditions (probable maximum flood or inflow design flood). Inundation maps are used by emergency management authorities to facilitate timely notification and evacuation of areas affected by a dam failure. The inundation maps should include the extent of the areas that would be flooded and the expected travel times for wave front and flood peaks at critical locations. Additional information that may be useful includes peak dam breach velocities and duration of inundation. The maps should highlight downstream infrastructure, developments, recreation areas, and any other significant features within the inundation zone for evacuation and rescue purposes.

Inundation maps should be developed by the licensee in coordination with the appropriate emergency management authorities who will rely heavily on the maps during an emergency. The purpose of this coordination is to ensure that (1) the authorities understand how to interpret the maps and (2) the maps contain sufficient and current information for the emergency management authorities to warn and evacuate people at risk from a dam failure.

Determining Downstream Impacts

Several factors have to be evaluated when dam failure inundation zones are being determined. The type of dam and the mechanisms that could lead to failures require careful consideration if a realistic breach scenario is to be developed. Size and shape of the breach, time of breach formation, hydraulic head, and storage in the reservoir are all inputs into the development of a dam failure hydrograph. The best available topographic data should be used for developing accurate volume and routing estimates. There are several methods and computer models available for developing the dam failure hydrograph and routing dam break flows downstream. Models that use unsteady flow and dynamic routing method are preferable. The type of model (1-dimension, 2-dimensional, or a combination of both) selected should be appropriate to the downstream reach.

A **fair weather** or “sunny day” dam failure, in which the reservoir is at normal full pool elevation and normal stream flow is prevailing, is generally considered to have the most potential for loss of human life due to the element of surprise. Failure of a dam during flood flow conditions, however, will result in downstream inundation at higher elevations and will include additional affected populations. A failure at the dam’s Inflow Design Flood (IDF) is considered to show the upper limit of inundation. Both the fair weather and IDF dam failure conditions should be considered to ensure that the EAP includes all communities and affected emergency management authorities that need to be notified.

A sensitivity analysis is necessary to ensure that all structures that could realistically be impacted are included on the inundation map and all necessary local emergency management authorities are included in the EAP. A sensitivity analysis should include such factors as varying the breach parameters (i.e. breach width and time to failure) for the fair weather and flood flow conditions.

A sensitivity analysis is often necessary when a licensee desires to demonstrate that a failure under any foreseeable failure scenario would not constitute a hazard to life and/or property, and an exemption from EAP requirements may be justified.

The need to consider the domino effect should be made on a case-by-case basis. If the assumed failure of a dam would cause the failure of any downstream dams, the analysis should consider the domino effect in routing the flood wave downstream. The licensee, after assuming a hypothetical failure of its dam, should make an engineering judgment regarding the potential for failure of the downstream dams during the routing of the dam break flood wave. For example, if a downstream dam has an earthen embankment that would be significantly overtopped due to the upstream dam failure, then it may be necessary to include the additional flooding from failure of the downstream dam on the inundation maps. Many factors should be considered for these cases, such as the expected performance of the downstream dams during high flows, the lag time between dams, and possible operation actions at downstream dams (e.g., drawdowns) that could alleviate the flood wave. Coordination of such studies with other downstream dam owners should be undertaken by the licensees where feasible. The licensee may coordinate with the FERC Regional Office staff to decide whether downstream dams should be considered to fail from the domino effect.

The flood wave resulting from the dam failure should be routed to a point where it no longer presents a hazard to downstream life or property, which includes downstream dams. This is where the inundation map is normally ended. For some projects where it would take several days for flows to diminish, it is possible to end the inundation maps at a point where real-time flood warning can be provided. Although not typically utilized due to the extensive planning and coordination with the National Weather Service required, such EAP's and inundation maps must indicate that real-time flood warning information can be issued.

Preparing Inundation Maps

The Commission recommends that licensees use Geographic Information System (GIS) technology to develop the inundation maps. Digital files of the inundation zones and cross section information should be submitted to the Commission based on the requirements listed in Appendix 6-M.

Once digital files of the inundation zones are created and geo-referenced, the files can be provided to emergency management authorities with GIS capabilities. The emergency management authorities can overlay the digital inundation zones on layers they have access to (e.g., property plats, addresses, owner names and phone numbers) as part of their hazard mitigation planning, which allows emergency management authorities better use of their own information during an emergency and greatly enhances their warning and evacuation capabilities. If licensees have GIS capabilities but the emergency management authorities do not, the licensees can offer to modify inundation maps to contain additional information provided by the emergency management authorities.

Inundation maps should make use of the most current topographic information and aerial photos available. Digital files of aerial photos and topographic maps are available from the United States Geological Survey at varying resolutions and many counties and municipalities have higher resolution digital aerial photos and topographic maps which may also be for licensee use.

Contents of Inundation Maps

Inundation maps should clearly show the direction of river flow, inundation zones, cross section information, dams, streets, buildings, railroads, bridges, campgrounds, and any other significant features. At the request of emergency management authorities, additional features, such as highlighted evacuation routes and emergency shelters may be included on the maps. All features should be shown using local names or terms. Printed inundation maps should be at a scale that is sufficient to clearly show the downstream inhabited areas within the inundation zones.

Inundation maps should show areas inundated under flows from a dam failure during (1) fair weather (sunny day) conditions and (2) flood conditions (PMF/IDF). Inundation maps also typically show normal water levels. Adding inundation zones beyond the normal flows and two dam failure zones will make the printed maps more confusing and is not recommended. However, such layers can be included with the submitted GIS data files provided they are clearly labeled and not shown on the printed inundation maps.

If there is good reason not to include both dam failure boundaries - such as the inundation boundaries for the fair weather breach and the IDF breach are essentially the same when shown at the map scale, or the authorities only want one inundation zone - then only one boundary is adequate. In all cases, practical considerations should govern in selecting the

dam break scenario displayed on the inundation maps since the ultimate goal is to develop the best workable EAP. The discussion supporting this conclusion should be documented and included in Appendix A of the EAP or on the Notes Section of the inundation map.

The lines delineating the inundated area should be drawn in such thickness or form (solid line, dashed line, dotted line) as to readily identify the inundation limits as the main features of the map but not bold enough to block houses, roads or other features which are inundated by the flood waters. The area between the inundation lines representing the water level may be shaded or colored to distinguish the area of inundation. Care should be taken to select shading or colors that will not block important features on the map. Additionally, critical features or inundated structures can be highlighted to ensure visibility.

When plotting inundation limits between cross sections used for analysis, the lines should reasonably reflect the change in water levels with consideration given to topographic patterns and both natural and manmade features.

When inundation lines enter the area of an existing lake or reservoir, they should be drawn to represent an increase in the water level of the lake or reservoir. If the increased water level overtops a dam, the appropriate inundation lines should continue downstream of the dam to represent the expected flooding.

Cross Sectional Information

The maps should include cross section information for selected critical areas downstream of the dam. The following information should be included for the fair weather breach and IDF breach scenarios:

- Distance of cross section downstream from the dam
- Travel times (in hours and minutes) of the leading edge and peak of the dam break flood waves starting from when the dam fails
- Expected peak water surface elevations
- Expected peak velocities (optional)
- Incremental rises in water levels
- Peak discharges
- Estimated duration of inundation (optional)

Some communities use local flood crest levels instead of elevations to describe floods. The licensee should prepare maps using terms accepted by the emergency management authorities and local residents. The licensee should also try to ensure the cross section information is useful to all first responders. For example, a first responder may prefer the maps show the expected height of water over a road instead of peak water levels and

incremental rise. However, the National Weather Service may need the incremental rise and water level to issue flood warnings.

Coordination between all map users is necessary to ensure that not too much technical information is displayed on the maps because excess information will hamper the first responder’s ability to quickly glean critical information from the map. For example, much of the detailed cross section information could be moved to the index map sheet while the indexed sheets display only text boxes summarizing the hazards associated with a dam failure at critical cross sections. An example of this is shown in Appendix 6-N.

An example cross section table is as follows:

XS 1 – 0.9 Mile Downstream of Dam (Sleepy Hollow)		
	Fair Weather	Flood
Arrival Time	20 min	32 min
Time to Peak	50 min	1 hr 10 min
Max Elevation (ft)	659.8	661.4
Incremental Rise (ft)	7.1	3.4
Peak Flow (cfs)	4,700	7,300
Estimated Duration of Inundation ¹	6 hr	7.5 hr
Peak Velocity (ft/s) ¹	15	10

¹Optional/Suggested

The text boxes on the following page convey three different flooding severity hazards at three different cross sections with the green text box representing low flooding severity, yellow indicating moderate flooding severity, and red signifying the most severe. Dam breach velocities along with flooding depths are used to determine the flooding severity and the information contained in this style of text box. Additional guidance on selecting flooding severity hazards can be found in Commission’s Engineering Guidelines for Risk Informed Decision Making Chapter R22 - Estimation of Life Safety Consequences, the US Bureau of Reclamation’s - Reclamation Consequence Estimating Methodology: Guidelines for Estimating Life Loss for Dam Safety Risk Analysis, and FEMA-P-946 - Federal Guidelines for Inundation Mapping of Flood Risks Associated with Dam Incidents and Failures.

RV Park
Will be affected by
shallow, non-life
threatening flows approx.
1.2 hours after dam

Adams Street Bridge
Begins overtopping 1.5
hours after dam failure.
Max depth Over Road =
2.8 feet.

Adams Street Subdivision
Severe, life threatening flooding
will arrive 1.0 hours after dam
failure.

Additional Information

A “Notes” sheet can be included to provide additional information and detailed information supporting the development of the maps can be provided in an appendix for reference. The “Notes” sheet can be used by dam safety personnel and, if need be, ignored by first responders. The following information should be included with the inundation maps, as applicable:

- A map index if inundation maps are shown on several sheets. (see sample inundation maps in Appendix 6-N)
- Identify the antecedent flow conditions the maps are based on and any other pertinent dam breach information.
- Water surface profiles showing the elevation prior to failure, the peak water surface elevation after failure, and highlighted locations of critical structures.
- Written description of the areas affected by the dam break to clarify unusual conditions and the specific area threatened, including the extent and depth of the expected flooding, relative to known landmarks and historical flood heights.
- Justification for providing only one inundation zone on the maps instead of both the fair weather and IDF conditions, if applicable.
- Accuracy and limitation of the information supplied on the inundation maps and how to use the maps. A note should advise that because of the methods, procedures, and assumptions used to develop the flooded areas, the limits of flooding shown and flood wave travel times are approximate and should be used only as a guideline for establishing evacuation zones. Areas that are inundated depend on actual failure or flooding conditions and may differ from the areas shown on the maps.

Sample Inundation Maps

Appendix 6-N contains sample inundation maps developed for fictional projects. The samples show both 1-dimensional and 2-dimensional inundation maps. The sample maps

are examples to aid coordination efforts with the affected resource agencies.

Coordination

The licensee should review the inundation maps with the local emergency management authorities during annual and exercise seminars (see Section 6-4.2.1). The licensee should explain the maps and the effects from a dam failure using non-technical language. It is often beneficial to bring photos of structures at major cross sections and explain the expected water levels on these structures from a dam failure. The licensee should explain that the inundation zones and travel times are approximate and may vary depending on an actual failure.

The licensee should try to ensure that the local emergency management authorities understand the maps including the terms used, the area that would need to be evacuated, and how much time they would have to evacuate the residents in case of a dam failure. The licensee should also confirm the maps contain accurate and sufficient information for the emergency responders to perform their jobs. In situations where emergency management authorities are responsible for multiple licensees, joint coordination is needed to strive for consistency in inundation map styles/content.

The licensee and emergency management authorities should review if any new developments, buildings, or recreation areas were recently constructed within the inundation zones or if there was a change in the use of existing structures (e.g., if a previously vacant building now has residents). It is important that the emergency management authorities are aware of all developments that could potentially be impacted by a dam failure, since they are responsible for evacuations. The licensee and emergency management authorities can review GIS data to ensure each has the latest available information. If new streets, campgrounds, bridges, etc. are not shown on the maps, it may be necessary to hand draw the new information on the maps until the maps are updated.

Updating Maps

If there are significant changes to downstream development (e.g., new streets, bridges, subdivisions) that are not shown on the inundation maps and more-current base map information is available, the inundation maps should be updated. At a minimum, maps should be updated and reprinted during the EAP reprint cycle every five years (see Section 6-2.2.4).

3. Part II: Appendices

Appendices follow the main body of the EAP and contain information that supports and supplements the material used in the development and maintenance of the EAP.

Some of the topics that should, at a minimum, be contained in the appendices are:

- A. Investigation and Analyses of Dam Break Floods
- B. Plans for Reviewing, Revising, and Distributing the EAP
- C. Plans for Posting the Notification Flowcharts
- D. Forms and Log Sheets
- E. Site Specific Concerns
- F. Documentation

Each topic is described below:

A. Investigations and Analyses of Dam Break Floods. This appendix should identify and briefly describe the method and assumptions selected to identify the potentially inundated areas. This appendix should also include a description of the possible limitations on the accuracy of the study (e.g., computer generated elevations are expected to be within a certain accuracy).

The following are the typical information that should be documented in the supporting dam break analyses.

- Type of dam
- Assumed size, shape, and location of breach
- Assumed time of breach formation
- Assumed water surface elevation at failure
- Storage-reservoir curve
- Method/computer model used to determine downstream impacts
- Source of topographic data used
- Source of the base map
- Inflow hydrographs for fair weather and flood conditions
- Discussion of any sensitivity analyses performed and the reasons for the selected values
- Reason for or against including a domino failure of downstream dams
- Table showing output results at cross sections for pre- and post-failure conditions

The type of dam and the mechanism which could cause failure require careful consideration. Additional guidance on the selection of the parameters that contribute to the dam failure hydrograph can be found in Chapter II of the Commission's Engineering

Guidelines and the Commission's Engineering Guidelines for Risk Informed Decision Making Chapter R22.

- B. Plans for Reviewing, Revising, and Distributing the EAP. Once developed, the EAP must be continually reviewed and periodically revised and redistributed in accordance with these Guidelines and the specific and detailed instructions contained in Section 12.24 of the Commission's Regulations. Plans for these activities should be documented in an appendix. In addition to a narrative description of this process, distribution lists and a format record of reviews and revisions should be included. Example forms for reviewing, revising, and distributing the EAP are provided in Appendix 6-L, Tables L-2 and L-3.
- C. Plans for Posting the Notification Flowchart. An up-to-date copy of the Notification Flowchart should be posted in prominent locations at the dam site, operations center, and other pertinent locations, such as the residences of key personnel. Posting at appropriate local Emergency Operations Centers is also recommended. Maintaining a list of the locations of the posted Notification Flowcharts in the EAP will ensure that new flowcharts are posted when updates are issued.
- D. Blank Forms and Log Sheets. For easy access and use during an incident, blank forms and log sheets may be placed in an appendix. Forms may include a Record of EAP Reviews and Updates, record of Plan Holders, Emergency Incident Log, and Emergency Termination Log (see Appendix 6-L).
- E. Site Specific Concerns. Each dam and upstream and downstream areas are unique. As a result, each EAP is unique. Appendices can provide a discussion of any site specific concerns that provide valuable information affecting the EAP and its implementation. References to where appropriate structural drawings and flood data are maintained may be helpful. Quick access to this information may be crucial during emergency events.
- F. Documentation. Include the most recent documentation of consultations with Federal, State and local emergency management authorities, including public safety and law enforcement. Copies of the actual documentation sheets should be submitted to the Regional Engineer. All other copies of the EAP need only contain general statements pertaining to the documentation (e.g. a list of agencies involved, a statement that up-to-date documentation is on file, a statement that necessary coordination meetings have been held, etc.).

Include any memorandums/letters of agreement between the licensee and authorities regarding emergency procedures (e.g., if there is an agreement that the licensee will warn residents living directly downstream of the dam).

Include letters of acknowledgment from the contacted agencies indicating the agencies reviewed the plan and understand their responsibilities for alerting and/or evacuating the public in those areas within their jurisdictions.

Documentation should be updated on an annual basis to ensure that all participants have received the updates to the EAP and have the most up-to-date EAP on file. Remove older/obsolete documentation, as necessary. An example of how to ensure that outdated information is returned is to include a revision log with specific pages to be updated and a self-addressed envelope for the replaced pages to be returned by mail.

6-4 EMERGENCY ACTION PLAN EXERCISES

6-4.1 General

Licensees should exercise the EAP in coordination with state, local and tribal emergency management authorities, including, but not limited to, entities listed on the Notification Flowchart.

Exercises promote prevention, preparedness, and response to incidents and emergencies, and may also be extended to include recovery operations. Exercising also demonstrates the EAP's effectiveness in an actual situation and demonstrates the readiness levels of key personnel. Periodic exercises result in an improved EAP as lessons learned are incorporated into the updated EAP document.

6-4.2 Types of Exercises

There are seven types of exercises defined in the Homeland Security Exercise and Evaluation Program (HSEEP). The types are divided into discussion-based and operations-based exercises.

Discussion-based Exercises

Discussion-based exercises familiarize participants with current plans, policies, agreements, and procedures, or may be used to develop new plans, policies, agreements, and procedures. The following are types of discussion-based exercises:

- **Seminar.** A seminar is an informal discussion, designed to orient participants to new or updated plans, policies, or procedures, *e.g.*, a seminar to review a new Evacuation Standard Operating Procedure.
- **Workshop.** A workshop resembles a seminar but is used to build specific products, such as a draft plan or policy. For example, a Training and Exercise Plan Workshop is used to develop a Multi-Year Training and Exercise Plan.

- **Tabletop Exercise.** A tabletop exercise involves key personnel discussing simulated scenarios in an informal setting. Tabletop exercises can be used to assess plans, policies, and procedures.
- **Games.** A game is a simulation of operations that often involves two or more teams, usually in a competitive environment, using rules, data, and procedures designed to depict an actual or assumed real-life situation.

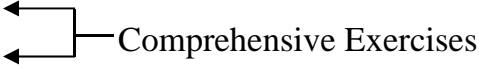
Operations-based Exercises

Operations-based exercises validate plans, policies, agreements and procedures; clarify roles and responsibilities; and identify resource gaps in an operational environment.

Types of operations-based exercises include:

- **Drill.** A drill is a coordinated, supervised activity usually employed to test a single specific operation or function within a single entity, such as testing sirens and warning systems, calling suppliers, checking material on hand, and conducting a call-down drill of those listed on the Notification Flowchart.
- **Functional Exercise.** A functional exercise examines and/or validates the coordination, command, and control between various multi-agency coordination centers, such as Emergency Operation Centers (EOCs) and joint field offices. A functional exercise does not involve any "boots on the ground," such as first responders or emergency officials responding to an incident in real time.
- **Full-Scale Exercises.** A full-scale exercise is a multi-agency, multi-jurisdictional, multi-discipline exercise involving functional, *e.g.*, joint field office, emergency operation centers, and "boots on the ground" response to a simulated event, such as activation of the EOC and role-playing to simulate an actual dam failure.

Of the seven types of exercises, five form the basis for the FERC's EAP Exercise Program:

- Seminar
 - Drill
 - Tabletop Exercise
 - Functional Exercise
 - Full Scale Exercise
- 

A licensee's exercise program should be built from the ground up, beginning with simple exercises and advancing to more complex exercises. Sufficient time should be provided

between each exercise to learn and improve from the experiences of the previous exercise.

Functional and full-scale exercises are considered comprehensive exercises that provide the necessary verification, training, and practice to improve the EAP and the operational readiness and coordination efforts of all parties responsible for responding to emergencies at a dam. The basic difference between these two exercise types is that a full-scale exercise involves actual field movement and mobilization; in a functional exercise, field activity is simulated.

The primary objectives of a comprehensive exercise (functional and full-scale) are listed below:

- Reveal the strengths and weaknesses of the EAP, including specified internal actions, external notification procedures, and adequacy of other information, such as inundation maps.
- Reveal deficiencies in resources and information available to the dam owner and emergency management authorities.
- Improve coordination efforts between the dam owner and emergency management authorities. Close coordination and cooperation among all responsible parties is vital for a successful response to an actual emergency.
- Clarify the roles and responsibilities of the dam owner and emergency management authorities.
- Improve individual performance of the people who respond to the dam failure or other emergency conditions.
- Gain public recognition of the EAP.

The following sections describe the five types of exercises and describe how the exercises relate to the Commission's EAP program. These guidelines include detailed information including exercise terminology and preparing for and performing higher level exercises based on FEMA and HSEEP guidance. More information on the HSEEP can be found at <https://hseep.dhs.gov>.

6-4.2.1 Seminar

A seminar is a face-to-face meeting that involves bringing together those with a role or interest in an EAP (i.e., licensee and State and local emergency management authorities) to discuss the project and EAP.

A. Purpose of Exercise

The purpose of the seminar is to enable each participant to become familiar with the EAP and the roles, responsibilities, and procedures of those involved. It is an opportunity to exchange information and ensure the EAP remains current and workable.

B. Participation

The seminar involves licensee personnel and emergency management authorities.

C. Requirements

Seminars are face-to-face meetings between licensees and primary emergency management authorities whose jurisdictions would be quickly inundated (i.e., within the first 2-3 hours) or have significant impacts from a dam failure (i.e., many people would need to be evacuated). These meetings should take place at least once a year. Separate seminars are not needed during years when tabletop, functional, or full-scale exercises are performed. This is because a discussion about the EAP and participants role during an emergency should happen before the high-level exercise starts during the player briefing.

D. Where to Conduct Exercise

Seminars can be done on a one-on-one basis, where the licensee visits an individual agency office. Alternatively, if a dam failure would significantly impact several jurisdictions, several parties could meet at one time and location. Licensees can also consider combining seminars for several dams within a river basin into one meeting.

E. Conducting the Exercise

The following list includes possible discussion topics during seminars:

1. Describe the project, possible effects of a dam failure, and EAP (especially the flowchart and inundation maps).
2. Discuss any recent development along the river and verify if the information on the inundation maps is adequate.
3. Discuss how emergency management authorities will implement their evacuation plan and if all affected residents can be warned and evacuated in a timely manner.
4. Discuss any public education efforts which occurred during the previous year.

5. Discuss emergency equipment at the project (e.g., sirens, back-up communication equipment).
6. Explain the difference between the emergency level categories of notification (i.e., imminent failure, potential failure, high flow, non-failure). Have the authorities explain how they would react to each condition.
7. Get feed-back from the emergency management authorities on whether the EAP is understandable and useful. If not, discuss what can be modified.
8. Discuss how parties will coordinate and exchange information throughout emergencies.
9. Discuss results from recent annual drills or higher-level exercises.
10. Hand-deliver annual updates or revisions such as changes in organizations, personnel, phone numbers, emergency response responsibilities, or other site specific information. Ensure previous updates have been incorporated into the agencies' plans and superseded information has been replaced.
11. Request the agencies to notify the licensee of any changes to key personnel immediately.
12. Review what parts of the EAP are necessary for particular agencies. Portions of the plan that don't apply to particular agencies can be retained by that agency in a separate folder or removed at their option.
13. Go over schedules for future exercises.

F. Reporting Requirements

The annual EAP Status Report should briefly describe the seminar. The EAP Status Report is further discussed in Section 6-2.2.6.

6-4.2.2 Drill

A drill tests, develops, or maintains skills in a single emergency response procedure. An example of a drill is an in-house exercise performed to verify the validity of telephone numbers and other means of communication along with the licensee's response.

A. Purpose of Exercise

The purpose of the drill is to ensure licensee personnel are fully cognizant of the procedures and actions required during an emergency, and that emergency procedures and equipment work properly.

B. Participation

The drill should include all operations staff, any personnel that work at the dam, and other licensee staff involved with the EAP. During the drill, licensee personnel should call all organizations on the notification flow chart to verify phone numbers and other means of communication are accurate.

C. Requirements

Each licensee is required to conduct an annual EAP training session and exercise known as the in-house drill to test the state of training and readiness of key licensee personnel responsible for actions during an emergency. The licensee should conduct an annual drill for each of its EAPs. It is acceptable for an annual drill to concurrently test the EAP for several dams when an overlap in notification is involved. No separate drill is required in any year when a comprehensive exercise takes place.

D. Conducting the Exercise

As part of the drill, a training session should be held with all licensee personnel involved with an emergency response. The training should focus on how all the internal personnel fit into the EAP and their roles and responsibilities for the different emergency levels.

The drill should simulate an emergency condition. The licensee staff member responsible for conducting the test should first develop a realistic scenario under which the EAP would be implemented. Then participants should be questioned on how they would react to certain situations up to and including enacting the EAP. Preferably, the scenario should be varied from year-to-year. Any special procedures required for nighttime, weekends, and holidays should also be considered when developing the scenario.

As part of the drill, participants should perform a call down test - contacting the organizations that would be involved in an emergency to ensure that telephone numbers and any other means of communication listed on the notification flow chart are accurate. During this call, participants can verify the contact information is correct, agency personnel are familiar with the EAP, and all parties know what they would do during an actual emergency. Beforehand, the licensee should try to ensure that any outside party being contacted is aware the call will be part of a drill. Furthermore, during the drill, the

outside parties should again be informed the call is part of a drill and is not an actual emergency.

Licensees are encouraged (not required) to consider the merits of a surprise in-house drill versus a planned one. The licensee at the time it implements a "surprise" drill should advise its employees that the drill is a test and not an actual emergency. While a planned drill will allow participants to rehearse their roles in the EAP, a surprise drill can be more educational because it is likely to expose basic flaws in the EAP.

Testing of remote sensing equipment at unattended dams and emergency notification equipment such as sirens and two-way radios should be performed at least once a year. Equipment tests do not necessarily have to be performed on the same day as other drill activities. However, the tests are considered part of the drill and should be reported on in the EAP Status Report.

E. Follow-up

Immediately following the drill, the licensee should assess (evaluate) the results with all involved participants. The responses to the emergency scenario at all levels should be reviewed. The purpose of this evaluation is to identify deficiencies in the EAP, including notification, priorities, responsibilities assigned, etc.

The licensee should prepare a brief report describing the drill, evaluation, and any lessons learned. If the drill indicates changes should be made to the EAP, the document should be revised and the revisions disseminated to all involved parties. It is recommended that revisions and updates be hand-delivered to significant emergency management authorities.

F. Reporting Requirements

The EAP Status Report should include a brief report describing the drill, evaluation, and any lessons learned. The report should also describe the project's emergency equipment and the date tested. The EAP Status Report is further discussed in Section 6-2.2.6.

6-4.2.3 Tabletop Exercise

The tabletop exercise involves a meeting of the licensee and EAP planholders, including State and local emergency management officials in a conference room environment. The exercise begins with the description of a simulated event and proceeds with discussions by the participants to evaluate the EAP and response procedures. The exercise provides opportunities throughout the exercise to stop and discuss what actions and responses would be appropriate.

A. Purpose of Exercise

The purpose of the tabletop exercise is to familiarize participants with roles, procedures, responsibilities, and personalities of the licensee and the emergency management authorities. The exercise should identify needed improvements in the EAP, identify needed improvements in the emergency management system and the licensee's organization, identify needed training/personnel deficiencies, and identify areas requiring additional coordination.

B. Participation

The tabletop exercise involves the various levels of the licensee and emergency management personnel that would be involved in an actual emergency. The exercise should also include other representatives of localities that could be affected by a dam failure, such as elected officials and campground owners. Also, representatives from the National Weather Service should be invited since they are responsible for initiating flood warnings.

The individuals involved in the exercise should be those people who are responsible for the coordination and implementation of the EAP. They should be those individuals from the licensee and authorities that would be most active during a disaster.

C. Requirements

The Commission recommends that tabletop exercises be performed prior to comprehensive exercises. It is beneficial that they take place at least 30 days prior to the comprehensive exercise so any changes to the EAP based on the tabletop exercise can be completed before the comprehensive exercise. Other options are holding a tabletop in the year before a comprehensive exercise will occur, or on the same day of the comprehensive exercise if it is difficult to get all parties involved to participate in exercises on two separate days. Although having a tabletop and comprehensive exercise on the same day is possible, it is not recommended. Licensees can also consider performing tabletop exercises as part of annual seminars.

The Regional Engineer may require a tabletop exercise be performed for certain projects to enhance coordination with emergency management authorities. This is done on a case-by-case basis.

D. Preparation

It is necessary to assemble an Exercise Planning Team who will design, develop, conduct, and evaluate the exercise. It is beneficial to include members of organizations and agencies that are participating in the exercise, but not participants themselves.

The process of developing a tabletop exercise involves *assessing the needs* for an exercise, *defining the scope* of the exercise, writing a *statement of purpose*, writing *objectives*, and developing a *scenario*. These steps are briefly discussed below.

The first step in the process of developing an exercise is to *assess the needs* of the participants by identifying those areas most in need of an exercise.

In *defining the scope* of an exercise, six components should be addressed in the developmental stage: (1) the types of licensee and emergency management agency activities or procedures you want to exercise; (2) the parties to be involved; (3) the kinds of personnel involved, with an understanding of their capabilities and critical tasks involved in their jobs; (4) the degree of realism desired; (5) the hazard or the selection of a high priority problem; and (6) the geographical area where the problem could occur.

The *statement of purpose* should clearly and concisely explain why the exercise is being conducted. It is largely written from the scope of the exercise and can be used to tell others about the exercise.

The next step in developing an exercise is writing *objectives* which define what should be accomplished by conducting the exercise. The needs assessment, scope, and purpose statement should be examined very closely during objective writing to address expected benefits of the exercise and what emergency actions are to be exercised. Emergency response organizations will typically develop objectives based on a pre-developed list of core capabilities and critical tasks that they want to focus on. Exercise objectives should be simple, measurable, achievable, realistic, and task-oriented. There should be a limited number of objectives, typically 3-7 depending on the complexity of the exercise.

The next step is to prepare a *scenario*. A scenario is a short written story that sets the scene for the exercise. It is an account composed of a few paragraphs that provides conditions that allow the exercise participants to demonstrate proficiency and competency in their roles. The job of the scenario is to get the exercise participants into the exercise as if they were confronting a real situation. The scenario should be written so that it helps participants understand the situation and reflect a sense of concern, urgency, and excitement.

While setting the scene for the simulated emergency and providing the technical details that depict conditions and events, the scenario should NOT provide participants with ALL the information necessary to respond to a situation. Participants will gather additional details during the exercise as the events unfold. The scenario should NOT suggest possible responses to the simulated emergency.

For tabletop exercises, a **Situation Manual** can be prepared for each participant. The manual includes an introduction, scenario, participant questions and references.

E. Conducting the Exercise

Prior to beginning a tabletop exercise, the licensee should conduct a player briefing to explain the project, the EAP (including emergency levels and inundation maps), the roles of all parties during the emergency, and procedures for the exercise. Any questions should be addressed prior to beginning the exercise.

Tabletop exercises are typically held in conference rooms. If the number of participants is about 25 or less, the exercise is typically run in a classroom style setting with a single facilitator leading the discussion of the group. With larger numbers of participants it is beneficial to separate organizations by their function (e.g., on-site dam operations, county emergency responders, and state emergency responders) at different tables and each table has a facilitator/evaluator to lead a discussion of the scenario and ask questions. A spokesperson for each table will report out key findings to the entire room.

The methodology of a tabletop exercise is an open-ended discussion in a meeting format through a facilitator. The discussion is allowed to be interrupted by questions and participant comments. The effectiveness is determined by feedback from participants and the impact this feedback has on evaluating and revising policies, plans, and procedures. There is no utilization of equipment or deployment of resources.

The facilitator begins the tabletop session by reading a scenario, or a portion of the scenario, which sets the scene for the simulated event. The scenario briefly describes what has happened and what is known at this point. For example, the first statement of a scenario could be:

“After two weeks of heavy rains, the project’s gates are fully open and are passing a record flow of 10,000 cfs. During the previous night, reservoir levels have risen 2.5 feet above normal levels to elevation 80 ft. This is three feet beneath the crest of the embankment. A member of the maintenance crew has just observed a new seep at the toe of the embankment near the low level outlet.”

Following the scenario, or portion of the scenario, the facilitator will typically pose problem statements and ask participants to explain how they would react. The following are issues often discussed during the tabletop exercises:

- What actions do the dam operators take?
- What do operators of other dams on the river need to know?
- Should the EAP be implemented?
- Who implements the EAP?

- Who has primary notification responsibility?
- What information is needed by the different players?
- What actions would each of the primary players take?
- Is the priority of calls on the notification flowchart appropriate?
- What are each emergency management authorities' actions, responsibilities, and considerations with regard to evacuations?
- Where will shelters be set up?
- Where will the Emergency Operations Center be set up?
- What evacuation routes are available?
- Who determines if outside assistance is needed?
- Are adequate resources available? If not, where can they be gotten?
- Who is providing public information and how?

Facilitators for tabletop exercises monitor the pace and flow of the exercise by introducing the scenario and stimulating discussion, making sure that no one participant dominates the exercise. The facilitator leads the exercise and makes sure every participant discusses their role during the exercise.

If there are residences, businesses, campgrounds, and recreation areas located in close proximity downstream of a dam, the timing of emergency responses is critical. The facilitator can have participants discuss the detailed steps they would take - from determining a problem at the dam through evacuations - and get them to estimate how long it would take to accomplish each step. These estimates can be used to establish the total response time, which can be compared to information from the inundation maps to determine if people can be warned and evacuated in time (see Section 6-5).

During the exercise, the facilitator or evaluators should note all issues being raised by the participants, especially those that will require follow-up actions. At the conclusion of the exercise, an oral after-action review, typically called a **Hot Wash**, should be conducted with exercise participants, planning team members, facilitators, and evaluators. The review should focus on (1) roles and responsibilities, (2) EAP and emergency response procedures, (3) necessary communications, and (4) the adequacy of materials, equipment, and staff levels. The review should address the procedures that worked well and the procedures that did not work well. Responses from all participants involved in the exercise should be considered. Input should be received both orally and in writing through feedback forms.

F. Benefits

The advantages of a tabletop exercise are that there is modest commitment in terms of time, cost and resources. It provides an effective method of reviewing plans, implementing procedures and policies, and it serves as an educational device to acquaint

the licensee and key agency personnel on emergency responsibilities and procedures. It also acquaints licensee and emergency response personnel with each other on a personal basis.

The disadvantages of a tabletop exercise are that it lacks realism, and does not provide a true test of participants' capabilities. It provides only a limited exercise of plans, procedures, and participants' staff capabilities.

G. Follow-up

Immediately after the Hot Wash has concluded, all facilitators and evaluators should meet with other members of the exercise planning team to hold a **Debrief**. During the Debrief, team members should discuss any issues and concerns noted during the exercise and areas for improvement. Following the Debrief, an evaluation should be performed to formalize what was learned.

The purposes of evaluating the exercise are to identify:

- Needed improvements in the EAP
- Needed improvements in the licensee's organization and the emergency management system,
- Needed training/personnel deficiencies,
- Whether the exercise has achieved its objectives, and
- Areas requiring additional coordination.

Data for an evaluation include the evaluator's observations, participants' oral and written comments, facilitator's observations, any subsequent clarification or discussion with participants, and exercise plans, objectives, expected actions, and procedures. The evaluation team should discuss and evaluate the events before, during, and after the exercise; actions taken by each participant; the time required to become aware of an emergency and to implement the EAP; and improvements for future emergencies.

Team members will then draft an Evaluation Report or After Action Report which describes what happened during the exercise, exemplary practices, issues that need to be addressed, and recommendations for improvement. A sample format for an Evaluation Report is in Appendix 6-B. Alternatively, HSEEP provides guidance on the format for After Action Reports and Improvement Plans.

H. Reporting Requirements

At least 90 days before performing a tabletop exercise, the licensee should submit a plan and schedule to the Regional Engineer explaining when and where the exercise will take place.

Within 60 days of completing a tabletop exercise, the licensee should submit to the Regional Engineer an Evaluation report of the exercise including comments from participants and any recommendations for modifications to emergency procedures and the EAP.

6-4.2.4 Functional Exercise

The functional exercise simulates a dam failure and other specified events in a stress-induced environment with time constraints. The participants “act out” their actual roles in a simulated emergency. **Conducting a functional exercise should be a major goal of every exercise program.** It offers the opportunity to test participants’ responses in a full simulation under "real-life" conditions, but without a field deployment of resources.

A functional exercise is considered a “comprehensive exercise”.

A. Purpose of Exercise

The functional exercise is designed to evaluate the following factors under simulated conditions that provide realism and stress:

- The capabilities and responses of the licensee and emergency management personnel.
- The workability of the information in the EAP.
- Coordination between the licensee and emergency management personnel.
- Individual and system-wide performances.

B. Participation

The functional exercise involves the various levels of the licensee and emergency response personnel that would be involved in an actual emergency. The exercise should also include other representatives of localities that could be affected by a dam failure, such as elected officials and campground owners. Also, representatives from the National Weather Service should be invited since they are responsible for initiating Flood Warnings.

The individuals involved in the functional exercise should be those people who are responsible for the coordination and implementation of the EAP. They should be those individuals from the licensee and authorities that would be most active during a disaster.

A functional exercise can involve policy, coordination, and operational response personnel of the licensee and involved emergency management authorities. It is

sometimes difficult because of busy schedules or other commitments to get policy-level personnel involved in a functional exercise, but their presence is beneficial. The licensee should attempt to involve key personnel so that the appropriate level of importance is understood by management.

C. Requirements

The Commission tries to have at least one comprehensive (i.e., functional or full-scale) exercise over a five year period in each river basin where there is a project required to have an EAP. This schedule is meant to ensure that licensee personnel and local emergency management authorities in each river basin do not have excessive lengths of time between exercises. If there are several dams owned by different organizations within a river basin or a licensee owns dams in adjacent basins, the following methods can be used to avoid excessive exercises:

1. Combining Exercises. In river basins with dams controlled by more than one dam owner, exercises can be combined to include multiple projects (See Figure 1). The exercise can be combined with other licensees or non-jurisdictional dams (e.g., U.S. Army Corps of Engineers, U.S. Bureau of Reclamation) in the same basin. Also, licensees that have projects in adjacent basins but whose failures would affect similar emergency management authorities may choose to have a single functional exercise that includes both projects (See Figure 2).
2. Alternating Tabletop and Functional Exercises. Licensees that have projects in several river basins which overlap the jurisdictions of emergency management authorities can propose a combination of Tabletop and Functional Exercises over a five year period. For example if a licensee owns two dams in two nearby basins with many of the same emergency management authorities, the licensee may alternate functional and tabletop exercises between the two projects every five years.
3. Piggybacking on Other Functional Exercises. Emergency management authorities may have other functional exercises scheduled throughout the year for different hazards (e.g., earthquakes, terrorism) and licensees can suggest the dam failure exercise be included. This is acceptable only if the dam failure scenario is adequately exercised. The exercise should test the warning and notification procedures for licensee personnel, the workability of the EAP, and how the emergency management authorities would evacuate downstream inundation zones. The licensee would still be responsible for inviting all emergency management authorities affected by the dam failure to attend and preparing adequate messages to test the dam failure scenario.

Licensees with several projects in a single basin should strive to focus on a failure at a

different project within the basin every five years or assume a domino failure of more than one of their dams. Licensees should have personnel from their other projects attend the functional exercise. The goal is to include as many of the licensee's personnel from different dams in the comprehensive exercise.

D. Preparation

Functional exercises should be performed after seminars, drills and tabletop exercises have been conducted. If reactions to earlier exercises are good, the policy-level personnel will be more likely to participate in a functional exercise.

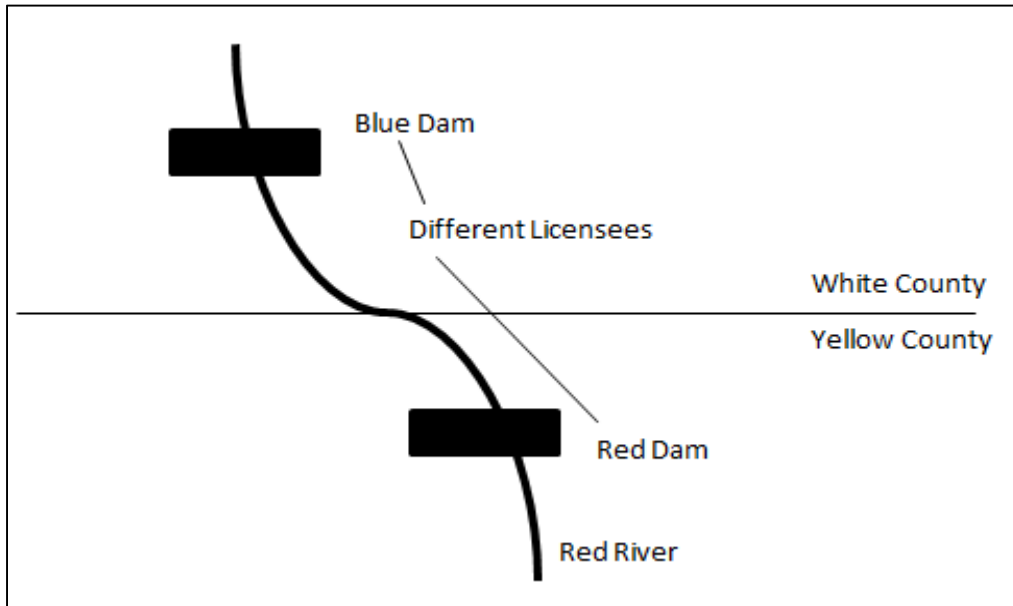


Figure 1 - Combined Functional Exercise

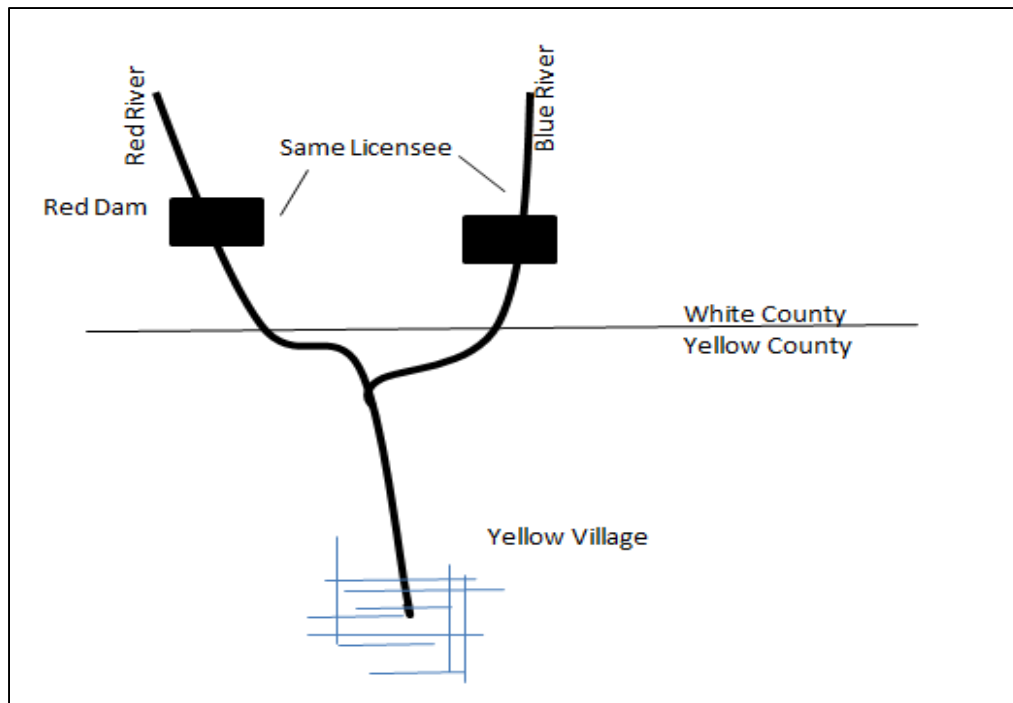


Figure 2 - Combined Functional Exercise

Simulation of a realistic emergency requires the development of objectives, a scenario, a Master Scenario Events List (MSEL), a timed sequence of injects, and communication between participants and simulators. These items will be developed by the Exercise Planning Team (See Section 6-4.2.3 on preparation for tabletop exercises).

The MSEL consists of a list of events that would occur in chronological order that would happen during the exercise. To create a MSEL, it is beneficial to first create a list of *major events* itemizing the events from the beginning of the exercise to the conclusion that will require a response by the licensee or the emergency preparedness authorities. Then for each major event, a list of *detailed events* should be created that itemizes the details for each major event. Based on the detailed events and a list of expected actions players should take for each detailed event, the exercise planning team can prepare **injects**. The injects transmit details of the exercise to the participants so that they will be able to respond with an action or decision.

A MSEL will typically list the inject number, its delivery time, a short description, the responsible controller giving the message, and the receiving player.

Other preparation tasks for a functional exercise include assuring adequate physical facilities, organizing displays and materials, recruiting and training exercise participants, and planning for the exercise evaluation. The level of complexity needed for the

functional exercise should be commensurate with the anticipated site conditions and complexity of the notification procedures.

Because these tasks are so varied and dependent upon each other's completion, it is important to plan this preparation time carefully. Milestones should be established along with responsibilities for each of the major activities of preparation.

For Functional Exercises, an **Exercise Plan** can be prepared for each participant. Exercise Plans are general information documents that help operations based exercises run smoothly by providing participants with a synopsis of the exercise.

E. Where to Conduct Exercise

The exercise can be conducted with the participants in one location or with the participants located at their own facilities. Having exercises where people are stationed where they work has the added benefit of evaluating communications through expected emergency communication links. However, there is a greater possibility to lose containment of messages (e.g., exercise messages may be confused for an actual emergency). Also, all parties will have to assemble after the exercise in one location for the evaluation session.

If possible, the licensee should encourage the activation of the Emergency Operations Center (EOC) at the State or local level, as appropriate, so that the EOC members can practice a coordinated, effective response in a time-pressured, realistic emergency situation. If the actual EOC is not activated, the exercise should bring together the policy, coordination and operational officials of the licensee and emergency management authorities into a simulated EOC.

F. Conducting the Exercise

Prior to beginning a functional exercise, the licensee should hold a Player Briefing. The licensee should explain the EAP (including emergency level categories and inundation maps) and the roles of all parties during the emergency. Also, the licensee should describe the dam, other project facilities, and the downstream impacts from a dam failure.

The functional exercise begins with a scenario which sets the scene for the simulated event. Following the scenario, injects describing detailed events are distributed to the participants. The injects should cause the participants to respond or take action.

The exercise should be conducted in a real-time environment, although compressed-time or skip time may be necessary to involve emergency responders further downstream. After the initial stages, momentum of the exercise is determined largely by spontaneous interaction among participants and simulators. Scenario-related injects of increasing

complexity, threat, and pressure are interspersed in an emergency situation designed to test the participants' skills, knowledge, awareness, and ability to respond under simulated conditions.

The functional exercise is immediately followed by a Hot Wash that allows participants to evaluate their performance and lessons learned throughout the exercise. The Hot Wash should be conducted with exercise participants, planning team members, controllers, and evaluators. The Hot Wash should focus on (1) roles and responsibilities of all participants, (2) EAP and emergency response procedures, (3) necessary communications, and (4) the adequacy of materials, equipment, and staff levels. The Hot Wash should address the procedures that worked well and the procedures that did not work well. Responses from all participants involved in the exercise should be considered. Input should be received both orally and in writing through feedback forms.

Apart from the actual participants in the functional exercise, there are three roles that representatives of the licensee and/or emergency preparedness authorities should fill. These are the exercise controller, exercise simulators, and exercise evaluators.

The controller's responsibilities include monitoring the sequence of events as they unfold, the flow of injects, the overall conduct of the exercise, controlling the spontaneous injects by simulators, coordinating information among simulators, and responding to unplanned situations.

The simulators' responsibilities include sending pre-scripted injects at the scheduled time, responding to unanticipated actions by participants with spontaneous injects, and maintaining contact with the controller about the progress of the exercise.

The evaluators have the task of observing the actions and decisions of the participants during the exercise and contributing, along with the comments of exercise participants, to the formation of an evaluation report. In particular, evaluators will be looking to see how participants react to the scenario events and injects. Ideally, there should be an evaluation team with representatives from the licensee and planholders.

G. Benefits

The functional exercise gives participants a fully simulated experience of being in a major disaster. The exercise provides the opportunity to test any functional area needed for an efficient response or recovery from an emergency. See Section 6-4.4 for a list of the five standard functions that should be included as a minimum in the exercise. Participants are able to assess the direction and control of the disaster management; the decision-making process, communication and information among participants, allocation of resources and staff; overall adequacy of resources to meet the disaster situation; and adequacy of current policies, plans, and procedures. The functional exercise also

encourages a spirit of cooperation and coordination between the licensee, the emergency management authorities, and the FERC.

H. Follow-up

Immediately after the Hot Wash has concluded, all controllers and evaluators should meet with other members of the exercise planning team to hold a Debrief (See Section 6-4.2.3.G). During the Debrief, team members should discuss any issues and concerns noted during the exercise and areas for improvement. Following the Debrief, an evaluation should be performed to formalize what was learned.

A written Evaluation Report or After Action Report and any follow-up to the recommendations in the report are vital aspects of the exercise. Appendix 6-B contains a suggested format for the Evaluation Report. Alternatively, HSEEP provides guidance on the format for After Action Reports and Improvement Plans.

I. Reporting Requirements

At least 90 days before performing a functional exercise, the licensee should submit a plan and schedule to the Regional Engineer explaining when and where the exercise will take place.

Within 60 days of completing a functional exercise, the licensee should submit to the Regional Engineer an evaluation report of the exercise including comments from participants and any recommendations for modifications to the EAP.

6-4.2.5 Full-Scale Exercise

The full-scale exercise is the most complex level of exercise. It evaluates the operational capability of all facets of the emergency management system (both licensee and State and local emergency management authorities) interactively in a stressful environment with the actual mobilization of personnel and resources. It includes field movement and deployment to demonstrate coordination and response capability. The participants actively "play-out" their roles in a dynamic environment that provides the highest degree of realism possible for the simulated event. Actual evacuation of critical residents may be exercised if previously announced to the public.

A full-scale exercise is considered a "comprehensive exercise."

A. Purpose of Exercise

A full-scale exercise is intended to evaluate the operational capability of licensee and agency participants in an interactive manner over a substantial period of time. It tests a

major portion of the basic elements existing within EAPs and the participants' actions to implement the EAPs in a stressful environment. Full-scale exercises test the mobilization of personnel and resources and the actual movement of emergency workers, equipment, and resources required to demonstrate coordination and response capabilities.

B. Participation

A full-scale exercise should include all participants that would be included in a functional exercise (e.g., policy makers, coordination personnel, operations personnel, National Weather Service, elected officials). In addition, the exercise should include response personnel that are responsible for such things as road closures, evacuations, and medical attention during an actual emergency. The exercise may include volunteers or local residents that could be affected by a dam failure.

C. Requirements

The Commission tries to have at least one comprehensive (i.e., functional or full-scale) exercise over a five year period in each river basin where there is a project required to have an EAP. Due to the complexity and expense in terms of personnel and equipment, the full-scale exercise will normally be performed at the licensee's option. The Regional Engineer may require a full-scale exercise for project-specific reasons or a lack of confidence in previously performed lower level exercises. For additional information refer to the Requirements for Functional Exercises in Section 6-4.2.4.

D. Preparation

Full-scale exercises should be the culmination of an exercise development program that has grown with the capacity of the participants to conduct exercises. This should also include an ongoing cycle of progressively more in-depth exercises and evaluations.

For agencies or local communities, full-scale exercises require considerable preparation and can often be aimed at practical tests of "first-in" responders, including police, fire, and medical personnel. They can be used to test triage (dealing with casualties) procedures, on-scene management of resources, and coordination through field command posts.

Careful consideration should be given to selecting the day, date, and time for any exercise. The inclusion of these types of considerations should be left to the agencies since they can best assess the benefits and constraints of doing so.

Ample warning should be given to the public so there is no confusion for an actual emergency.

The scope, statement of purpose, objectives, scenario, MSEL, and injects should be developed by an Exercise Planning Team. (See Sections 6-4.2.3D and 6-4.2.4D on preparation for tabletop and functional exercises)

In any exercise, a real emergency might occur, especially during a lengthy full-scale exercise. During a real emergency, it may be necessary for some participants to leave. If possible, both the licensee and emergency preparedness authorities should ensure there are enough personnel and equipment not involved in the exercise to respond to a real emergency.

E. Where to Conduct Exercise

Because a full-scale exercise requires the mobilization of personnel and resources, careful consideration must also be given to the selection of an exercise site. The primary factor here is one of adequate space, financial capability, and support.

During the exercise, participants should make use of designated Emergency Operations Centers. Field sites should focus on areas that could be impacted by a dam failure.

F. Conducting the Exercise

A full-scale exercise adds a field component that interacts with a functional exercise through simulated injects. Other major components of a full-scale exercise include testing the deployment of seldom-used resources; involving policy, coordination, operational, and field response personnel and resources; and testing a major portion of EAPs, resources, and capabilities.

Full-scale exercises add an integration and coordination component to the functional exercise. They do not substitute for simulation; instead, they complement it. Events and injects may be complex and detailed. Many of the injects will be pre-scripted and scheduled, while others may be dynamically input by controllers in response to the flow of the exercise.

As with the functional exercise, the controller is responsible for assuring that the exercise starts on schedule. Simulators and evaluators should keep a log of all significant events. Also, each participant should log its actions as much as possible. Videotaping the exercise and evaluation can be beneficial.

The safety and well-being of participants and the general public is a major factor for the full-scale exercise. A safety officer should be designated to analyze and oversee the entire exercise from a safety perspective.

At the conclusion of the exercise, the participants, planning team members, controllers, and evaluators will need to meet in one location for the Hot Wash. The Hot Wash should focus on (1) roles and responsibilities of all participants, (2) EAP and emergency response procedures, (3) necessary communications, and (4) the adequacy of materials, equipment, and staff levels. The Hot Wash should address the procedures that worked well and the procedures that did not work well. Responses from all participants involved in the exercise should be considered. Input should be received both orally and in writing through feedback forms.

G. Benefits

Full-scale exercises draw media and community attention to emergency preparedness; teach by doing; test total coordination, not only among policy and coordination officials, but also field forces; test many licensee and agency emergency management functions at one time; evaluate cooperation; and point out physical resource capabilities. They can be a true test of the total emergency management system and the effectiveness of a specific EAP.

Full-scale exercises greatly expand the scope and visibility of the exercise program. A well designed, full-scale exercise can be used to obtain a great deal of favorable media attention. In fact, a full-scale exercise of any magnitude will draw media attention whether it is sought or not. Therefore, it is wise to include the media in any exercise plans. The media can be extremely helpful in a number of ways, and it will increase realism if they are present. Alternatively, a poorly conducted exercise can create credibility problems for the licensee's entire EAP program.

H. Follow-up

Immediately after the Hot Wash has concluded, all controllers and evaluators should meet with other members of the exercise planning team to hold a Debrief (See Section 6-4.2.3G). During the Debrief, team members should discuss any issues and concerns noted during the exercise and areas for improvement. As part of the Debrief, an evaluation should be performed to formalize what was learned.

Based on findings from the Debrief, the licensee should prepare and submit a written Evaluation Report or After Action Report and follow up on the recommendations in the report. Appendix 6-B contains a sample outline for an exercise Evaluation Report. Alternatively, HSEEP provides guidance on the format for After Action Reports and Improvement Plans.

I. Reporting Requirements

At least 90 days before performing a full-scale exercise, the licensee should submit a plan and schedule to the Regional Engineer explaining when and where the exercise will take place.

Within 60 days of completing a full-scale exercise, the licensee should submit to the Regional Engineer an evaluation report of the exercise including comments from participants and any recommendations for modifications to the EAP.

6-4.3 Licensee's Role for Developing and Conducting Exercises

The design of an effective exercise depends on the coordination and cooperation of the licensee, the FERC, and the emergency management authorities. Ideally, the licensee should chair the exercise. It may also be appropriate for an emergency management authority representative to co-chair the exercise. The licensee should assemble an Exercise Planning Team who will design, develop, conduct, and evaluate the exercise. It is beneficial to include members of organizations and agencies that are participating in the exercise, but not participants themselves. The licensee does not necessarily have to serve as the controller or facilitator of the exercise.

As chair, the licensee should oversee the development of the exercise. It has the responsibility to coordinate the schedule for the actual exercise, including the seminars, drills, tabletop exercises, etc. The licensee should advise the Regional Engineer of the plan and schedule for the exercise, including the date of each aspect of the exercise. (See Section 6-2.2.3 for reporting requirements.)

The primary function of a comprehensive exercise is to test the response of the licensee and emergency management authorities from a dam failure. The licensee, as chair, should ensure that this remains the primary focus of the exercise.

The licensee should define the scope of the exercise and write a statement of purpose prior to contacting the emergency management authorities to coordinate an exercise. The statement of purpose can be used to tell the authorities about an exercise. The licensee should clearly set forth for the authorities the aspects of the EAP that it wants to examine and the level of involvement of the State and local authorities. The local authorities may introduce other emergencies that could occur at the time of the dam failure to test their capabilities to respond to several incidents at one time.

The FERC will provide assistance, as necessary. The FERC will participate in the exercise as an observer and will participate in the follow-up evaluation of the exercise.

6-4.4 FERC Goals and Objectives

The Commission's main objective of the EAP exercise program is to ensure that EAPs are periodically reviewed and that each EAP is workable in an actual emergency. A licensee's exercise program should build on the competencies developed from simpler exercises to achieve greater success with more complex exercises. Before a comprehensive exercise can be conducted, it is necessary to lay the groundwork for that exercise. Seminars, drills, and a tabletop exercise should be performed before the comprehensive exercise is conducted. The FERC focuses primarily on high hazard dams in identifying those projects that warrant a comprehensive exercise.

A comprehensive exercise consists of either a functional or full-scale exercise. A full-scale exercise of a simulated emergency is the ideal approach to evaluate every participant's knowledge, understanding, and reaction to a dam failure event. However, practical considerations indicate that full-scale exercises may not be appropriate in all cases. Due to the complexity and expense in terms of personnel and equipment committal, the full-scale exercise will normally be executed at the option of the licensee unless peculiar circumstances of a particular project or lack of confidence in previously performed lower level exercises warrants the Regional Engineer to require a full-scale exercise. **Therefore, the Commission's goal is to have licensees conduct a functional exercise of an EAP as their comprehensive exercise.**

Each EAP is unique and each exercise must be tailored to the EAP being tested. For example, several unique applications to a dam failure event include the verification of failure, the moving or expanding nature of the area in danger, the impacts on timing of response, the disruption of transportation, areas that will become isolated due to flooding, alarms and sensors to detect a dam failure emergency, and concern for transients and recreationists (i.e., hikers, boaters, fisherman, campers). Other complications could include the extent of flooding depending on the conditions at the time of failure, power and communication outages, and failure during times of darkness and on weekends or holidays. In addition, there are site specific concerns and complications that should be considered.

There are five standard functions or capabilities of the emergency preparedness authorities that should be included in a comprehensive exercise. When coordinating with State and local emergency management authorities during the development of a comprehensive exercise, the licensee should advise the authorities that it would like the exercise to focus on at least the following five functions:

A. Alert, Notification, and Warning

This tests the communication system, the primary and/or alternate back-up systems, and the messages to determine if they are appropriate and clearly understood. It verifies the

names and phone numbers on the notification flowchart and their order of priority. Remote sensing equipment should be tested at unattended dams prior to or at the start of a comprehensive exercise.

B. Direction and Control Function

This tests and evaluates the emergency operations capability and timely response in a stressful environment. It includes the response to health problems, fire, downed power lines and loss of life, including drownings.

C. Evacuation

This is a key issue in the exercise as it tests the participants' understanding of the inundation maps. Experience indicates the inundation boundaries and the road names thereon may not always be clear and fully understood. Maps are often revised as a result of the exercise.

D. Shelters

This reveals those shelters that should not be used because they are in the flood plain or access to the shelters is affected by transportation through the inundation area.

E. Public Information

This tests the capability to issue timely and accurate information for a dam failure event.

The licensee, in discussing these five areas with the State and local emergency management authorities, should provide the authorities with opportunities to identify other areas they believe should be exercised to evaluate their effectiveness to respond to situations unique to a dam failure situation.

There are four major results that should be achieved through an EAP exercise:

A. Develop a Spirit of Cooperation

This is to include the licensee, the State and local emergency management authorities, and the FERC. Without a cooperative spirit, the EAP program will not be as successful.

B. Exchange of Knowledge

During the exercise, the licensee, the FERC, and the State and local emergency management authorities will help each party to understand their individual responsibilities and capabilities. The exercise also provides the opportunity to ensure that

all parties clearly understand the EAP, particularly critical matters such as the data presented on the inundation maps and the notification flowchart. The exercise process should also reveal deficiencies in resources and information available to the licensee and the State and local emergency management authorities.

C. Evaluation of EAP Exercises

The purpose of the exercise is to identify areas for improvement of the EAP. One of the follow-up requirements to drills and tabletop, functional, and full-scale exercises is a Hot Wash to find out what each person has learned and if anything should be revised. The Hot Wash should be held immediately after the exercise. The participants should be asked for comments in a discussion format as well as in written form. The participants should be encouraged to suggest changes to the EAP that would improve the plan and help them perform their responsibilities during emergencies. Immediately after the Hot Wash has concluded, all controllers and evaluators should meet with other members of the Exercise Planning Team to hold a Debrief (See Section 6-4.2.3G). During the Debrief, team members should discuss any issues and concerns noted during the exercise and areas for improvement.

Following the exercise, a written evaluation report must be prepared by the licensee and submitted to the Regional Engineer. See Section 6-2.2.3 for reporting requirements and Appendix 6-C for a suggested report format.

The evaluation report does not need to be elaborate; it should be clear and concise in the presentation of the information required. The report should include:

- Documentation and an evaluation of the various aspects of the exercise, including the timeliness of responses and areas of concern.
- Observations and recommendations that result from the exercise,
- A summary of the Hot Wash comments and lessons learned by the participants,
- Comments made during the Hot Wash and Debrief from the licensee and the participating emergency management authorities regarding their respective participation in the exercise.
- The participants' written evaluations,
- Any subsequent clarification or discussions, and

- A plan and schedule to make changes to the EAP or other follow-up actions.

D. Revision to EAPs

An exercise may reveal areas of the EAP that require revisions. This should reveal the strengths and weaknesses of the EAP, including specified internal actions, external notification procedures, and adequacy of other information, such as inundation maps.

The Commission offers the "Emergency Action Plan Exercise Design Course" at various locations throughout the United States at least once a year. This course is tailored for licensees and other dam owners. The course includes an invited speaker from a FERC-licensed project to provide the "licensee perspective" related to the design of an EAP exercise. The Commission endeavors to also invite other appropriate agencies, such as the National Weather Service, State dam safety officials, and local emergency management authority personnel to contribute to the course instruction. We recommend licensees encourage their local emergency management authority personnel to participate in the course. The FERC Regional Offices should be contacted for availability of this course.

Another source of "hands-on" training is to attend tabletop, functional, or full-scale exercises. Licensees can contact Regional Offices for a list of upcoming exercises and contact information. As licensees develop and conduct their exercises, they are encouraged to invite other licensees as observers or evaluators. As a licensee observes an actual exercise, it may identify deficiencies in its own plans and will be able to make improvements before it holds its own exercise.

6-5 TIME SENSITIVE EMERGENCY ACTION PLAN

One goal of the Federal Energy Regulatory Commission is to ensure there are workable and effective EAPs for dams under its jurisdiction. There are unique challenges associated with projects immediately upstream of individual residences, recreation areas, campgrounds, and population centers. In these instances, there is minimal time between a dam failure and when people would be inundated. For an EAP to be considered effective, the following actions must occur before people would be impacted from a dam failure:

1. Detection and verification of emergency
2. Notification of local emergency management authorities
3. Warning and, if necessary, evacuation of population at risk

Licensees should coordinate with emergency management authorities to minimize the response times required to complete these actions during a dam failure.

If these actions cannot be completed prior to the arrival of the flood wave from the dam breach, then the EAP is said to be **Time Sensitive**. When high risk areas are present downstream, the licensee should perform a **Sudden Failure Assessment** to determine if the EAP is Time Sensitive.

Sudden Failure Assessment

A Sudden Failure Assessment determines the adequacy of current emergency procedures and the benefits of proposed modifications to decrease the combined response times. The calculation compares the sum of the Detection Time, Verification Time, Notification Time, and Emergency Management Authority Response Time versus the Time to Impact for the closest downstream population at risk. If the excess response time is a negative number, the EAP is Time Sensitive. Appendix 6-O provides a detailed procedure for conducting a Sudden Failure Assessment.

If an EAP is Time Sensitive, the licensee should develop a plan and schedule for implementing measures to improve the excess response time calculated by the Sudden Failure Assessment. This plan should be developed in cooperation with local emergency management authorities. Some examples of ways for improving response times are:

Detection

- Tighten existing headwater and tailwater set points.
- Install new remote monitoring systems.
- Use thermal imaging (temperature changes) for detecting breaches.
- Install solar-powered instruments that need no electrical or communication hook-ups.

Verification

- Install independent/redundant instruments and alarms.
- Install remote access cameras (still-photo or video).
- Install lights on gages for nighttime camera verification.
- Verify high flows with real-time USGS gages and the National Weather Service.
- Get non-employees that are closer to the dam to verify a problem (e.g. local police).

Notification

- Streamline internal procedures as described on the notification flow chart.
- Add redundancy to the notification flow chart in case people are unavailable.
- Provide preliminary notification to emergency management authorities.
- Develop pre-scripted messages for callers.
- Use a dam-owner controlled Reverse 911 system to notify several agencies at

once.

Emergency Management Authority Response

- Use Reverse 911 system to notify residents.
- Prepare pre-scripted message for Reverse 911 system that explain what residents should do.
- Use automatic alert system that sends text messages to residents.
- Install sirens.
- Provide NOAA radios to residents.
- Have dam owner warn residents directly (upon agreement with emergency management authority).

An updated Sudden Failure Assessment should be included as part of the plan and schedule for addressing a Time Sensitive EAP, documenting how the proposed measures would improve response times, and that local emergency management authorities were involved in the planning process. The licensee should notify the Commission when the enhancements have been implemented and tested. The licensee should also provide a final sudden failure assessment.

Public Education

The licensee should coordinate with the local emergency management authorities to develop and provide public education to critical downstream areas explaining what actions people should take during an emergency with the dam. It is recommended to provide annual public education to any residents within areas having a +15 minute excess response time or less.

The following are examples of how to provide public education:

- Letters
- Calendars with emergency information in front
- Articles in community newsletters
- Coordination through neighborhood volunteer liaisons
- Public meetings (these are most effective following an incident that affects the community – such as the installation of a new siren or after a flood)
- Signs showing evacuation routes (campgrounds/recreation areas)
- Brochures/posters at campgrounds/recreation areas

The following are issues typically addressed with public education:

- What people should do if they notice the river unexpectedly high and rising or they notice a problem with the dam.

- What are signs that a problem is developing at the dam. (This is applicable primarily for residents that live within view of a remote structure.)
- Where people could go to be out of the inundation zone.
- How people should treat moving or deep standing water.
- What residents should do if they are trapped in their house.
- What people should do if they hear a siren or get a Reverse 911 call.
- Who people should contact if they have questions.

It is up to both the licensee and the emergency management authority to reach a consensus on what information needs to be provided to the public. The licensee typically provides information about the area that could be inundated from a dam failure and describes what would indicate a problem with the dam. The emergency management authority typically provides information about how residents should respond to an emergency.

Annual Reporting

As part of the annual EAP Status Report, the licensee should submit the results from the most current Sudden Failure Assessment, and an explanation of any response time enhancement implemented or changes in downstream population that would affect the Sudden Failure Assessment results. The EAP Status Report should document the completion of annual public education and include a brief description or example.

6-6 EAP EXEMPTION REQUIREMENTS

6-6.1 Exemption Justification

In order to receive an exemption from filing an EAP, a licensee must demonstrate that no reasonably foreseeable project emergency (i.e., failure of a dam or water retaining structure) would endanger life, health or property. To satisfactorily demonstrate the consequences of a failure, the licensee should submit a report that documents all reconnaissance and other studies performed to determine that failure of the dam will not present a hazard to human life or cause significant property damage under all flood flow conditions up to the Inflow Design Flood. Regional Office staff will periodically review the circumstances pertaining to those projects that have already been exempted from EAP requirements to determine if additional documentation is necessary to verify the validity and continuation of previously granted EAP exemptions.

Chapter II of the Engineering Guidelines discusses in detail the procedure for performing a hazard evaluation and estimating the consequences of a dam failure. If the results of a field reconnaissance study of the areas downstream of the dam are inconclusive in determining the hazard potential of the dam, a dam breach analysis should be performed

and results of the analysis furnished in the report. The dam breach analysis should consider failure under normal operating conditions (i.e., fair weather) and flood flows up to the point where no significant increase in hazard to downstream life and property occurs as a result of failure, i.e. the inflow design flood. For each flood event analyzed, it should be assumed that the failure is initiated when the peak flow or reservoir elevation is reached. Dam failures should be assumed to occur at the peak and not on the rising limb of the inflow flood hydrograph. A sensitivity analysis should also be performed to establish the effect of breach width and time to failure on downstream flood levels at various flood flow conditions.

An inundation map and, if necessary, water surface profiles, should be developed and furnished for the flow condition which results in the greatest potential for loss of life and significant property damage. The method and assumptions utilized in the dam breach analysis should be fully documented. The inundation map and water surface profiles should delineate the affected areas and water surface elevations prior to failure with the dam in place and after the assumed failure. The map and river profiles should also show the travel time for the arrival of the initial or leading edge of the flood wave and the peak elevation of the flood wave at critical locations downstream of the dam. It is important that the inundation map be developed at a scale sufficient to be used for identifying the location of downstream inhabitants within the area subject to possible danger.

6-6.2 Annual Verification

The licensee should annually perform a field reconnaissance to verify if there were any changes to upstream and downstream conditions affecting the determination that no reasonably foreseeable project emergency would endanger life, health or property. If there are any changes to these conditions, it will be necessary to evaluate whether the exemption remains valid. By December 31 of each year, the licensee should send a letter to the Regional Engineer: (1) discussing the results of the field reconnaissance, (2) requesting a continuation of the exemption from filing an EAP (see Section 6-2.2.7), if still eligible, and (3) including as a separate enclosure with the annual verification, the contact list along with a statement that the information provided was verified to be accurate (see Section 6-6.3).

6-6.3 Contact List

Sudden releases of flows from projects exempt from having an EAP may still affect river conditions and be of concern to upstream and downstream interests. Licensees of projects exempt from EAP requirements should develop, maintain, post, and annually verify a contact list of people and organizations such as local emergency management authorities and upstream and downstream dam owners that will be called during flood events, if the dam is in danger of failing, or has failed. The licensees should annually verify the contact information on the list is accurate and include the contact list as an

enclosure to their annual request for a continuation of exemption from filing an EAP by December 31 each year (see Section 6-2.2.7).

6-7 RADIOLOGICAL EMERGENCY RESPONSE PLANS

Each owner of a hydroelectric project under the jurisdiction of the Federal Energy Regulatory Commission located within a 10-mile radius of a nuclear plant licensed to operate shall prepare a radiological emergency response plan to be implemented in the event of a severe accident or incident resulting in the release of radioactive materials. A plan is required if the 10-mile radius includes any project structures such as the dam or powerhouse that are used in changing water flows, or project facilities that would be affected by radioactive materials in such a manner that would interfere with project operations. The plan will be a supplement to the Emergency Action Plan and made a part thereof. It should contain, but not be limited to, the following items:

- A. Detailed procedures for:
 - 1. The evacuation of power plant personnel when advised or directed to do so by the appropriate State or local government official.
 - 2. Setting of gate openings.
 - 3. Continuation, curtailment or cessation of generation.
 - 4. Coordination with, and notification of, customers, power pools, and other interconnected power suppliers.
 - 5. Advance coordination with operators of upstream and downstream reservoirs.
 - 6. Other actions as considered appropriate.

- B. A list of State and/or local government officials who are responsible for notification of hydroelectric project personnel that nuclear accident or incident is developing (or has occurred). This part of the plan should:
 - 1. Specifically identify the State or local government officials responsible for notifying individual(s) in the hydroelectric power plant owner's organization.
 - 2. Include provisions for keeping the owner's key personnel currently informed on the developing situation to allow timely action or response at the affected hydroelectric project.
 - 3. Identify, if other than the officials noted above, the State or local government agency representatives authorized to direct or advise implementation of action, such as evacuation of the area, or other appropriate action.

- C. Notification plans should be developed for alerting the concerned individuals of the proposed plan implementation as described below. Reference can be made to the notification procedures contained in the main body of the emergency action plan if appropriate.

1. Local, State, and Federal government officials, including the FERC Regional Engineer or alternate.
2. Operators of water-related facilities.
3. Residents and owners of properties that could be endangered by the change in project operation.
4. Supervisors and other company officials.

The Radiological emergency response supplement to the emergency action plan shall be posted with the main body of the emergency action plan in a prominent location accessible to operating and supervisory personnel. Such personnel shall be familiar with their responsibilities under the plan. Training of these personnel shall be conducted to assure adequate and timely performance of their duties in the event of an emergency.

As with the other parts of the emergency action plan, all aspects of the plan are subject to continuous review and updating. At least once a year, a comprehensive review shall be made of the plan. Any revisions shall be made after consultation with Federal, State, and local agencies, and electric power producers and users, as appropriate. The need for an update shall be reported to the Regional Engineer no later than December 31, of each year.

The affected owner will be requested to file a plan no later than 3 months after the date of issuance of a license to operate a nuclear plant.

If the Regional Engineer determines that an emergency action plan is not required for the hydroelectric project, the radiological supplement shall, nevertheless, be filed. Evidence of coordination with the appropriate State official responsible for emergency preparedness, should be obtained and forwarded with the plan. Three copies should be submitted to the Regional Office.

6-8 EMERGENCY ACTION PLANS AT FEDERAL DAMS

When a project is located at a Federal dam, the licensee is to cooperate with the appropriate Federal agency in emergency action planning in case of an accident to or failure of structures under Commission jurisdiction that may affect the integrity and/or operation of the Federal project. Memorandums of Understanding (MOU) between the Commission and various Federal agencies, in conjunction with project licenses, require this cooperation.

Therefore, an Emergency Action Plan should be prepared for notifying the appropriate representatives of the Federal agency of an emergency. The licensee must ensure that the operating personnel are familiar with the procedures outlined in the plan. It is important that the EAP cooperate with the Federal agency's emergency action plan and in no way

supersede it. Three copies of the plan should be submitted to the Commission's Regional Engineer. The notification procedures are subject to the requirements for training, exercising, updating and posting described on in Section 6-3.2.2 VIII B. The plan is subject Section 6-2.2.6 - EAP Status Reports

The EAP does not need to conform to the full format discussed in Section 6-3.2, but should be sufficient for required cooperation with the Federal agency. At a minimum, the EAP should include:

1. The procedure(s) for notifying the Federal agency of an emergency
2. The procedure(s) for notifying the Commission's Regional Engineer of an emergency
3. A written statement, verified in accordance with Section 12.13 of the Commission's regulations, indicating that the licensee will cooperate in the implementation of that Federal agency's EAP
4. A description of the licensee's responsibilities and plans to act under the Federal agency's emergency action plan in the event of an emergency at either the Federal dam or the licensed project
5. Include any memorandums/letters of agreement between the licensee and Federal agency regarding emergency procedures

The notification procedure is subject to the requirements for training, exercising, updating and posting described on in Section 6-3.2.2 VIII B.

6-9 TEMPORARY CONSTRUCTION EMERGENCY ACTION PLANS

A Temporary Construction Emergency Action Plan (TCEAP) is required where construction workers or the public would be endangered from failure of the temporary construction work. The TCEAP should be submitted at least 60 days before starting construction to the Regional Engineer for review and evaluation.

The TCEAP should include the following:

1. A notification list of emergency response authorities.
2. A plan drawing showing the proposed arrangement of the structure.
3. The location of safety devices and escape routes.
4. Action levels (based on the Construction PFMA, if applicable), when the plan will be activated and when evacuation will occur.
5. A brief description of testing procedures for the plan.

The TCEAP should be posted at a strategic location at the construction site visible to all workers and discussed during weekly safety meetings. Periodic testing of the plan should

be performed at least quarterly and be documented by the contractor and Quality Control staff.

6-10 GLOSSARY

Breach: An opening through the dam resulting in partial or total failure of the dam.

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 landslides upstream of the dam on property located around the reservoir.

Dam failure: Catastrophic type of failure characterized by the sudden, rapid, and uncontrolled release of impounded water. There are lesser degrees of failure, but any malfunction or abnormality outside the design assumptions and parameters that adversely affect a dam's primary function of impounding water is properly considered a failure. Lesser degrees of failure can progressively lead to or heighten the risk of a catastrophic failure. They are, however, normally amendable to corrective action.

Debrief: When team members discuss any issues and concerns noted during the exercise and areas for improvement. Should be conducted immediately after the **Hot Wash**.

Drill: A drill is a coordinated, supervised activity usually employed to test a single specific operation or function within a single entity, such as testing sirens and warning systems, calling suppliers, checking material on hand, and conducting a call-down drill of those listed on the Notification Flowchart.

EAP exercise: Activity designed to promote prevention, preparedness, and response to incidents and emergencies, and may also be extended to include recovery operations. The exercise also demonstrates the EAP's effectiveness in an actual situation and demonstrates the readiness levels of key personnel. Periodic exercises result in an improved EAP because lessons learned are incorporated into the updated EAP document. Exercises consist of testing and performing the duties, tasks, or operations identified and defined within the EAP through a simulated event.

Emergency: Any incident, whether natural or manmade, that requires responsive action to protect life or property.

Emergency Action Plan (EAP): Formal document that identifies potential emergency conditions at a dam and specifies preplanned actions to be followed to minimize property damage and loss of life. The EAP describes actions the dam owner will take to moderate or alleviate a problem at the dam, as well as actions the dam owner, in coordination with

emergency management authorities, will take to respond to incidents or emergencies related to the dam.

Emergency alert system: A federally established network of commercial radio stations that voluntarily provide official emergency instructions or directions to the public during an emergency.

Emergency management authority: State, local, Tribal, or Territorial agency responsible for emergency operations, planning, mitigation, preparedness, response, and recovery for all hazards. Names of emergency management authorities vary (e.g., Division of Emergency Management, Comprehensive Emergency Management, Disaster Emergency Services, Emergency and Disaster Services).

Emergency Operations Center: The location or facility where responsible officials gather during an emergency to direct and coordinate emergency operations, to communicate with other jurisdictions and with field emergency forces, and to formulate protective action decisions and recommendations during an emergency.

Exercise Plan: General information documents that help operation based exercises run smoothly by providing participants with a synopsis of the exercise.

Fair Weather: A time when the reservoir is at normal full pool elevation and normal stream flow is prevailing. Generally considered to have the most potential for loss of human life due to the element of surprise.

Flood hydrograph: Graph showing the discharge, height, or other characteristic of a flood with respect to time for a given point on a stream.

Flood routing: 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.

Full-Scale Exercises: A full-scale exercise is a multi-agency, multi-jurisdictional, multi-discipline exercise involving functional, *e.g.*, joint field office, emergency operation centers, and "boots on the ground" response to a simulated event, such as activation of the EOC and role-playing to simulate an actual dam failure.

Functional Exercise: A functional exercise examines and/or validates the coordination, command, and control between various multi-agency coordination centers, such as Emergency Operation Centers (EOCs) and joint field offices. A functional exercise does not involve any "boots on the ground," such as first responders or emergency officials responding to an incident in real time.

Games: A game is a simulation of operations that often involves two or more teams,

usually in a competitive environment, using rules, data, and procedures designed to depict an actual or assumed real-life situation.

Hazard potential: Situation that creates the potential for adverse consequences, such as loss of life, property damage, or other adverse impact. 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 the effects of backwater flooding or the effects of landslides around the reservoir perimeter.

Headwater: Water immediately upstream from a dam. The water surface elevation varies due to fluctuations in inflow and the amount of water passed through the dam.

High Flow: A flood occurring on the river system, but no apparent threat to the integrity of the dam is present.

Hot Wash: An oral after-action review of the EAP exercise conducted with the exercise participants, planning team members, facilitators and evaluators.

Imminent Failure: The dam has failed, is failing, or is about to fail.

Incident: A malfunction/deviation of a project feature or some other unusual occurrence that could, if left unchecked, lead to an uncontrolled release or excessive controlled release of water from an impounding structure.

Inflow Design Flood (IDF): Flow used in the design of a dam and its appurtenant works, particularly for sizing the spillway and outlet works, and for determining the maximum height of the dam, freeboard, and temporary storage requirements. The IDF is typically the flow above which the incremental increase in water surface elevation due to failure of a dam is no longer considered to present an unacceptable threat to downstream life or property. The upper limit of an IDF is the Probable Maximum Flood.

Injects: Scripted details of messages or events transmitted during an exercise to the participants so that they will be able to respond with an action or decision.

Inundation map: Map delineating areas that would be flooded as a result of a dam failure.

Inundation zone: Area downstream of the dam that would be inundated by the released water. This zone is typically demarcated by a boundary reflecting the vertical elevation of the peak flow of water for both a flood failure and “sunny day” failure situation.

Licensee: The company or entity which is granted a license from the Federal Energy

Regulatory Commission for a hydropower project. This guideline refers to all applicants for licenses, holders of licenses, and holders of Exemptions from Licensing (i.e., exemptees) as “licensees”.

Master Scenario Events List: A chronological listing of scripted events and injects that take place during an operations-based exercise.

Non-Failure: An event at a dam that will not, by itself, lead to a failure, but requires investigation and notification of internal and/or external personnel.

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

Potential Failure: An event at a dam that indicates conditions are developing at the dam that could lead to a dam failure.

Probable Maximum Flood (PMF): Flood that may be expected from the most severe combination of critical meteorological and hydrologic conditions that is reasonably possible in the drainage basin under study.

Seminar: A seminar is an informal discussion, designed to orient participants to new or updated plans, policies, or procedures, e.g., a seminar to review a new Evacuation Standard Operating Procedure.

Situation Manual: A written overview for participants of a discussion-based exercise which typically includes an introduction, scenario, participant questions, and references.

Sudden Failure Assessment: A calculation that compares the sum of the Detection Time, Verification Time, Notification Time, and Emergency Management Authority Response Time versus the Time to Impact for the closest downstream population at risk. If the excess response time is a negative number, the EAP is **Time Sensitive**.

Tabletop Exercise: A tabletop exercise involves key personnel discussing simulated scenarios in an informal setting. Tabletop exercises can be used to assess plans, policies, and procedures.

Tailwater: Water immediately downstream from a dam. The water surface elevation varies due to fluctuations in the outflow from the structures of a dam. Tailwater monitoring is an important consideration because a failure of a dam will cause a rapid rise in the level of the tailwater.

Time Sensitive: When the time required to detect/verify the emergency, notify local EMA’s and warn/evacuate the population at risk exceeds the arrival time of the flood

wave, the EAP is said to be **Time Sensitive**.

Workshop: A workshop resembles a seminar but is used to build specific products, such as a draft plan or policy. For example, a Training and Exercise Plan Workshop is used to develop a Multi-Year Training and Exercise Plan.

6-11 APPENDICES

Appendix 6-A is informational. Appendices 6-B, 6-C, 6-D, 6-E, 6-I, 6-M, and 6-O are strongly encouraged. The remaining Appendices (6-F, 6-G, 6-H, 6-J, 6-K, 6-L, and 6-N) are optional and are intended to provide examples that could be beneficial to an EAP.

Appendix 6-A – FEMA Courses and Documents Pertinent to EAPs

Appendix 6-B – Sample Evaluation Report Format for EAP Exercises

Appendix 6-C – Sample EAP Status Reports and Annual Actions Required for EAP Updates

Appendix 6-D – EAP Review Checklist

Appendix 6-E – Sample Title Page and Verification Form

Appendix 6-F – EAP Responsibilities

Appendix 6-G – Example Notification Flowchart

Appendix 6-H – Sample Guidance Table for Determining Emergency Level

Appendix 6-I – Example High Flow Notification Table

Appendix 6-J – Emergency Notification Information and Messages

Appendix 6-K – Example Emergency Level – Potential Failure

Appendix 6-L – Example Forms and Logs

Appendix 6-M – FERC Requirements for Submitting GIS Inundation Zones

Appendix 6-N – Sample Inundation Maps

Appendix 6-O – Time Sensitive/Sudden Failure Assessment

APPENDIX 6-A

FEMA Courses and Documents Pertinent to EAPs

FEMA Courses and Documents Pertinent to EAPs

FEMA Independent Study Courses – FEMA offers independent study courses about EAP exercises and other emergency management topics. Detail information about the courses can be viewed at the following website:

<https://training.fema.gov/emicourses/>

References and Sources of Information:

Engineering Guidelines for Risk Informed Decision Making, Federal Energy Regulatory Commission

Federal Emergency Management Agency Independent Study Courses – FEMA offers independent study courses about EAP exercises and other emergency management topics.

Federal Guidelines for Dam Safety, Emergency Action Planning for Dams, FEMA P-64 (July 2013)

Federal Guidelines for Inundation Mapping of Flood Risks Associated with Dam Incidents and Failures, FEMA P-946 (July 2013)

Homeland Security Exercise and Evaluation Program (HSEEP), U.S. Department of Homeland Security (April 2013)

HSEEP – Lessons Learned Information Sharing, U.S. Department of Homeland Security

HSEEP Toolkit, U.S. Department of Homeland Security

National Dam Safety Program – Training Aids for Dam Safety (TADS), FEMA 609DVD (October 2007)

APPENDIX 6-B

Sample Evaluation Report Format for EAP Exercises

Report on (Tabletop, Functional, Full-Scale) EAP Exercise

Name of Project
Project Owner
FERC Project Number
National Inventory of Dams Number

1. Exercise Overview

- A. Type of exercise, date, duration, location
- B. Participating Organizations
- C. Planning Team Members

2. Exercise Design Summary

- A. Exercise Purpose
- B. Exercise Design (who organized and developed the exercise)
- C. Exercise Objectives
- D. Scenario Summary

3. Analysis of Capabilities

- A. Ability of the licensee to timely recognize and address problems at the dam and notify appropriate agencies/organizations
- B. Ability of agencies to timely react to the situation, provide warning, execute evacuations, and set up shelters
- C. Ability of licensee and agencies to coordinate information during the emergency and provide public information
- D. Any other capabilities tested

4. Table Summarizing Hotwash Oral and Written Comments

5. Lessons Learned

6. Recommendations for Improvement

7. Plan and Schedule for Follow-Up Actions

Appendices

- A. List of participants
- B. Exercise handouts
- C. MSEL
- D. Copies of Hot Wash written comments
- E. Acronyms table (if needed)

APPENDIX 6-C

Sample EAP Status Reports and Annual Actions Required for EAP Updates

EAP Status Report for White Project, FERC No. XXXX

Annual EAP Review Performed: August 15, 2014

Annual Update Sent to Planholders: September 18, 2014

Last Full Reprint Sent: December 1, 2011

Annual Seminar: September 18, 2014

We went over the EAP, inundation maps, and roles and responsibilities. We hand-delivered the annual update to the Alpha County EMA. Alpha County confirmed there is no new development which affects the inundation maps. Special emphasis was placed on the meaning of emergency levels and how all parties would respond during different scenarios. We also discussed the use of the County's automatic notification system which is now set up to call all residents/businesses within the inundation zone in the advent of a serious emergency.

Annual Training/Drill/Call Down Test: July 12-13, 2014.

The training began with a discussion of EAP, the possible impacts of a dam failure and everyone's roles and responsibilities. We went through 3 scenarios and how everyone would respond. All participants understood their roles. We determined that the Utility public relations will be notified early in any developing emergency and will send a person to any Joint Information Center that is created for the emergency. The Call-Down Test found two superseded cell-phone numbers which were revised in the annual update.

Emergency Equipment Test:

Emergency Generator: Jan. 15, Apr. 1, July 3, Oct. 7, 2014

Warning Sirens at campground: Feb. 3, Aug. 12, 2014

Satellite Phones at powerhouse: Apr. 1, July 3, Nov. 1, 2014

Sudden Failure Assessment: December 5, 2012 (Last Updated)

Time to Impact: 25 min

Detection Time: 5 min

Verification Time: 15 min

Notification Time: 10 min

EMA Response Time: 10 min

Excess Response Time: -15 min

There were no changes in downstream population during 2014. In 2015, we will implement a camera system to decrease verification time.

Public Education: Alpha County sent a March 15, 2014 letter to the four residences within the inundation zone explaining how to determine if there is an emergency and how the residents will be warned (letter attached).

Coordination Checklist for White Project, FERC No. XXXX:

Organization	Name	Title	Received Update ¹	Participated in Annual Seminar	Participated in Annual Drill & Call Down
Utility	Joe Smith	Operator	Yes	No	Yes
	Thomas Knapp	Manager, Hydro Engineering	Yes	Yes	Yes
	Jason Morgan	VP Energy Projects	Yes	No	Yes
	Judith Robertson	Public Relations	Yes	No	Yes
Alpha County	Varies	Dispatcher	Yes	No	Yes
	Deloris Shea	Sheriff	Yes	No	No
	Ralph Watts	EMA	Yes	Yes	Yes
Beta County	Joe Girardi	EMA	Yes	No	No
State	Al Sanders	EMA	Yes	No	No
	Phyllis Kline	Dam Safety	Yes	No	No
FERC	Walter Johnson	Regional Engineer	Yes	No	Yes
NWS	Josephine Hunt	Hydrologist	Yes	No	Yes
Downstream Camp	Pop Jones	Owner	N/A	No	Yes
Downstream Dam	Varies	Control Room	Yes	No	Yes
Upstream Dam	Varies	Control Room	N/A	No	Yes

Prepared by: Thomas Knapp (202) 555-1234

¹ Confirmed by mailed returned receipt, telephone call, or in person.

APPENDIX 6-D

EAP Review Checklist

EAP Review Checklist

1. General Document Items

	Is the name of the dam and other relevant identifiers, such as NID, state, and federal ID numbers, clearly labeled in large letters in the EAP?
	Is the document a controlled document, including the names, titles, and addresses of all plan holders?
	Is there a table of contents?
	Are the roles and responsibilities of key emergency personnel clearly documented, preferably at the beginning of the document?
	Is there an up-to-date revision sheet provided near the beginning of the document?
	Are revision numbers and revision dates provided as footers on each page of the document?

2. Detection Items

	Are detection and/or early warning systems at the dam clearly described, including dam operators' observations, instrumentation systems, and observations by the general public?
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3. Decision Making Items

	Are the emergency levels clearly described?
	Are there clear guidelines and decision criteria to help the dam owner determine the appropriate level for potential unusual and emergency conditions that could occur at the dam?

4. Notification and Communication Items

	Are primary and back-up communication systems among the dam owner, local emergency responders, and other key stakeholders described in the document?
	Are the notification flowcharts complete and logical?
	Are phone numbers, after-hours phone numbers, and back-up personnel listed on the notification flowcharts and emergency contact lists?
	Do the notification flowcharts include contacts to provide timely engineering support?
	Do the notification flowcharts include contacts for timely notification of local emergency management organizations for more serious emergency levels?
	Do the notification flowcharts minimize the number of calls that the dam operators are required to make, so that they can focus on implementing preventative actions?

5. Pre-planned Action Items

	Are there descriptions of recommended pre-planned actions for potential unusual and emergency conditions at the dam?
	Is there a list of locally available engineering, labor, materials, and equipment resources that can be referenced in an emergency?
	Has the contact information for the locally available resources been recently updated or verified?

6. Termination and Follow-up Items

	Does the document describe who has the authority to terminate emergency operations?
	Are the procedures for terminating emergency operations clearly described in the document?
	Does the document have guidance on follow-up responsibilities after the emergency is terminated?

7. Inundation Mapping

	Does the inundation map include a north arrow and a bar scale?
	Are the inundation areas clearly delineated and labeled? This is especially important if there are “fair weather” failure and “PMF plus breach” inundation limits shown on the inundation maps.
	Does the inundation map include a qualification stating that the inundation limits for an actual dam failure may vary in some ways from what is shown on the inundation map?
	Are local roads, drainages, and other landmarks clearly labeled on the basemap?
	Is the downstream limit of the inundation mapping logical (e.g. at a major reservoir, river, or other water course)?
	Were channel cross sections taken at critical downstream locations, such as at major road crossings, schools, major population centers, etc.?
	Is the following flood inundation information provided at important downstream cross sections: Peak flood stage Flood wave arrival time Time to peak discharge Maximum water surface elevation Peak discharge

8. Other Items

	Are clear procedures for testing and updating the document provided?
	Is the frequency of testing and updating the document clearly described?

	Is the person or position responsible for updating the document indicated in the document along with updated contact information for that person?
	Are the processes for training personnel in how to use the document and the frequency and responsibility for this training clearly described in the document?
	Are key hydrologic/hydraulic data, such as spillway and outlet discharge curves and reservoir area capacity curves, provided in the document?
	Does the document include a general location map that shows where the dam is located relative to other key local roads, drainages, and population centers?

APPENDIX 6-E

Sample Title Page and Verification Form

[Title Page]

EMERGENCY ACTION PLAN

[Name of Development]

Project No. [FERC No.]

National Inventory of Dams No.

Name of the licensee/exemptee/applicant for license:

Address:

Submitted [date]

Verification:1

State of [],

County of [], ss:

The undersigned, being first duly sworn, states that [he, she] has read the following document and knows the contents of it, and that all of the statements contained in that document are true and correct, to the best of [his, her] knowledge and belief.

(Name of Person Signing)

(Title)

Sworn to and subscribed before me this [day] of [month], [year].

(Signature of Notary Public or other state or local official authorized by law to notarize documents).

SEAL

¹The verification form is to be completed only by the licensee, exemptee, or applicant for license that prepared the plan, not by agencies that received copies of the plan.

APPENDIX 6-F

EAP Responsibilities

Table 6-F.1: EAP Responsibilities Summary

Licensee	<ol style="list-style-type: none"> 1. Verify and assess emergency conditions at the dam 2. Notify other participating emergency management agencies 3. Take corrective action at facility 4. Issues condition status reports 5. Declare termination of emergency at facility
Town Anywhere (In County Y) Police, Fire & Rescue	<ol style="list-style-type: none"> 1. Receive condition status reports from Licensee 2. Notify Public within Town Anywhere limits 3. Conduct evacuation from inundation areas within town limits, if required 4. Render assistance to County Y, as necessary 5. Render assistance to Licensee, as necessary
County X Police, Fire & Rescue, and Emergency Services	<ol style="list-style-type: none"> 1. Receive condition status reports from Licensee 2. Notify public within County X 3. Conduct evacuation from inundation areas in County X, if required 4. Provide mutual aid to County Y, if requested and able
County Y Police, Fire & Rescue, and Emergency Services	<ol style="list-style-type: none"> 1. Receive condition status reports from Licensee 2. Notify public within County Y 3. Conduct evacuation from inundation areas in County Y, if appropriate

Note: Dam and downstream areas are in both County X and County Y. Town Anywhere is only in County Y.

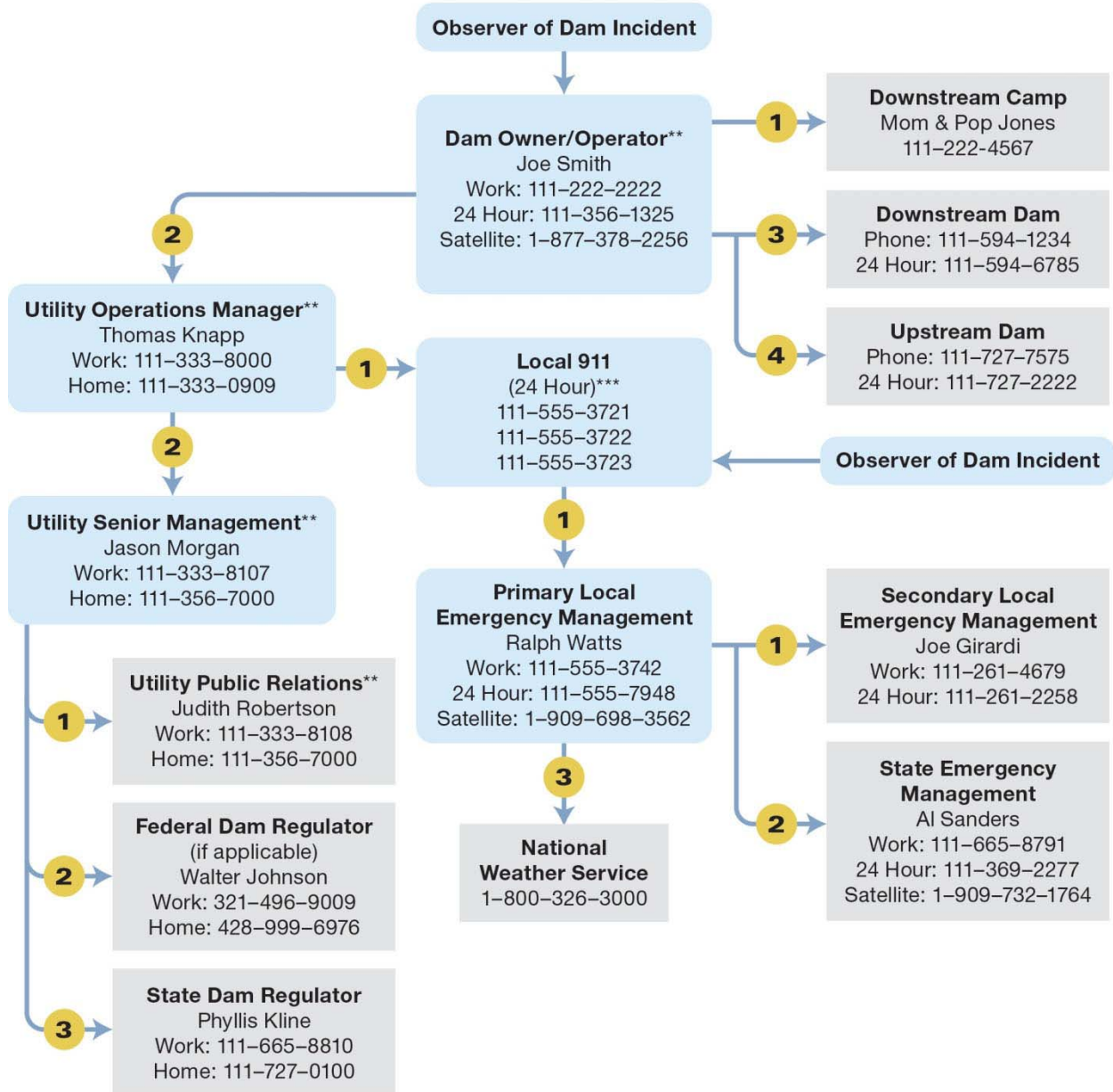
Table 6-F.2: Licensee Responsibilities Summary

<p>24/7 Operations Command Center</p>	<ol style="list-style-type: none"> 1. Detect incident from alarms. 2. Confirm incident by camera system. 3. If no one is on-site, determine emergency level and dispatch operator to site. 5. Make calls on notification flow chart. 6. Coordinate with Operator and Engineering on gate operations and emergency procedures. 7. Coordinate with upstream and downstream dams on operations. 8. Provide regular status reports to senior management.
<p>On-site Dam Operator</p>	<ol style="list-style-type: none"> 1. Detect/confirm incident at dam. 2. Determine emergency level. 3. Make calls on notification flow chart 4. Coordinate with Command Center and Engineering on gate operations and emergency procedures. 5. Implement gate operations and other emergency procedures. 6. Provide regular status reports to senior management.
<p>Engineering Manager</p>	<ol style="list-style-type: none"> 1. Support On-site Operator and Operations Command Center on emergency level. 2. Make calls on notification flow chart. 3. Determine emergency operation and construction procedures. 4. Coordinate with Operator and Command Ctr. on gate operations and emergency procedures. 5. Dispatch engineers & construction crews as necessary. 6. Dispatch engineer as technical liaison to County Emergency Operations Center. 7. Provide regular status reports to senior management.
<p>Senior Management</p>	<ol style="list-style-type: none"> 1. Make calls on notification flow chart. 2. Initiate periodic status report conference calls with dam site, command center, engineering, and public relations. 3. Provide regular status reports to County Emergency Operations Center. 4. Coordinate with upper management. 5. Coordinate with public relations staff at County and technical liaison at County Emergency Operations Center.
<p>Public Relations</p>	<ol style="list-style-type: none"> 1. Mobilize to County Offices. 2. Participate in periodic status report conference calls with dam site, command center, engineering, and management. 3. Provide input to staff on emergency communications. 4. Represent utility to media.

APPENDIX 6-G

Example Notification Flowchart

Appendix G Example Notification Flowchart*



= call sequence

* Use this chart in coordination with Notification Contact Table for additional contact information.

** Utility personnel should refer to EAP for sample warning messages.

*** Call Dam Operator if 911 is notified by non-utility observer.

APPENDIX 6-H

Sample Guidance Table for Determining Emergency Level

Table 6-H.1: Sample Guidance Table for Determining Emergency Level

Event	Situation	Emergency Level
Earth Spillway Flow	Reservoir water surface elevation at auxiliary spillway crest or spillway is flowing with no active erosion	Non-failure
	Spillway flowing with active gully erosion	Potential failure
	Spillway flow that could result in flood of people downstream if the reservoir level continues to rise	Potential failure
	Spillway flowing with an advancing headcut that is threatening the control section	Imminent failure
Embankment Overtopping	Reservoir level is XX feet/inches below the top of the dam	Potential failure
	Water from the reservoir is flowing over the top of the dam	Imminent failure
Seepage	New seepage areas in or near dam	Non-failure
	New seepage areas with cloudy discharge or increasing flow rate	Potential failure
	Seepage with discharge greater than XX gallons per minute	Imminent failure
Sinkholes	Observation of new sinkhole in reservoir area or on embankment	Potential failure
	Rapidly enlarging sinkhole	Imminent failure
Embankment Cracking	New cracks in the embankment greater than XX inches wide without seepage	Non-failure
	Cracks in the embankment with seepage	Potential failure
Embankment Movement	Visual movement/slippage of the embankment slope	Non-failure
	Sudden or rapidly proceeding slides of the embankment slopes	Imminent failure
Instruments	Instrumentation readings beyond predetermined values	Non-failure
Earthquake	Measurable earthquake felt or reported on or within XX miles of the dam	Non-failure
	Earthquake resulted in visible damage to the dam or appurtenances	Potential failure
	Earthquake resulted in uncontrolled release of water from the dam	Imminent failure
Security Threat	Verified bomb threat that, if carried out, could result in damage to the dam	Potential failure
	Detonated bomb that has resulted in damage to the dam or appurtenances	Imminent failure
Sabotage/ Vandalism	Damage that could adversely impact the functioning of the dam	Non-failure
	Damage that has resulted in seepage flow	Potential failure
	Damage that has resulted in uncontrolled water release	Imminent failure

APPENDIX 6-I

Example High Flow Notification Table

Table 6-I.1: Example High Flow Notification Table

The following is an example table that correlates outflows from a dam, expected impacts, and the organizations that will be notified. Actual organizations and order of notification should be coordinated with all emergency management authorities involved.

# of Gates Open	Flow (cfs)	Downstream Impacts	Organizations to be Notified
1-4	<10,000	None	None
5	12,500	Minor riverbank flooding	Town Police, National Weather Service, Downstream Dam Owner
6	15,000	Minor flooding of local roads near river	Town Police, National Weather Service, Downstream Dam Owner
7	17,500	Significant flooding of local roads near river	Town Police, National Weather Service, Downstream Dam Owner
8	20,000	State Highway 92 bridge flooded, significant flooding of local roads and houses near river	Town Police, National Weather Service, Downstream Dam Owner, State Emergency Management Authority

APPENDIX 6-J

Emergency Notification Information and Messages

Table 6-J.1: Emergency Notification Information and Messages

The following table is an example of the information a dam owner will provide to external organizations during emergencies:

Level	Information to External Organizations
High Flow	(1) Explain how much flow the dam is currently passing, and the timing and amount of projected flows. (2) If known, describe at what flows downstream areas get flooded. (3) State that the dam is <i>NOT</i> in danger of failing. (4) Indicate when you will give the next status report. (5) Indicate who can be called for any follow-up questions.
Non-Failure	(1) Explain what is happening at the dam. (2) Describe if the event could pose a hazard to downstream areas (e.g., gate failure). (3) State that the dam is <i>NOT</i> in danger of failing. (4) Indicate when you will give the next status report. (5) Indicate who can be called for any follow-up questions.
Potential Failure	(1) Explain what is happening at the dam. (2) State you are determining this to be a <i>POTENTIAL FAILURE</i> . (3) Describe what actions are being taken to prevent the dam failure. (4) Provide an estimate of how long before the dam would be at risk of failing (e.g., during floods that could overtop the dam). (5) Refer to the inundation maps and explain what downstream areas are at risk from a dam failure. (6) Indicate when you will give the next status report. (7) Indicate who can be called for any follow-up questions.
Imminent Failure	(1) Explain that the dam is failing, is about to fail, or has failed. (2) State you are determining this to be an <i>IMMINENT FAILURE</i> . (3) Refer to the inundation maps and explain what downstream areas are at risk from a dam failure and estimate when flows should reach critical downstream areas. (4) Indicate when you will give the next status report. (5) Indicate who can be called for any follow-up questions.

Example Pre-scripted Notification Messages

The source for the following pre-scripted notification messages is the **sample** Emergency Action Plan (EAP) for Rock Creek Watershed, Dam No. 23, developed by the U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS). The emergency levels and parts of the messages have been modified to conform to this guidance document.

Potential Failure

- “This is _____ (Identify yourself; name, position).
- We have an emergency condition at Rock Creek Watershed, Dam No. 23, located 2 miles south of Rock City.
- We have activated the Emergency Action Plan for this dam and are determining this to be a **Potential Failure** condition.
- We are implementing predetermined actions to respond to a rapidly developing situation that could result in dam failure.
- Please prepare to evacuate the area along low-lying portions of Rock Creek.
- The dam could potentially fail as early as 11 am today.
- Reference the evacuation map in your copy of the Emergency Action Plan.
- We will advise you when the situation is resolved or if the situation gets worse.
- I can be contacted at the following number _____. If you cannot reach me, please call the following alternative number_____.”

Imminent Failure

- “This is an emergency. This is _____(Identify yourself; name, position).
- Rock Creek Watershed, Dam No. 23, located 2 miles south of Rock City, is failing. The downstream area must be evacuated immediately. Repeat, Rock Creek Watershed, Dam No. 23, is failing; evacuate the area along low-lying portions of Rock Creek.
- We have activated the Emergency Action Plan for this dam and are determining this to be an **Imminent Failure** condition. Reference the evacuation map in your copy of the Emergency Action Plan.
- I can be contacted at the following number _____. If you cannot reach me, please call the following alternative number_____.

- *The next status report will be provided in approximately thirty minutes.”*

The following pre-scripted message may be used as a guide for emergency management authorities to communicate the status of the emergency with the public:

- *Attention: This is an emergency message from the Sheriff. Listen carefully. Your life may depend on immediate action.*
- *Rock Creek Watershed, Dam No. 23, located 2 miles south of Rock City is failing. Repeat. Rock Creek Watershed, Dam No. 23, located 2 miles south of Rock City is failing.*
- *If you are in or near this area, proceed immediately to high ground away from the valley. Do not travel on Highway 44 south of Rock City or return to your home to recover your possessions. You cannot outrun or drive away from the flood wave. Proceed immediately to high ground away from the valley.*
- *Repeat message.*

APPENDIX 6-K

Example Emergency Level – Potential Failure

Table 6-K.1: Example Emergency Level – Potential Failure

Description of Condition	Item	Action to be Taken
HIGH WATER LEVEL / LARGE SPILLWAY RELEASE		
Reservoir level reaches elevation XXX ft and is rising at a rate of greater than one foot per hour.	1	Check for signs of erosion from spillway channel, particularly near wing walls.
	2	Assess cause of increased reservoir stage, especially during fair weather conditions.
	3	Perform additional tasks as directed by Dam Engineer.
	4	Make notifications if condition worsens such that downstream flooding is imminent.
SEEPAGE		
Localized new seepage or boil(s) observed along downstream face / toe of earthen embankment with muddy discharge and increasing but controllable discharge of water.	1	Measure and record feature dimensions, approximate flow rate, and relative location to existing surface features. Take photos if camera is available. Document location on a site plan and in inspection report.
	2	Place a ring of sand bags with a weir at the top towards the natural drainage path to monitor flow rate. If boil becomes too large to sand bag, place a blanket filter over the area using non-woven filter fabric and pea gravel. Attempt to contain flow in such a manner (without performing any excavations) that flow rates can be measured. Stockpile gravel and sand fill for later use, if necessary.
	3	Inspect the dam and collect piezometer, water level and seepage flow data daily unless otherwise instructed by engineer. Record any changes of conditions. Carefully observe dam for signs of depressions, seepage, sinkholes, cracking or movement.
	4	Contact geotechnical engineer and provide all data collected.
	5	Maintain continuous monitoring of feature. Record measured flow rate and any changes of condition, including presence or absence of muddy discharge.
	6	Review information collected by field inspection and provide additional instructions / actions as required. Recommend remedial seepage and stability measures.
	7	Make notifications if condition worsens such that failure is imminent.
SABOTAGE AND MISCELLANEOUS OTHER ISSUES		
Criminal action with significant damage to embankment or structures where significant repairs are required and the integrity of the facility is compromised – condition appears stable with time.	1	Contact law enforcement authorities and restrict all access (except emergency responders) to dam. Restrict traffic on dam crest to essential emergency operations only.
	2	Assess extent of damage and visually inspect entire dam for additional less obvious damages. Based on inspection results, confirm if extent of damages to various components of the dam warrants revised emergency level and additional notifications.
	3	If necessary to lower reservoir level, open drain valve(s).
	4	Perform additional tasks as directed by the Dam Engineer or designee.
	5	Make notifications if conditions worsen.

Description of Condition	Item	Action to be Taken
EMBANKMENT DEFORMATION		
<p>CRACKS: New longitudinal (along the embankment) or transverse (across the embankment) cracks more than 6 inches deep or more than 3 inches wide or increasing with time. New concave cracks on or near the embankment crest associated with slope movement.</p>	1	Measure and record feature dimensions, approximate flow rate, and relative location to existing surface features. Take photos if camera is available. Document location on a site plan and in inspection report.
	2	Restrict traffic on dam crest to essential emergency operations only.
	3	Contact geotechnical engineer and provide all data collected.
	4	Place buttress fill (min 3 ft high, 15 ft wide) against base of slope immediately below surface feature and extending 20 ft beyond visible feature limits (parallel to the embankment). Stock pile additional fill.
	5	Place sand bags as necessary around crack area to divert any storm water runoff from flowing into crack(s).
	6	Inspect the dam; collect piezometer and water level data twice daily unless otherwise instructed by engineer; and record any changes of condition. Carefully observe dam for signs of depressions, seepage, sinkholes, cracking or movement.
	7	Review information collected by field inspectors and provide additional instructions / actions as required. Consider survey monitoring.
	8	Make notifications if conditions worsen such that failure is imminent.
<p>SLIDES / EROSION: Deep slide / erosion (greater than 2 feet deep) on the embankment that may also extend beyond the embankment toe but does not encroach onto the embankment crest and appears stable with time.</p>	1	Measure and record feature dimensions, approximate flow rate, and relative location to existing surface features. Take photos if camera is available. Document location on a site plan and in inspection report.
	2	Restrict traffic on dam crest to essential emergency operations only.
	3	Contact geotechnical engineer and provide all data collected.
	4	Re-establish embankment fill slope. Place 5 ft high buttress fill against base of slope at the slide location that extends at least 15 ft beyond the furthest downstream limits (perpendicular to the embankment) and extending 20 ft beyond visible feature limits at either end (parallel to the embankment).
	5	Place sand bags as necessary around slide area to divert any storm water runoff from flowing into slide(s).
	6	Inspect the dam; collect piezometer and water level data daily unless otherwise instructed by engineer; and record any changes of condition. Carefully observe dam for signs of depressions, seepage, sinkholes, cracking or movement.
	7	Review information collected by field inspectors and provide additional instructions / actions as required. Consider survey monitoring.
	8	Make notifications if conditions worsen such that failure is imminent.

Description of Condition	Item	Action to be Taken
EMBANKMENT DEFORMATION (CONT.)		
SINKHOLES: Small depression observed on the embankment or within 50 feet of the embankment toe that is less than 5 feet deep and 30 feet wide or which is increasing with time.	1	Slowly open drain valve(s) to lower reservoir elevation.
	2	Measure and record feature dimensions, approximate flow rate, and relative location to existing surface features. Take photos if camera is available. Document location on a site plan and in inspection report.
	3	Restrict traffic on dam crest to essential emergency operations only.
	4	Contact geotechnical engineer and provide all data collected.
	5	Backfill the depression with relatively clean earth fill (free of organic materials) generally even with surrounding grade and slightly mounded (6 to 12 inches higher) in the center in order to shed storm water away from the depression. Stock pile additional fill.
	6	Inspect the dam; collect piezometer and water level data daily unless otherwise instructed by engineer; and record any changes of condition. Carefully observe dam for signs of depressions, seepage, sinkholes, cracking or movement.
	7	Review information collected by field inspectors and provide additional instructions / actions as required. Consider remedial construction such as grouting.
	8	Make notifications if conditions worsen such that failure is imminent.
GATE (VALVE) MALFUNCTION OR FAILURE		
Dam gates / valves damaged structurally (sabotage, debris, etc.) with uncontrolled release of water at a constant volume. Condition appears stable.	1	Close any other gates, if open.
	2	Install XXX or use other methods to stop or slow down the flow of water.
	2	Consult a structural / mechanical engineer for evaluation and recommendations. Consult dam remediation contractor for evaluation and recommendations.
	3	Repair / replace gate / valve as necessary.
	4	Make notifications if conditions worsen such that further structural failure is imminent.
SABATOGUE AND MISCELLANEOUS OTHER ISSUES		
Criminal action with significant damage to embankment or structures where significant repairs are required and the integrity of the facility is compromised – condition appears stable with time.	1	Contact law enforcement authorities and restrict all access (except emergency responders) to dam. Restrict traffic on dam crest to essential emergency operations only.
	2	Assess extent of damage and visually inspect entire dam for additional less obvious damages. Based on inspection results, confirm if extent of damages to various components of the dam warrants revised emergency level and additional notifications.
	3	If necessary to lower reservoir level, open drain valve(s).
	4	Perform additional tasks as directed by the Dam Engineer or designee.
	5	Make notifications if conditions worsen.

APPENDIX 6-L

Example Forms and Logs

APPENDIX 6-L.2: Example Record of Plan Holders

Copy Number	Organization	Person Receiving Copy
1	Regional Dam Safety Engineer,	
2	Div. of Dam Safety Director	
3	County 24-hr. Emergency Communications Center	
4	County Coordinator of Emergency Operations	
5	Utility General Managers Office, incident command post	
6	State emergency management agency	
7	Technical Consultants / engineer	
8	DOT, Resident Engineer	

APPENDIX 6-L.3: Example Record of Reviews and Revisions

Revision #	Date	Sections Reviewed or Revisions Made	By Whom

APPENDIX 6-L.4: Example Dam Emergency Termination Log

DAM NAME:	COUNTY:
DAM LOCATION:	STREAM / RIVER:
DATE / TIME:	
WEATHER CONDITIONS:	
GENERAL DESCRIPTION OF EMERGENCY SITUATION:	
AREA(S) OF DAM AFFECTED:	
EXTENT OF DAMAGE TO DAM & POSSIBLE CAUSES:	
EFFECT ON DAM OPERATION:	
INITIAL RESERVOIR ELEVATION / TIME:	
MAXIMUM RESERVOIR ELEVATION / TIME:	
FINAL RESERVOIR ELEVATION / TIME:	
DESCRIPTION OF AREA FLOODED DOWNSTREAM / DAMAGES / LOSS OF LIFE:	
JUSTIFICATION FOR TERMINATION OF DAM SAFETY EMERGENCY:	
OTHER DATA AND COMMENTS:	
REPORT PREPARED BY (PRINTED NAME & SIGNATURE):	
DATE:	

APPENDIX 6-M

FERC Requirements for Submitting GIS Inundation Zones

FERC Requirements for Submitting GIS Inundation Zones

General Specifications of GIS data

The following five (5) types of data files will be required for submitting GIS inundation zones to the FERC. The GIS files can then be converted into a variety of data formats (CAD, ArcGIS online, QGIS, Google Earth, etc.) or incorporated directly into systems used by emergency management authorities.

1. Point File

The point file will be used both for locating project structures, such as dams and powerhouses, as well as for reference points for georeferencing raster format inundation maps. Points can be acquired by survey, GPS, or by identification of electronic coordinates of features (such as road intersections) from a USGS DRG or DOQQ. A minimum of three points are required for each map panel on the inundation map sheets and the points should be spread over the entire raster dataset rather than concentrating them in one area. Most inundation map sheets will have a single map panel, but if inset maps are used to illustrate different resolutions, these insets must have three or more reference points as well.

2. Rasters

A raster map is simply a digital copy of the paper inundation map used in the EAP. The digital copy can either be a scanned copy of an existing paper map, or a digitally created map from GIS or CAD software. This copy will be georeferenced by FERC staff using the required point file, and used to verify the accuracy of the GIS failure inundation polygon files.

The raster (and paper) maps must have a minimum of three reference points for each map panel. If a sheet has insets or a split drawing with match lines, then each inset or split must have its own 3 reference points. The point file labels when plotted on the actual inundation map should not be so prominent as to obscure important features.

The inundation area delineated on the map must overlay the failure inundation polygon (see 3 below) EXACTLY when georeferenced using the reference points provided by the licensee. The map must overlay the USGS QUADS or the DOQQs with a positional error no greater than 40 ft.

3. Failure Inundation Polygon

The failure inundation zone should be a single shapefile feature for each flood scenario (i.e. fair weather, PMF, etc), and should be a closed polygon.

This polygon can be used by emergency management authorities to delineate the affected area, which can then be cross-referenced with other GIS layers.

Gridded data from 1-D and 2-D hydraulic modeling to develop the inundation area can be created as part of the flood modeling process. The gridded data can be useful in assessment of life loss and damage estimates. Submittal of the inundation flood depth grid file is optional and can be submitted in binary (*.flt) or ASCII (*.asc) electronic formats.

4. Cross Section File

The cross section file is used for determining the timing and depth of flooding at a given location. This information can be used by emergency responders to identify houses or subdivisions that are high priority due to early flooding or excessive flooding depths. For 1-dimensional models, submit only information from the cross sections shown on the inundation maps.

In 2-dimensional models, there are no “true” cross-sections. Thus, cross-section file can be created from the raster (grid) output of the 2-dimensional model. Flood characteristics can be displayed in various ways (e.g. isoline/contours, polylines, vectors, etc.) or can also be averaged across the entire cross-section or separated by main channel and overbank areas on a 2-dimensional inundation map. Appendix 6-N contains examples of these options. There are two options for submitting flood data timing and severity information. The licensee should coordinate with the FERC Regional Office staff and the emergency management authorities regarding these options prior to submittal to ensure that the most effective 2-dimensional inundation map is created.

(1) Submit only the artificially created cross-sections.

(2) Submit a point file from the raster (grid) output of the 2-dimensional model showing the inundation depth grid and include a data table for the artificial cross-sections on the inundation map.

Note: When using a 2-dimensional model it is imperative that the methods used to display and tabularize the data be clearly and thoroughly described in the Metadata file.

Similar to inundation depth grids, the arrival time and duration grids can be created from 1-D or 2-D engineering models. Such grid files can be submitted in binary (*.flt) or ASCII (*.asc) electronic formats. Arrival time

and duration grids are optional.

5. Metadata Text File

A metadata file is literally “data about data.” Metadata is a text file that describes the details of the data set such as the source, the year the data was produced, the coordinate system used to create the data (Albers Equal Area – see Technical specs below), the datum (NAD 83 should be used – NAD 27 should not be used unless there is no other alternative), and the units of measurement (meters should be used). One metadata file should be included with each of the above four files.

Technical Specifications

All data submitted should meet the following requirements.

1. Spatial Projection

All data files shall be filed in Albers’s Equal Area Conic Projection, a readily available national scale spatial projection, which has the following specifications:

Parameters:

False Easting: 0.000000

False Northing: 0.000000

Central Meridian: -96.000000

Standard Parallel 1: 29.500000

Standard Parallel 2: 45.500000

Latitude of Origin: 37.500000

Units: meters

Horizontal Datum: North American Datum 1983

Vertical Datum: North American Datum (NAVD88) is preferred, however, if a local datum is used a conversion to NAVD88 should be provided.

2. Accuracy

All georeferenced electronic data files must be positionally accurate to ± 40 feet in order to comply with National Map Accuracy Standards for maps at a 1:24,000 scale.

We recognize available base data is not as accurate in Alaska. These projects should attempt to meet our standards to the best extent possible. If the accuracy standards above cannot be met, include a written description of the base data used to georeference the inundation area.

The following data requirements are unique to each data type:

Point File

A minimum of three reference points will be required for map panel. The points should be spread out or triangular in orientation to facilitate accurate georeferencing of the raster files. Typically, each inundation map will have one map panel per sheet. If a sheet has more than one map panel, such as an inset at a different scale or a split drawing with match lines, each of the map panels should have three reference points. Include points at the main section of the dam and other major project features, such as the powerhouse or saddle dike. The location of the coordinate for the dams should be the spillway or the approximate center of the impounding structure, if possible. The location of the powerhouse should be the approximate center of the building.

The following data fields should be included in any point file submittal:

Field Name	Field Type	Units	Description
ID	ObjectID	None	Field reserved by GIS data – the ID of the point
Shape	Geometry	Point	Field reserved by GIS data – where the point geometry is stored
Project	Integer	None	FERC Project Number
Dam_Name	Text	None	Name of Dam
Sheet	Integer	None	Sheet number that reference points refer
DESC	Text	None	A description of the point, i.e. center of dam crest, road intersection

Raster

Each sheet of the inundation maps must be contained in a separate electronic raster file, which meets the following format specification:

IMAGERY - black & white raster file
FILE TYPE – Tagged Image File Format, (TIFF) or equivalent with world file

RESOLUTION –300 dpi desired, (200 dpi min)
FILE SIZE – less than 10 MB desired

These desired formats minimize file storage space on computer servers, and are universally read by most computer software. Each sheet must contain a minimum of three known reference points. The positional coordinates of each reference point must be shown.

Failure Inundation Polygon

The dam failure inundation polygon should match the inundation area on the EAP paper maps. Each inundation area must be a closed polygon. A collection of line segments, such as from a converted CAD file, will not be accepted.

The following data fields should be included in the failure inundation area attribute table:

Field Name	Field Type	Units	Description
ID	ObjectID	None	Field reserved by GIS data – the ID of the polygon
Shape	Geometry	Polygon	Field reserved by GIS data – where the polygon geometry is stored
Project	Integer	None	FERC Project Number
Dam_Name	Text	None	Name of Dam
Scenario	Text	None	Fair weather or IDF

Cross Section

The cross section file should include a single polyline feature for each of the cross section locations shown on the inundation maps. For 2D models, either the point file should be submitted or the single polyline feature cross section file created for those cross sections plotted on the inundation maps.

Alternatively, a simple text box could be used to convey the different flooding severity hazards at each cross section with the technical detail in the following table shown on the index map. See Appendix 6-N for examples of these types of inundation maps.

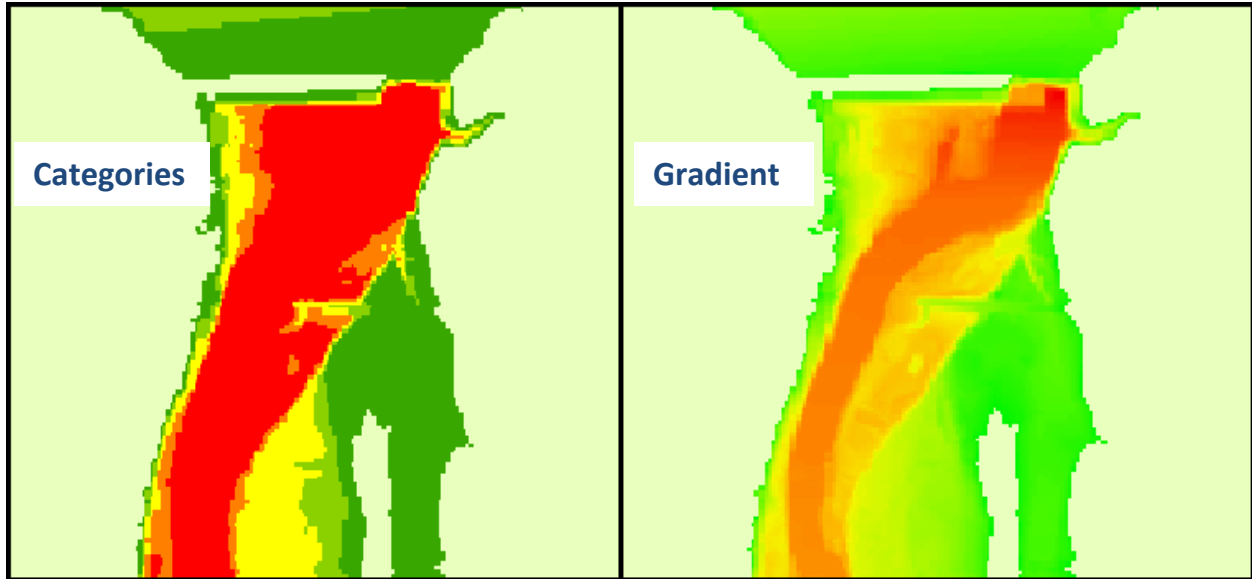
The following data fields should be included in the cross section attribute table (or point file for 2D):

Field Name	Field Type	Units	Description
ID	ObjectID	None	Field reserved by GIS data – the ID of the cross section line
Shape	Geometry	Lines	Field reserved by GIS data – where the line geometry is stored
Project	Integer	None	FERC Project Number
Dam_Name	Text	None	Name of Dam
DIST	Float	Miles	The distance of the cross section downstream of the dam
IDF_TOA	Float	Hours	Time of arrival of leading edge of IDF failure hydrograph
IDF_TTP	Float	Hours	Time to peak of IDF failure hydrograph
IDF_WSEL	Float	Feet	Peak water surface elevation of IDF failure hydrograph
IDF_RISE	Float	Feet	Incremental rise due to IDF dam failure
IDF_FLOW	Float	CFS	Peak flow of IDF failure hydrograph
IDF_DUR ¹	Float	Hours	Time of IDF failure inundation
IDF_VEL ¹	Float	Feet/sec	Velocity of IDF dam breach flow
FW_TOA	Float	Hours	Time of arrival of leading edge of fair weather failure hydrograph
FW_TTP	Float	Hours	Time to peak of fair weather failure hydrograph
FW_WSEL	Float	Feet	Peak water surface elevation of fair weather failure hydrograph
FW_RISE	Float	Feet	Incremental rise due to fair weather dam failure
FW_FLOW	Float	CFS	Peak flow of fair weather failure hydrograph
FW_DUR ¹	Float	Hours	Time of fair weather failure inundation
FW_VEL ¹	Float	Feet/sec	Velocity of fair weather dam breach flow

¹Optional/Suggested: The selection of the reported dam breach velocities should consider the location of structures in the critical downstream areas. Only if the impacted structures are obviously well into the flood plain should overbank velocity be reported. Otherwise, the fastest velocity from the model rather than the average velocity of the entire cross section should be reported.

Important notes for 2D inundation maps:

- A minimum of 1-2 cross sections with flood wave characteristics should be displayed per inundation map sheet if there are no critical areas (i.e. rural or forested downstream areas).
- The deepest depth from the model should be used to compute the incremental rise.
- A map legend should be provided on the map for gridded values. It is preferable to use categories rather than a smooth color gradient (see example below showing categories on the left and a gradient on the right).



Metadata

One metadata file should be included with each of the other four file types. The metadata should be a simple text file and should contain background information about each of the data sources. Metadata should be submitted in Federal Geographic Data Committee format (<http://www.fgdc.gov/metadata>). Items that are required in the metadata are: the model used to calculate the inundation, the date of the dam break model run, the source and date of the elevation data for the model, and the PMF/IDF, and fair weather flows used in the model.

APPENDIX 6-N

Sample Inundation Maps

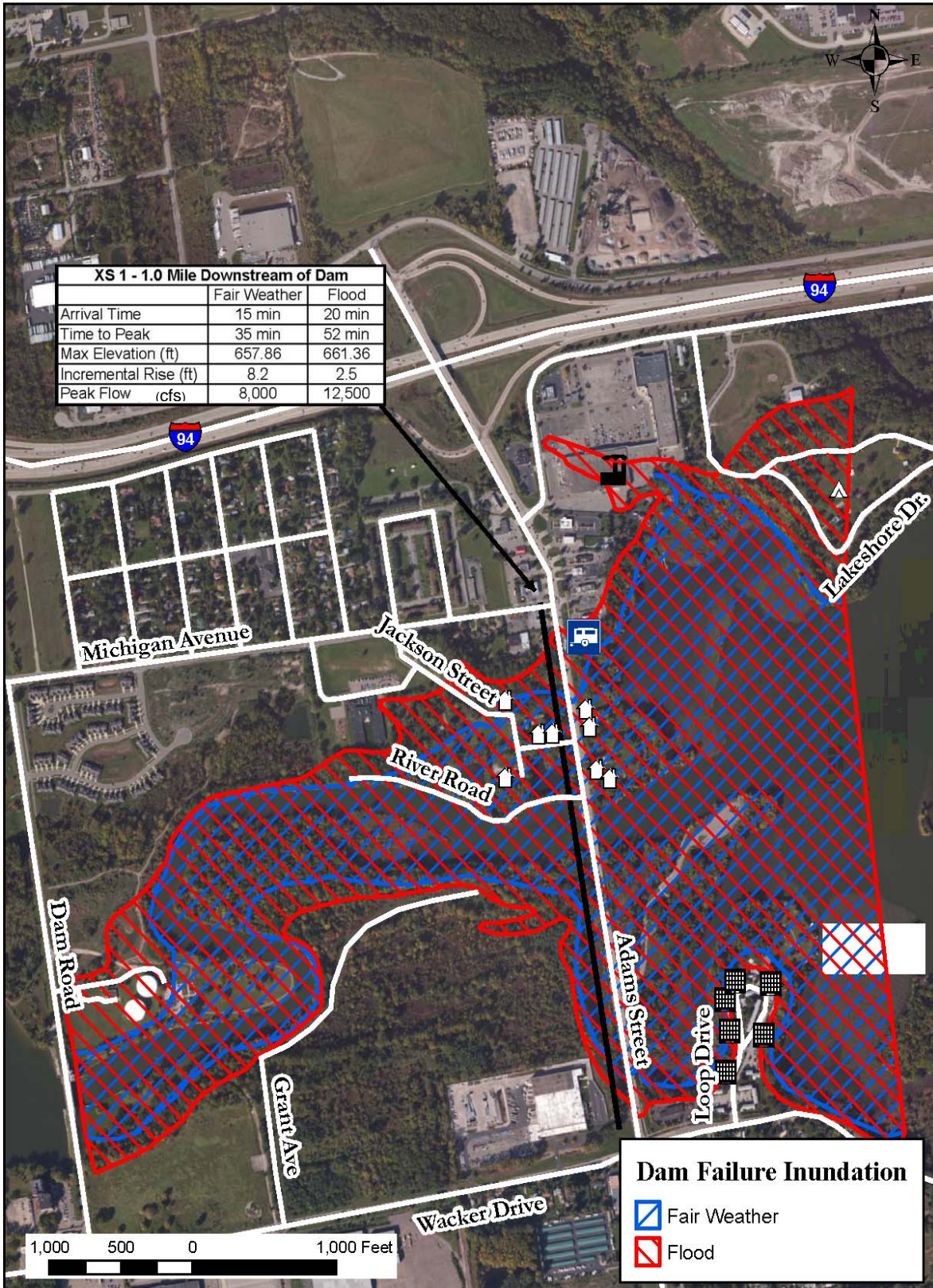


Figure 6-N.1: Example of a Traditional Inundation Map

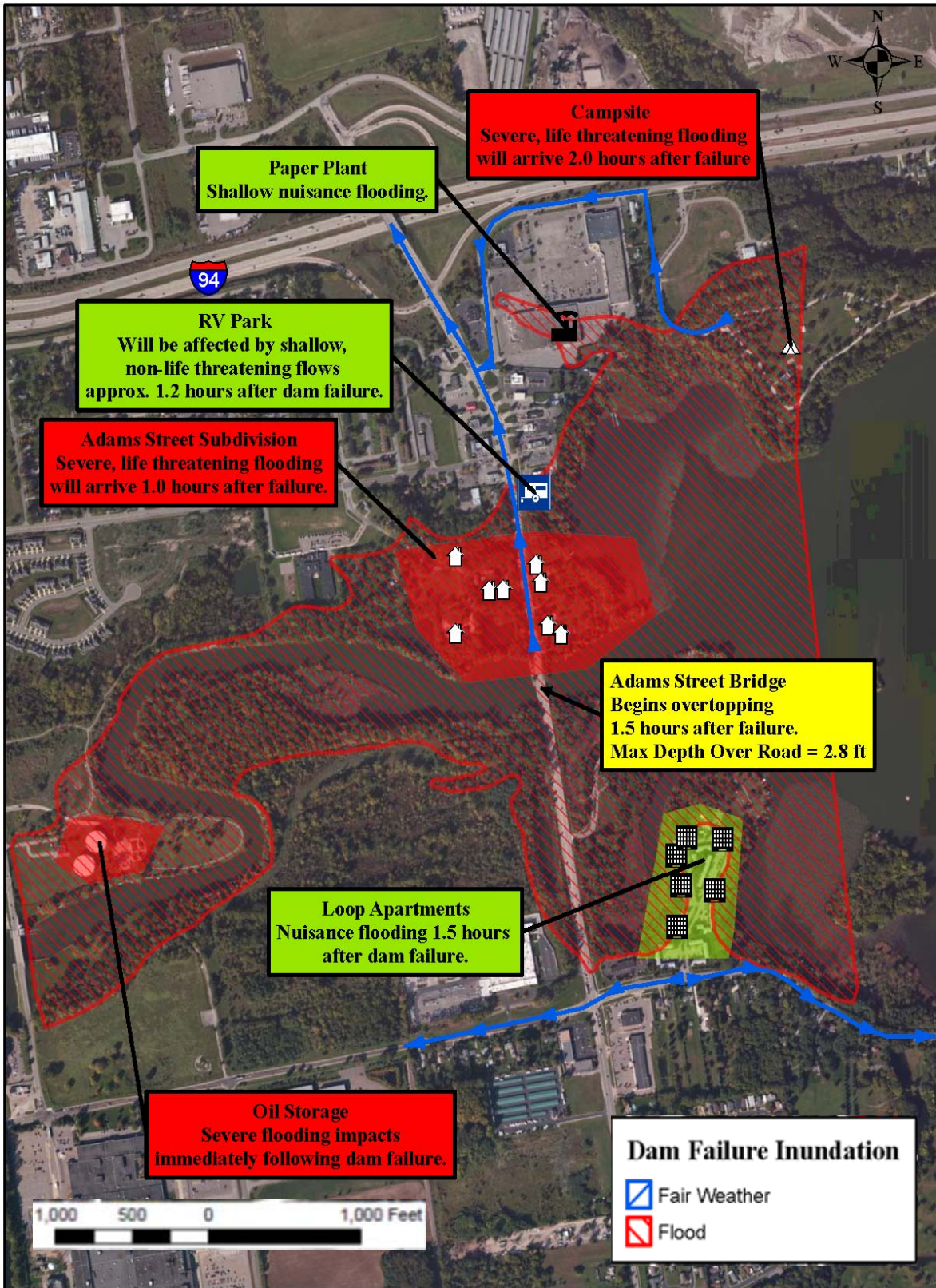
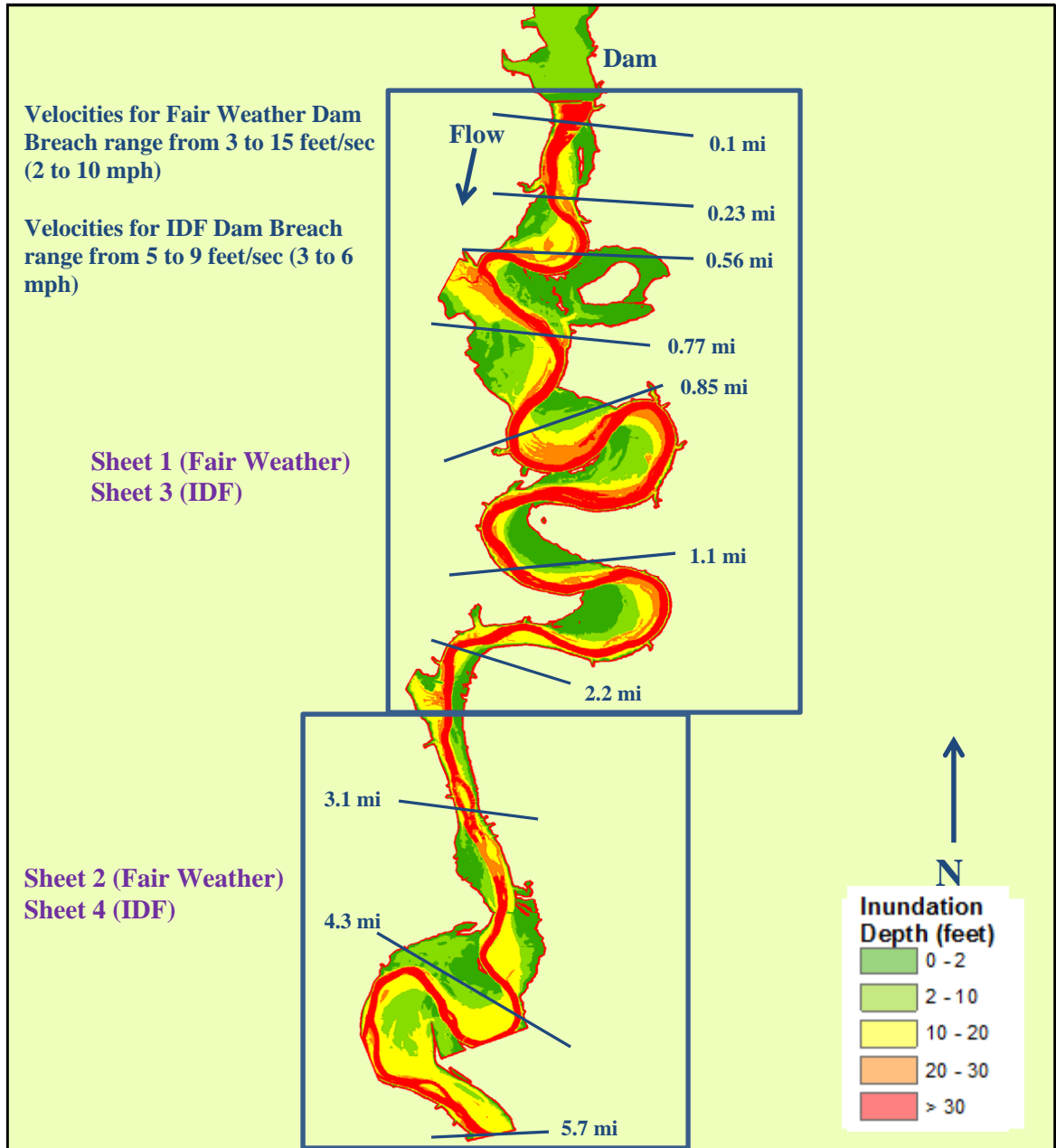


Figure 6-N.2: Example of a Traditional Inundation Map Conveying Flood Hazards



Fair Weather Breach Scenario									IDF Breach Scenario								
Distance Downstream of Dam (Mile)	Cross-Section	Normal River El. (feet MSL)	Peak Breach River El. (feet MSL)	Incremental Rise (feet)	Peak Dam Breach Flow (cfs)	Arrival Time (Hr:Min)	Time to Peak (Hr:Min)	Duration of Inundation (Hr:Min)	Distance Downstream of Dam (Mile)	Cross-Section	IDF River El. (feet MSL)	Peak Breach River El. (feet MSL)	Incremental Rise (feet)	Peak Dam Breach Flow (cfs)	Arrival Time (Hr:Min)	Time to Peak (Hr:Min)	Duration of Inundation (Hr:Min)
0.1		665.1	709.1	44	111,000	0:01	0:35		0.1		677.6	701.6	24	137,400	0:01	0:56	
0.23		665.0	702.0	37	108,900	0:08	0:40		0.23		677.5	694.5	17	135,300	0:06	1:14	
0.56	Granite St	664.5	696.5	32	101,800	0:15	0:52	5:02	0.56	Granite St	677.0	692.0	15	128,200	0:10	1:36	>24 hrs
0.77		664.3	690.3	26	92,400	0:21	1:02		0.77		676.8	689.8	13	118,800	0:17	1:58	
0.85	Bridge	664.1	686.1	22	87,500	0:29	1:09	4:40	0.85	Bridge	676.6	687.6	11	113,900	0:23	2:16	>24 hrs
1.1	River's Bend	663.9	682.9	19	84,900	0:35	1:16	4:32	1.1	River's Bend	676.4	685.4	9	111,300	0:29	2:49	>24 hrs
2.2		663.2	675.2	12	66,300	0:56	1:49		2.2		675.7	682.7	7	92,700	0:44	3:15	
3.1		662.9	668.9	6	42,600	1:21	2:14		3.1		675.4	678.4	3	69,000	1:01	3:56	
4.3	Hemlock St	662.5	665.5	3	19,900	1:57	2:58	2:46	4.3	Hemlock St	675.0	676.0	1	46,300	1:36	4:27	>24 hrs
5.7		662.1	663.1	1	8,100	2:34	3:46		5.7		674.6	675.1	0.5	34,500	2:06	5:02	

Figure 6-N.3: Example Showing Index Map with Cross-Section Summary Tables

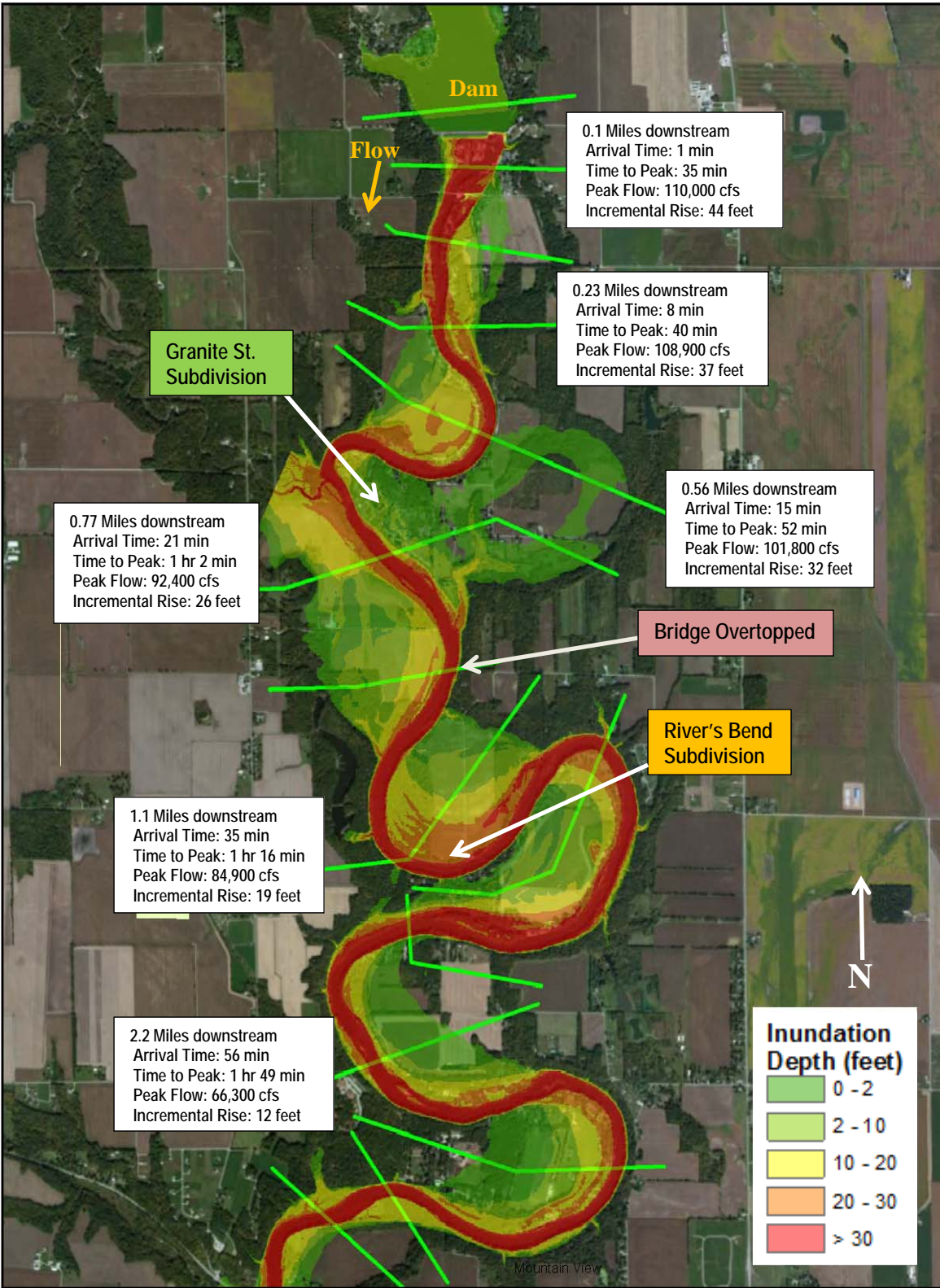


Figure 6-N.4: Example Showing a 2-D Inundation Map Using Aerial Background, Gridded Depth Legend and Traditional Cross-Section Information

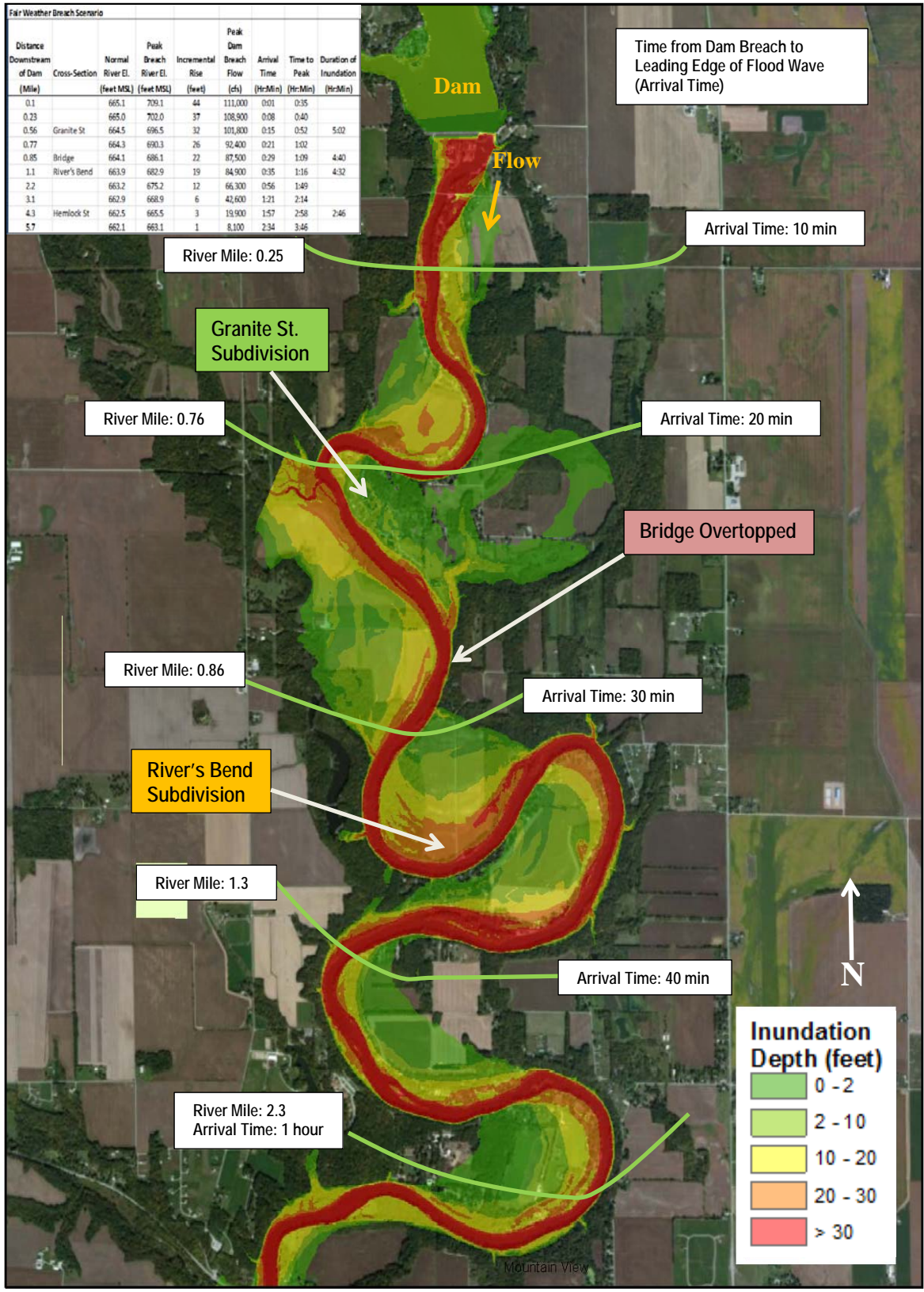


Figure 6-N.5: Example Showing a 2-D Inundation Map Using USGS Background, Gradient Depth Legend and Cross-Sections Conveying Flood Hazards

APPENDIX 6-O

Time Sensitive/Sudden Failure Assessment

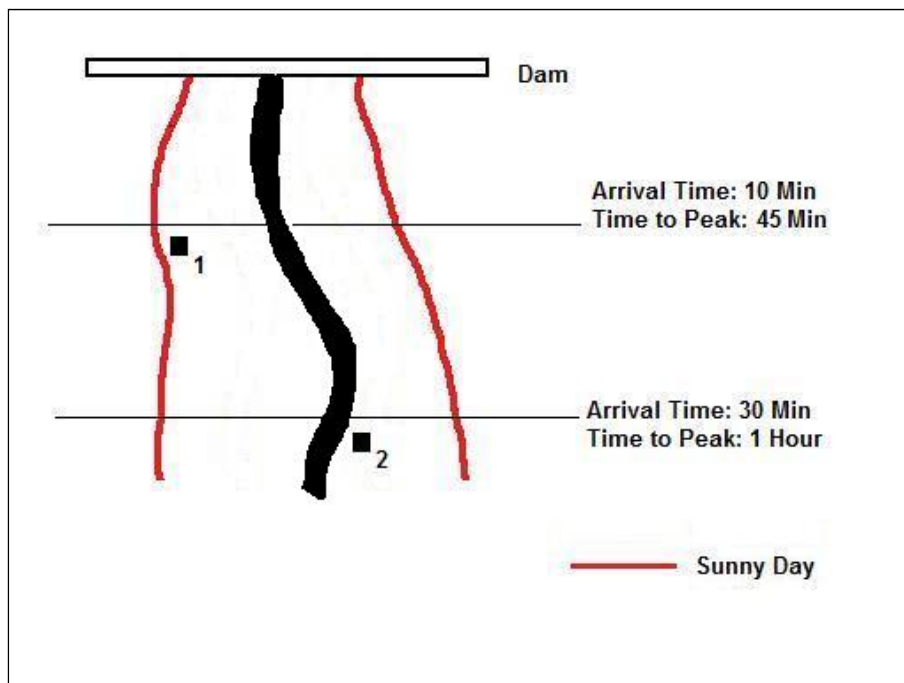
METHOD FOR ASSESSING TIME-SENSITIVE EAPS

This document describes a method for assessing time-sensitive Emergency Action Plans (EAPs). The method – called a Sudden Failure Assessment - conservatively assumes a sudden, unexpected failure of the dam with no pre-warning to the licensee.

SUDDEN-FAILURE ASSESSMENT

(A) Determine Time to Impact – The time to impact is the amount of time it would take for a flood wave from a dam failure to significantly impact the first non-project downstream structure (e.g., residence, campground, business, etc.) based on the fair weather/sunny day inundation zone in the EAP.

As an example, the figure below shows the area downstream of a dam from the EAP's inundation map. Structure 1 is located at an elevation near the fair weather/sunny day inundation line. It would likely receive impacts just before the Time to Peak – which is about 45 minutes – and only be impacted by a few inches of water from a failure. Structure 2 is close to the river's edge and at an elevation that would receive significant impacts close to the arrival time - which is about 30 minutes. Based on this map, the licensee estimates the time to impact for the nearest structure is 30 minutes.



(B) Determine Detection Time – The detection time is the amount of time after the sudden failure begins until the licensee's staff is aware there is a problem at the dam. Typically, this warning is triggered by instrumentation at the project. If the site is unmanned during part of the day, the detection time should conservatively be estimated

for non-working hours when operators would be warned through communication systems such as autodialers. Where possible, time estimates should be based on actual tests of the instrumentation and communication systems.

In the example, an unexpected failure of the dam during non-working hours would trigger the headwater and tailwater sensors. When these sensors are triggered, an autodialer calls the nearest operator and project manager. The headwater sensor is currently set to alarm if there is a 2 foot drop within 10 minutes and the tailwater sensor is set to alarm if there is a four foot rise within 10 minutes. Based on a test of the system, the licensee determines the total detection time - including the time for the sensors to trigger and the call to be received by project personnel - is about 14 minutes.

(C) Determine Verification Time – The verification time is the amount of time to verify a problem at the dam, either visually or by other means, once the problem has been detected. If the site is unmanned during part of the day, the verification time should conservatively be estimated for non-working hours. The verification time should be based on actual tests or drills for the amount of time it takes to have someone confirm a problem.

In the example, the project's instrumentation triggers an autodialer to call the operator and project manager. A test was performed to determine how long it takes the operator to get to the site initiated by an unannounced call to the operator's home. The test revealed it took the operator 23 minutes to reach and inspect the dam.

(D) Determine Notification Time – The notification time is how long it would take to notify the local emergency management agency (EMA) after a problem is verified. This includes any internal discussion among licensee personnel before the EMA is notified. The notification time can be estimated from the call down test performed during the annual drill.

In the example, the operator visually verifies a problem at the dam and calls the project manager to explain what is happening at the dam. The project manager then decides to activate the EAP and contacts the local EMA according to the notification flow chart. During the most recent call down test, it took 8 minutes from when the operator called the project manager to when the project manager completed her discussion with the local EMA.

(E) Calculate Licensee's Total Response Time – The licensee's total response time is the amount of time to detect, verify, and notify the EMA of an emergency. This is the sum of steps B, C, and D.

Step	Time (min)
B	14
C	23
D	8
E	45

(F) Get Estimate of EMA’s Response Time – The EMA’s response time is how much time the local EMA needs to warn and/or evacuate the critical residences close to the dam. This can be asked during the annual seminar/meeting with the local EMA.

In the example, the EMA indicates first responders would need at least 20 minutes as a lead time in order to warn and/or evacuate the two closest houses within the inundation zone. The other structures within the inundation zone are further downstream and would be able to be evacuated before the flood arrives in those areas.

(G) Calculate Excess Response Time – The excess response time is the difference between the time to impact and the sum of the licensee’s and EMA’s response times ($A - (E + F)$). If the excess response time is negative, there is not enough time to warn and evacuate people before the flood wave arrives. If the excess response time is positive, then the amount of time for an emergency response should be adequate.

Step	Time (min)
A	30
E	45
F	20
$A - (E + F)$	-35

(H) Assess Results – If the excess response time in step G is negative, try to come up with methods to decrease the detection, verification, and notification times that would yield positive values. Even if the excess response time is positive, it may still be beneficial to take additional measures to maximize the chance of safely warning and evacuating all downstream residents during an emergency.

The goal is to get the excess response greater than zero. If all options to decrease the detection, verification, and notification times have been considered and the excess response time is still negative, the only possibility for saving additional time is with the EMA’s response. In these cases, coordinate with the local EMA to determine if anything can be done to decrease the EMA response time through enhanced warning systems, public education, etc.

For some projects with residences directly downstream, it may be impossible to get positive excess response times. For these projects, the goal should be to get an excess response time as close to zero as possible.

In the example, the following enhancements were made to the licensee’s system:

Enhancement	Time Parameter Impacted	Benefit
Adjust trigger points on headwater/tailwater levels to activate sooner.	Detection	Quicker detection.
Install internet-accessible cameras pointed at headwater and tailwater staff gages.	Verification	Eliminates drive to dam to verify emergency.
	Notification	Allows project manager to activate EAP without talking to operator. Provides redundancy if operator is unavailable.
Operator will contact EMA directly if failure is evident.	Notification	Allows operator to activate EAP without talking to project manager. Provides redundancy if project manager is unavailable.
Create Pre-Scripted Messages for Project Manager/Operator to inform local EMA of emergency.	Notification	Allows project manager/operator to give EMA all information they would need as quickly as possible.

The proposed changes would decrease the licensee’s response time but the excess response time would still remain negative:

Step	Time Parameter	Time (min)
A	Time to Impact	30
B	Detection Time	10
C	Verification Time	5
D	Notification Time	5
E	Licensee Response Time (B + C + D)	20
F	EMA Response Time	20
G	Excess Response Time (A – (E + F))	-10

At this point, the licensee coordinated with the local EMA to determine if additional measures could be made to decrease the EMA response time. The EMA and licensee agreed to keep contact information for the two critical houses in the EAP and both the licensee and EMA will call the residents during an emergency. Each year, the residents are given evacuation procedures to follow if they ever notice a problem or receive a call. The additional measures decrease the EMA response time to yield a positive excess response time.