

Emergency Management Planning for Floods Affected by Dams



Australian Institute for
Disaster Resilience

AUSTRALIAN DISASTER RESILIENCE
HANDBOOK COLLECTION

Emergency Management
Planning for Floods
Affected by Dams

Manual 23



Australian Government
Attorney-General's Department

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The first publications in the original Australian Emergency Manual Series were primarily skills reference manuals produced from 1989 onwards. In August 1996, on advice from the National Emergency Management Principles and Practice Advisory Group, the Series was expanded to include a more comprehensive range of emergency management principles and practice reference publications.

In 2011, Handbooks were introduced to better align the Series with the *National Strategy for Disaster Resilience*. Compiled by practitioners with management and service-delivery experience in a range of disaster events, the handbooks comprised principles, strategies and actions to help the management and delivery of support services in a disaster context.

In 2015, the Australian Institute for Disaster Resilience (AIDR) was appointed custodian of the handbooks and manuals in the series. Now known as the Australian Disaster Resilience Handbook Collection, AIDR continues to provide guidance on the national principles and practices in disaster resilience in Australia through management and publication of the Collection.

The Handbook Collection is developed and reviewed by national consultative committees representing a range of state and territory agencies, governments, organisations and individuals involved in disaster resilience. The Collection is sponsored by the Australian Government Attorney-General's Department.

Access to the Collection and further details are available at www.knowledge.aidr.org.au.

Australian National Disaster Resilience Handbook Collection (2011 –)

Handbook 1 Disaster health

Handbook 2 Community recovery

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Handbook 4 Evacuation planning

Handbook 5 Communicating with people with a disability – National Guidelines for Emergency Managers

Handbook 6 National Strategy for Disaster Resilience – community engagement framework

Handbook 7 Managing the floodplain: a guide to best practice in flood risk management in Australia

Guideline 7-1 Guideline for using the national generic brief for flood investigations to develop project specific specifications

Guideline 7-2 Technical Flood Risk Management Guideline: flood emergency response classification of the floodplain

Guideline 7-3 Technical flood risk management guideline: flood hazard

Template 7-4 Technical project brief template

Guideline 7-5 Technical Flood Risk Management Guideline - flood information to support land-use planning

Guideline 7-6 Technical flood risk management guideline: assessing options and service levels for treating existing risk

Practice Note 7-7 Considering flooding in land-use planning activities

Handbook 8 Lessons management

Handbook 9 Australian Emergency Management Arrangements

Handbook 10 National Emergency Risk Assessment Guidelines (*plus supporting guideline*)

Guideline 10-1 National Emergency Risk Assessment Guidelines: practice guide

Handbook 11 *renamed Guideline 10-1 National Emergency Risk Assessment Guidelines: practice guide*

Handbook 12 *Spontaneous volunteer management*

Australian Emergency Management Manual Series

The most recent list of publications in the Manuals series includes 46 titles.

The manuals have not been reviewed since 2011 or earlier and the Manual Series is undergoing a review which will see relevant Manuals move into the Handbook Collection. Current and past editions of the Manuals will remain available on the AIDR Knowledge Hub at www.knowledge.aidr.org.au.

Manual Series Catalogue: 2004 - 2011

Manual 1 Emergency management concepts and principles (2004)

Manual 2 *Australian Emergency Management Arrangements (superseded by Handbook 9)*

Manual 3 Australian Emergency Management Glossary (1998)

Manual 4 Australian Emergency Management Terms Thesaurus (1998)

Manual 5 *Emergency risk management – applications guide (superseded by Handbook 10)*

Manual 6 *Implementing emergency risk management – a facilitator’s guide to working with committees and communities (superseded by Handbook 10)*

Manual 7 Planning safer communities – land use planning for natural hazards (2002, currently under review)

Manual 8 *Emergency catering (2003, archived)*

Manual 12 Safe and healthy mass gatherings (1999)

Manual 13 Health aspects of chemical, biological and radiological hazards (2000)

Manual 14 Post disaster survey and assessment (2001)

Manual 15 Community emergency planning (1992)

Manual 16 Urban search and rescue – capability guidelines for structural collapse (2002)

Manual 17 Multi-agency incident management (replaced by AIIMS)

Manual 18 Community and personal support services (1998)

Manual 19 *Managing the floodplain (superseded by Handbook 7)*

Manual 20 Flood preparedness (2009)

Manual 21 Flood warning (2009)

Manual 22 Flood response (2009)

Manual 23 Emergency management planning for floods affected by dams (2009)

Manual 24 Reducing the community impact of landslides (2001)

Manual 25 Guidelines for psychological services: emergency managers guide (2003)

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- Manual 26** Guidelines for psychological services: mental health practitioners guide (2003)
 - Manual 27** Disaster loss assessment guidelines (2002)
 - Manual 28** Economic and financial aspects of disaster recovery (2002)
 - Manual 29** Community development in recovery from disaster (2003)
 - Manual 30** Storm and water damage operations (2007) (information may not be appropriate to all situations)
 - Manual 31** Operations centre management (2001)
 - Manual 32** Leadership (1997)
 - Manual 33** National Land search operations (2014) (refer to the Land Search Operations Manual website)
 - Manual 34** Road rescue (2009)
 - Manual 35** General and disaster rescue (2006)
 - Manual 36** Map reading and navigation (2001)
 - Manual 37** Four-wheel-drive vehicle operation (1997)
 - Manual 38** Communications (1998)
 - Manual 39** Flood rescue boat operation (2009)
 - Manual 40** Vertical Rescue (2001)
 - Manual 41** *Small group training management (1999, archived)*
 - Manual 42** *Managing Exercises (superseded by Handbook 3)*
 - Manual 43** Emergency planning (2004)
 - Manual 44** Guidelines for emergency management in culturally and linguistically diverse communities (2007)
 - Manual 45** Guidelines for the development of community education, awareness and education programs (2010)
 - Manual 46** Tsunami (2010)

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Foreword

This Guide is the result of a review of the original Australian Emergency Manual of the same title which was prepared in 1999-2000 by a team of emergency managers, dam safety specialists and dam owners from around Australia. The review was conducted by Norm Himsley (New South Wales Dams Safety Committee) and Chas Keys (formerly of the New South Wales State Emergency Service) with input from Peter Allen, Ron Guppy and Nguyen Khanh (Office of the Water Supply Regulator, Queensland) and David Dole (Murray Darling Basin Authority). All these people have experience and expertise in the management of emergencies at dams or in planning for and managing floods affected by dams.

The Guide is one of a series of documents on flood management whose review was instigated and managed by the National Flood Risk Advisory Group, a sub-group of the Australian Emergency Management Committee. The project was coordinated by Major General Hori Howard of the Australian Council of State Emergency Services and made possible by the financial contributions of the Commonwealth Attorney-General's Department and the Australasian Fire and Emergency Service Authorities Council.

The Guide is intended to be used by all those in Australia who have roles to play in managing floods caused or exacerbated by dams and their operation. These include emergency management practitioners, dam owners and members of dam safety regulatory authorities.

The document is intended to provide broad guidance on matters relating to the operation of dams (where this causes or exacerbates flooding) and to flooding caused by dam failure. It reflects considerable expertise developed over many years of dam safety and flood emergency planning in the Australian states and territories. The Guide seeks to define 'best practice' in the management of flooding affected by dams, as this is currently understood in Australia. It does not seek to define or describe current practices or arrangements, which may vary considerably between jurisdictions. Users will find it valuable to refer to other publications in the Australian Emergency Manuals series and to manuals produced by dam safety experts.

Every attempt has been made to use neutral terminology. As a result the Guide does not use the specific terminology (for example in relation to officers, programs and management structures) employed in the various states and territories.

Martin Studdert, AM
First Assistant Secretary
National Security Capability Development Division
Attorney-General's Department

Introduction

In a Nutshell...

Dams can exacerbate existing floods or create them. Because of this it is necessary for planning to be conducted to facilitate the management of floods which are caused or made worse by dams – whether as a result of dam operations or dam failure. The development of appropriate plans needs to involve dam owners, dam safety regulators and emergency management agencies, and should incorporate consultation with potentially affected communities.

General

The community is exposed to many hazards, including floods. Modern emergency management practice takes account of such hazards and seeks, by the application of appropriate management tools, to minimise the risks these hazards impose upon the community.

While dams provide numerous benefits for communities, including flood mitigation, they may themselves create flood hazards in addition to the floods which occur 'naturally'. At the extreme, if dams fail and uncontrollably release their contents, the resulting 'dam-break' flooding can be disastrous for communities downstream. Routine dam operations may also cause flooding as a result of the intentional release of impounded water from storages, and the inappropriate operation of gated dams can have the same effects.

Both dam owners and emergency management agencies have obligations to be prepared for emergencies that arise at the sites of dams and for the flooding that may result from the release of water.

Purpose

This Guide aims to assist the community to be prepared for floods affected by dams, including dam break emergencies, by describing procedures which will:

- ensure that communities are aware of their exposure to these hazards,
- develop emergency action plans to minimise the consequences of these hazards within each community, and
- facilitate the integration of all related emergency management planning.

The guidelines provided are indicative of best practice for the emergency management of floods affected by dams.

Scope

These guidelines are a generic set of procedures for coordinating emergency management planning for floods affected by dams. Aspects covered are:

- flooding caused or exacerbated by the failure of dams by various means,
- flooding caused or exacerbated by the operation of dams,
- methods of identifying the likelihood and consequences of flooding affected by dams,
- the roles and responsibilities of dam owners, emergency managers and dam safety regulators,
- emergency risk management,
- communication activities and responsibilities, and
- stakeholder involvement.

The guidelines are not intended to be prescriptive, nor is it anticipated that all aspects of them will necessarily apply to every situation. It is also not intended that the guidelines will replace, or unnecessarily reproduce, the related documentation that exists on matters of dam safety or emergency management planning for floods (see References).

Legislative Framework

Most levels of government have legislative responsibilities to protect the community from harm. These responsibilities, which relate to duty of care and liability considerations, are implemented in various ways by different levels of government throughout Australia.

Legislation and regulations pertaining specifically to dam safety exist in most states and territories in Australia. The relevant authorities should be consulted for guidance in referring to the appropriate legislation.

Related Documents

In the application of the guidelines, it will necessary to refer to related documents. Key documents are listed in the References at the end of the Guide.

Stakeholders

There are four groups of stakeholders with interests in emergency management planning for floods affected by dams, as follows:

- **The community.** Communities affected by dams, especially those downstream of dams, have a significant stake in the responsible management of dams and the preparedness of dam owners and emergency agencies to respond to floods. An informed and prepared community can provide valuable input to dam owners in setting up operating rules, thus enhancing the ability of emergency managers to minimise the impacts of flooding. Through effective consultation processes the community should be supported to express their concerns, share experiences, influence solutions and, most importantly, have access to timely and relevant information. This relates not only to reducing the loss of life. Other consequences (damage to property, the environment or infrastructure, social impacts etc) may also be substantial.
- **Dam Owners.** A dam owner is the person, organisation or legal entity responsible for the control, operation and maintenance of a dam. A dam owner has a responsibility to develop and share critical information with stakeholders regarding the condition of the dam, the extent and nature of dam outflows (including those resulting from irrigation and environmental flows, from any emergency need to release water, as well as from potential dam failures), and the dam safety management procedures in place to respond to a range of risks.
- **Emergency Management Agencies.** Emergency management organisations in each state and territory in Australia have a responsibility to ensure planning is in place to deal with flooding. Where floods are affected (ie caused or made worse) by outflows from dams, the plans should contain specific arrangements relating to dam management practices and potential dam failure situations. The emergency management organisations will rely on dam owners for essential information needed to formulate these arrangements.
- **Dam Safety Regulators.** Dam safety regulators are the agencies responsible for the development of dam safety standards, and for auditing and enforcing their compliance by dam owners.

CHAPTER 2

Why Use These Guidelines?

In a Nutshell...

Modern emergency planning requires a close integration between dam safety planning and general community emergency management planning. Thus dam owners, emergency managers and dam safety regulators must share information and develop strategies to reduce the impacts of floods caused or affected by dams.

The Reasons

Historically in Australia there was a tendency for planning for dam safety to occur somewhat separately from general community emergency management planning. The aim of the planning, by both dam owners and emergency management agencies, was community protection, but the separation of planning processes tended to discourage consultation and therefore to increase risks to communities. These guidelines provide processes designed to accomplish seamless emergency management planning in relation to floods caused or affected by dams.

The community impact of floods affected by dams, including dam-break floods, can be greatly reduced if communities have recognised the risk beforehand and put in place emergency plans and other appropriate measures.

In order to protect life, property, infrastructure and the environment from such floods, it is necessary to have:

- an alert, informed and prepared community whose members understand the hazards and risks associated with the flooding which could occur,
- programs to reduce the risk arising from dam operations and from emergencies at dams,
- a clear definition of those responsible for emergency management and dam safety,
- cooperation between emergency management agencies, dam owners, the community and dam safety regulators,
- a coordinated approach to the use of resources, and
- arrangements to enable communities to recover from flood emergencies.

The intent of these guidelines is not to replace any of the existing emergency management processes associated with dams or community flood preparedness, but to ensure that there is an integrated and coordinated approach to management by both dam owners and emergency managers for the benefit of the community.

Why Dams Affect Floods

All dams on waterways impose a range of permanent effects on the natural streamflows and typically change the peak, timing and duration of floods. At one end of the spectrum are those structures (such as weirs and dams with uncontrolled spillways) that have minimal capability to modify flows. In these cases the flow modifications are typically a lessening of the flood peak accompanied by a lengthening of flood duration (see Figure 1 (a)). This effect can vary considerably depending on catchment size, dam storage capacity, rainfall intensity and the degree of storage deficit (below Full Supply Level) at the onset of a flood. Flood detention basins, for example, can have effects ranging from virtually nil (in extreme flood events) to great (in small ones).

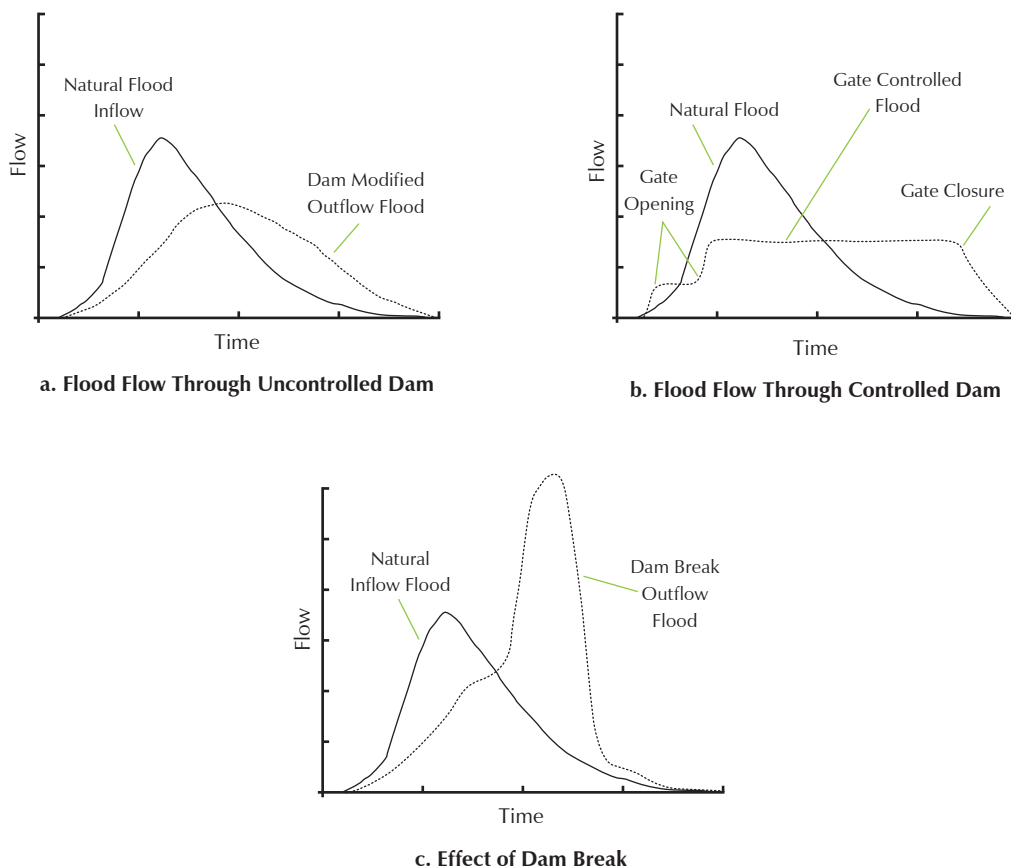


Figure 1: Flood-Handling Effects of Dams

At the other end of the spectrum are those dams that have a significant capacity to modify flood flows because they have the capability for owner control. In particular, these dams can influence the impact of flood events by changing flows downstream of the dam by the use of gates, valves, fuse plugs (which create the effect of a dam failure of limited extent) and other control devices. In flood events, such devices are normally operated in accordance with a particular strategy, either to minimise the rise in storage levels or to reduce downstream flood flows and heights (or to achieve a combination of these effects). A flood peak may be deliberately stored for later release, or 'pre-released' because the dam operator needs to create extra space in a reservoir by letting out some of the stored water ahead of an approaching flood (Figure 1 (b)). Such releases can create difficulties if the people downstream are not expecting them or lack awareness of the potential for flooding which brings them about.

In general, and whether dams are gated or not, the bigger the flood the less is their potential flood mitigation effect. Furthermore, the potential mitigation effect of a dam decreases in a downstream direction.

Dams also have the potential to fail and the subsequent dam-break floods can cause substantial damage downstream. The effect of dam failure on flood flows is illustrated in Figure 1 (c). Dam-failure floods involving a risk to life are rare events, but failure usually causes extremely rapid rises in downstream flood levels and often these rises occur with little or no effective warning especially if the population at risk is close to the dam.

The Integrated Planning Approach

Emergency management planning, for floods affected by dams, involves the integration of plans that are the responsibility of either the dam owner or the emergency management planner. These are set out below.

Dam Owners' Emergency Plans

Dam owners have a responsibility to prepare emergency plans for all dams for which failure would threaten life and property. These plans:

- identify emergency conditions that could endanger a dam and the effects of these conditions on the dam,
- prescribe procedures that should be followed to mitigate the consequences, and
- provide timely warning to emergency management organisations for the implementation of protection measures for downstream communities.

In addition, the plans identify and prescribe the necessary actions to warn downstream communities about water releases, planned or unplanned, which may cause flooding (for example of roads or farmland).

These plans are usually referred to as Emergency Action Plans (EAP) or Dam Safety Emergency Plans (DSEP) unless these terms are superseded by individual state/territory terminology. Details of these planning arrangements are contained in Section 8 of the ANCOLD document **Guidelines on Dam Safety Management** (1994).

Community Flood Plans

The community's ability to cope effectively with the impact of hazards will depend, in part, on whether emergency management plans exist that cover prevention, preparedness, response and recovery. In most states and territories, legislation requires preparation, testing and review of emergency plans. Community flood plans (which are usually prepared for local council areas or parts or combinations of council areas) are a vital component of this planning process. The community flood plans will, where appropriate, have linkages to both regional-level and state-level emergency management plans. Floods affected by dams constitute a special type of flood whose management needs to be integrated with planning for other floods.

EMA Guides of value in developing and implementing community flood plans are included in Part III, Volume 3 of the Australian Emergency Manuals Series as listed in the References at the end of this Guide. Of particular use in the context of flood planning is the **Flood Preparedness** Guide.

Common Interests

The community, dam owners, emergency managers and dam regulators all have an interest in ensuring that emergency management planning is undertaken to reduce the impact of floods caused or affected by dams. This common interest requires the sharing of information and joint efforts in developing strategies that will benefit all parties. The common interests between these groups relate to planning to mitigate damage from flooding downstream of dams. This is shown in the Figure 2. To make integration of planning processes explicit, arrangements relating to these interests should be reinforced by cross-referencing between dam owners' emergency plans and community flood plans.

In particular, those preparing community flood plans need to recognise that:

- operational releases from a dam, or dam failure, may be initiated **after** significant flooding has occurred, closing roads and rendering difficult downstream responses (such as relocating farm animals or evacuating people), and

- for communities located immediately below dams it may be appropriate for the dam owner rather than a central emergency management organisation to issue warnings in relation to operational releases or potential dam failure.

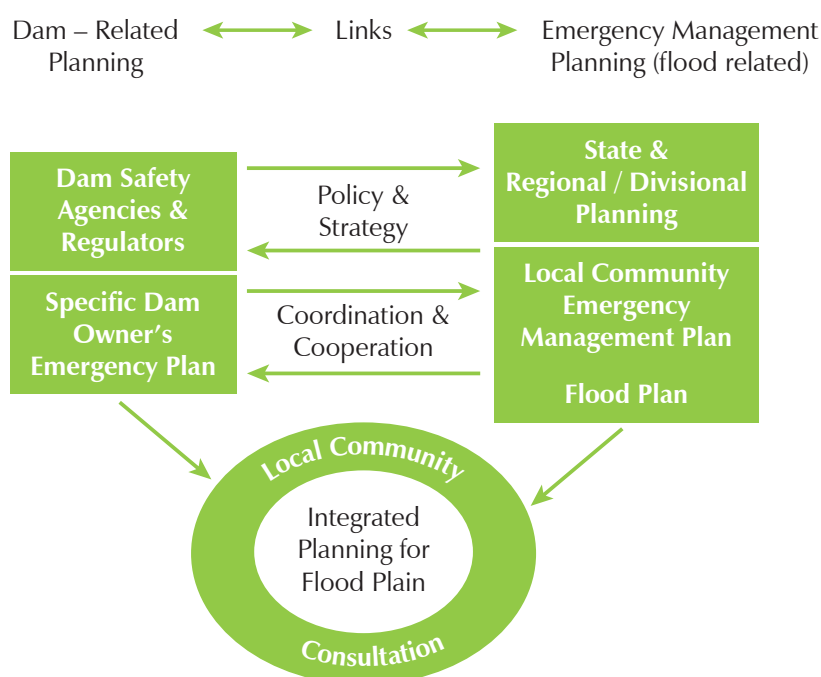


Figure 2: Flood Planning Relationships

Application

In a Nutshell...

Planning should be conducted for all dams which, because of releases as a result of failure or dam operation, might pose a risk to life or property. The planning process should establish roles and responsibilities clearly, identify the resources needed to manage emergency events involving dams, develop appropriate strategies to warn and evacuate those at risk and develop procedures for plan audits, testing and review.

Emergency Risk Management

Both dam owners and emergency management agencies operate within a framework of risk management. The dam owners apply this approach to flood operations and dam safety, while emergency management organisations apply it to community safety.

The risk management process provides overarching principles for defining, evaluating and treating various risks, along with iterative processes for developing two-way communication processes, monitoring performance and reviewing outcomes. The approach is represented diagrammatically in Figure 3.

Note that the decision to accept a risk which has been imposed by the existence of a dam can only be made by the affected community after proper consultation with the dam owner, regulator and all appropriate emergency agencies.

When to Plan

Dam owners should prepare Emergency Plans for all dams that pose a risk to life or property, whether because of potential failure or because of flooding that could be caused by dam operation. A dam owner's Emergency Plan is a demonstration of prudent management and should take into account all hazards and circumstances that may affect the operation or integrity of the dam.

The emergency management framework outlines general guiding principles for determining priorities for emergency management planning. In broad terms, priority for planning should be directed to the areas where a known dam safety deficiency exists and community vulnerability is high. In such situations, interim risk reduction measures should be given high priority until permanent improvements are implemented. All stakeholders should be advised accordingly.

It is, however, acknowledged through overarching risk management principles that a systematic approach is the most appropriate means for identifying and managing risk. The very nature of emergency risk management implies that risks can be prioritised and appropriate treatment of risks determined through assessment and evaluation of options.

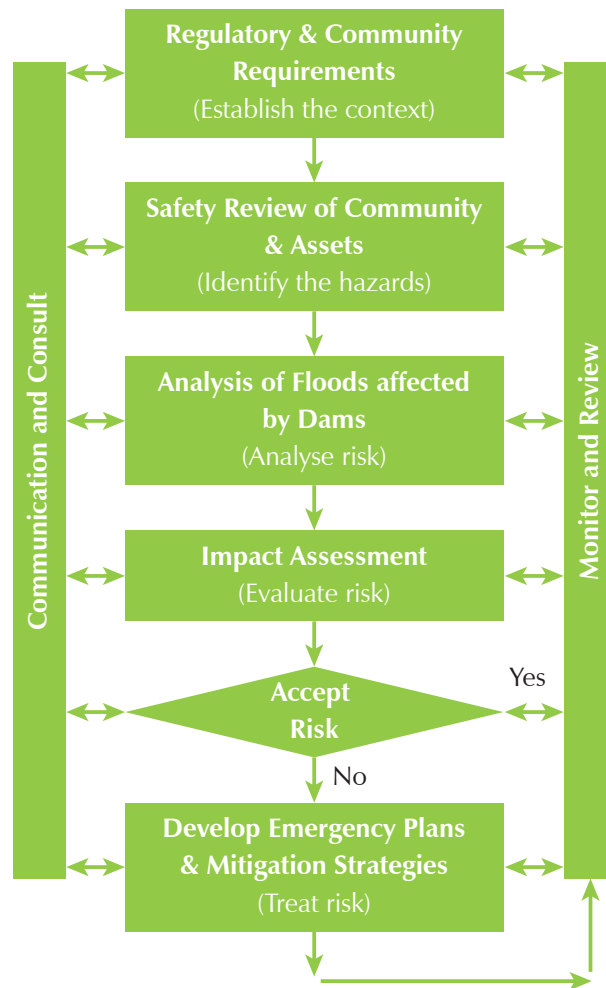


Figure 3: The Risk Management Framework (Adapted from AS/NZS 4360 (2004), Risk Management)

Prioritisation of planning for dam emergencies will be determined on the basis of relevant information, including the:

- condition of the dam and the degree, if any, of dam safety deficiency,
- population at risk and community vulnerability,
- scale of flood risk costs,
- range of other consequences (eg on property, the environment, or community value of the dam),
- stakeholder perceptions and expectations, and
- state of knowledge and planning commitments for different scenarios.

Where a dam safety deficiency exists, the dam owner, the dam safety regulator and emergency management agencies should work cooperatively to achieve the level of planning appropriate to the risk. Expertise and resources may need to be shared to optimise the outcome.

Planning needs and priorities should be jointly reviewed as further relevant information comes to hand. The planning sequence and a diagrammatic outline of how to apply these Guidelines are shown in Figure 4.

Critical Planning Elements

The following paragraphs detail critical aspects which need to be addressed to ensure the planning process is properly implemented.

Roles and Responsibilities

Establishing clear, unambiguous roles and responsibilities is recognised as an essential task of successful planning. Negotiating roles and responsibilities may be difficult but is essential for successful planning and implementation.

In the case of planning associated with floods affected by dams, the broad division of responsibilities is shown in Table 1.

Actual application and sharing of these broad responsibilities may be modified somewhat by agreement in the case of deficient dams, or by negotiation for other reasons. Planning would normally be more urgent for dams associated with higher potential costs of risks.

Needs of Stakeholders

Each of the stakeholders in dam-related flood events has specific needs. These are described below:

- **Dam owners** need to do the following:
 - Understand the safety status of their structures. Best practice demands up-to-date consultation on various aspects, including structural, hydrologic, earthquake, foundation engineering and operational inputs, using specialist assistance where necessary. Australian best practice is described in ANCOLD Guidelines.
 - Establish on-going liaison with emergency management agencies. This will provide support in planning, communications and warning, together with a coordinated approach to community awareness and education.

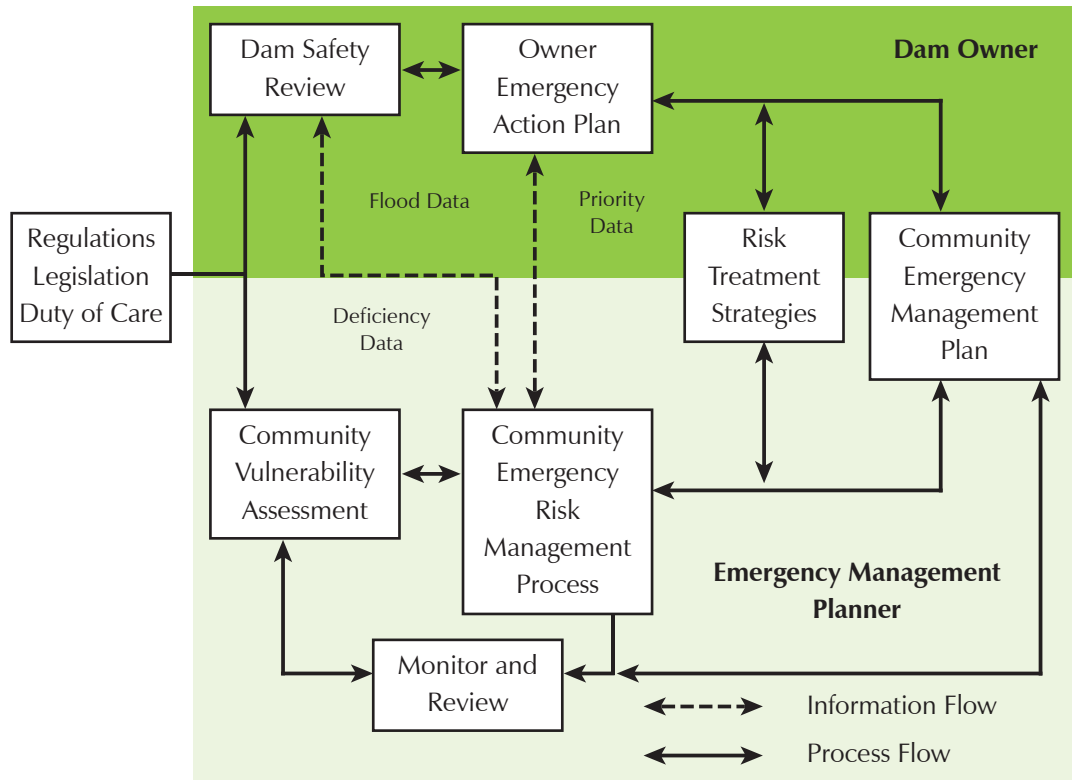


Figure 4: Application of Guidelines

- Understand the nature and extent of critical floods including dam-break floods and other major floods. This will require liaison with specialists on extreme rainfall and the analysis of dam-breach scenarios, as well as knowledge of the floodplain downstream (in order to develop inundation maps).
- Develop their own response plans for site-specific dam emergency scenarios. This will include planning and the development of procedures for detection, analysis, decision and notification. It may also include on-site activities such as structural interventions and site security measures relating to the risk level and the size of the dam.
- Assist emergency agencies in the establishment of flood warning systems for deliberate releases of water and for potential dam failure.
- Ensure that plans are exercised periodically.

Table 1: Division of Planning Responsibilities

Primary Stakeholders	Broad Responsibilities
Dam Safety Regulators	<p>Set requirements for dam safety emergency planning and audits of dam owner response actions.</p> <p>Regulate compliance with these requirements.</p>
Dam Owners	<p>Provide emergency managers with information about the safety of their dams, plus the characteristics and extent of critical floods, including dam-break inundation maps. This is required both during planning phases and during critical flood events.</p> <p>Provide emergency managers and the community with information about the characteristics of planned and unplanned releases from their dams.</p> <p>Be prepared to provide emergency managers with likely discharges from dams in the cases of floods other than those associated with releases or potential dam failure.</p> <p>Develop community warning systems as needed.</p> <p>Develop plans for managing emergencies at the dam, including communications and notification plans.</p> <p>Develop community awareness strategies in coordination with emergency management agencies.</p>
Emergency Management Agencies	<p>Develop emergency management plans to manage the full range of floods affected by dams, including liaison with dam owners.</p> <p>Develop community warning systems as needed, together with evacuation plans where appropriate. Develop community awareness and education strategies in coordination with dam owners.</p>
Affected Community	<p>Participate in the emergency risk management process and maintain community awareness and preparedness.</p>

- **Emergency Managers** need to do the following:
 - Receive planning information from dam owners in a form that enables emergency management planners to evaluate the risks posed to relevant communities and for which responses can be developed. This information relates both to the nature and extent of dam-break and other major flooding (including flood depths, flow velocities and timings at critical areas) and to flooding that might be caused by releases from dams to meet irrigation and environmental requirements or the need for releases under emergency conditions.

- Establish on-going liaison with dam owners. This will assist in communications and provide support in understanding and analysing technical information. It will also assist in developing a coordinated approach to community awareness and education initiatives.
- Gather all other available information needed to develop emergency management plans. This includes the demographics of the population at risk and an analysis of evacuation strategies (eg evacuation routes and evacuation centres) and emergency security measures (ie mitigation measures).
- Put dam-break flood impacts into proper perspective. Dam-break events will typically be high consequence, low probability events with emergency planning being usually an extension of flood emergency planning.
- Have identified resources to implement the response plan (including secure communications and appropriate public warning systems).
- Ensure that plans incorporating arrangements to deal with floods affected by dams are exercised periodically in conjunction with dam owners.
- **Community.** The affected community needs to be provided with:
 - information on the flood risk, escape routes, evacuation centres and the response required of them in relation to warnings,
 - opportunities to be involved in and influence the planning process,
 - accurate and timely information during emergency events, and
 - confidence in the emergency management arrangements.
- **Dam Safety Regulators** need to:
 - be provided by dam owners with information on dam safety status and any proposed remedial measures (short or long-term) in sufficient detail to conduct audits to ensure the safety of dams,
 - audit emergency planning arrangements of dam owners for currency and effectiveness, and
 - maintain liaison with emergency management agencies and dam owners to assist in strategic policy development.

Resources

The identification of the resources required to manage an emergency event is an essential part of emergency management planning. In respect to floods affected by dams, dam owners and emergency managers alike need to identify requirements and backups in terms of physical and human resources. It is important to assess what is needed rather than limit the scope to what is readily available. When the total list of needs is completed, a range of potential sources can then be developed.

The scale of the impacts from a dam failure could range from a local response to a large-scale response in which outside resources would be required to support both the dam owner and the emergency agencies. The dam owner's emergency plan and the local community emergency management plan should list the 24-hour contact information for suppliers of resources, or list the resources required and how to access them. Among the resources required after dam failure will be water for the area previously supplied by the dam.

Negotiation

Stakeholders in the planning process should negotiate and reach consensus on their planning needs from the outset. This will reduce the potential for works or studies to be completed that may not satisfy all stakeholders.

The negotiations may cover such issues as:

- clarification of the risks involved,
- responsibilities in relation to costs or cost sharing of studies, works or plan developments,
- who is responsible for developing and maintaining plans and warning systems,
- who is responsible for advising the community of the risks, both prior to and during an event,
- availability and access to resources (and who pays),
- who has the responsibility to fund and produce public information material, and
- liability and indemnity issues (where resolvable).

It is recommended that these matters be resolved and appropriately documented early in the planning process.

Flood Information

The dam owner should supply information to emergency management planners on the characteristics of floods affected by dams. Floods that need consideration include the following:

- **Operational Floods.** These floods would not endanger the dam but could endanger life, property, transport links or the environment downstream.
- **'Sunny Day' Failure.** These are floods caused by unexpected failure of the dam. They may happen at any time (eg due to earthquake action) and may not involve a rainfall event.
- **Dam Crest Flood (DCF) or Imminent Failure Flood (IFF).** These are floods which, when routed through the storage, raise the storage to its maximum safe level. This is analysed for cases of both dam break and no dam break.
- **Probable Maximum Flood (PMF).** This is the extreme flood for the catchment, with and without dam break.

For each of these situations, inundation maps will be required. In order to produce the required flood inundation information for dam-failure floods, a dam-break analysis (including inundation maps) will normally be required as follows:

- **Dam-Break Analysis.** This involves computer simulation of floods down a river system where the outputs are depth, velocity and timing of the floods as they proceed downstream. There are various levels of sophistication available. The methods used will depend on the degree of accuracy or reliability required from the outputs. Generally the higher the hazard or risk posted by the dam, the greater will be the requirements of the analysis and survey accuracy. More information on dam break analysis can be obtained from the **ANCOLD Guidelines on Assessment of the Consequence of Dam Failure (2000)**.
- **Inundation Maps.** For each flood analysed, information should be documented in a form suitable for use by emergency management planners. This should include:
 - areas affected as (inundation maps showing depth and velocity),
 - peak water levels (as profiles along flood paths showing impact sites),
 - travel times (as arrival times of initial rise, peak water level and indicative recession times),
 - size and rate of development of the assumed breach, and
 - accuracy of flood information.

This information should relate to specific impact sites such as populated areas, road transport lifelines and essential community infrastructure. Consideration should be given to the storage and retrieval of the above information on computer systems incorporating GIS, as well as to the transmission of the information during emergency events.

For cases of potential dam failure, mapping should be conducted downstream to a point at which the incremental effect of dam failure is negligible or to the point at which the discharge is contained within the bed and banks.

Description of Community Vulnerability

Using the inundation maps, the persons likely to be affected by floods should be identified and their ability to manage their well-being during floods assessed. Evacuation routes should be assessed for susceptibility to flooding. Community vulnerability (including its assessment) is described in more detail in the Australian Emergency Manual **Emergency Risk Management: Applications Guide**.

Evacuation Issues

In most cases evacuation will take place using vehicles and the road network. Evacuation routes may be affected before the arrival of the flood peak. It is critical to analyse the effect of **all** flooding on the roads that will be used, and not just the effect of the dam.

The main points to consider are as follows:

- Dam failures can be very rapid compared to the time required to complete evacuation.
- People closest to the dam have least time for evacuation and may need special warning arrangements.
- An evacuation route can be cut by mainstream or tributary flooding before the time it would be needed to escape from the path of an imminent dam failure flood. Depending on the location of the road closure(s), evacuation may have to take place earlier in downstream areas than in areas nearer to the dam.
- Typically, dam-failure floods will be much larger than ‘natural’ floods which people in the area remember and they will involve more rapid rates of rise in flood levels.
- Depending on the time needed for evacuation, a decision to evacuate may have to be made on the basis of flood predictions based on rainfall estimates.

- In an attempt to reduce the peak height of a flood, a dam may be operated to release stored water in advance of the arrival of flood inflows. Such releases, in some circumstances, can have the undesirable effect of closing evacuation routes earlier than would otherwise have been the case and the road closures could prevent or truncate an evacuation operation. Conversely floodwater may be temporarily stored in a dam to extend the available evacuation time.
- Localised stormwater flooding can often close roads independently of mainstream flooding. This can also have the effect of preventing evacuation at a critical time or reducing the total amount of time available. When considering evacuation, particularly in extreme events related to dams, the stormwater design capacity for local roads must be considered.

Warning and Notification

Established flood warning systems are generally arranged between the Bureau of Meteorology, dam owners, the State Emergency Service (SES), other emergency agencies and the community. While the Bureau of Meteorology may not be involved in the prediction of all floods affected by dams, integration of further automatic monitoring by dam owners with existing Bureau of Meteorology flood prediction systems could set up a more reliable means of triggering the warning process.

Warning time for evacuation needs to be considered in time blocks of not less than one hour to ensure that action plans can be realistically implemented. Warning systems should avoid long-term reliance on electronic equipment such as pagers that have to be used or maintained by the affected individuals downstream. Experience has shown that type of equipment is often not kept in working condition by individuals in the general public.

The dam owner should notify downstream residents directly of flood releases if the available warning times to those residents are less than those available through the emergency management system. Such arrangements should arise from negotiated agreement between stakeholders and recorded in the emergency management plans.

Communication Issues

Communication during emergencies is very important to the overall success of an emergency operation. Methods of communication need to be reliable, practised and reviewed to ensure that the dam owner, emergency management agencies and the community are all informed of any developing situation. Communications systems also need to be reliable and a back-up system should be identified.

There is also a need for agreed arrangements for the release of information to the media and who will be conducting any media briefings.

Audit, Testing and Review

It is necessary to regularly audit, realistically test and review all emergency management plans, including those related to dams. The timing for these reviews should reflect regulatory requirements, the changing dynamics of local risk, any changes to resources and changes to current knowledge. The reviews should be carried out on a regular basis and, in particular, after any operation of the plans. Reviews of plans and procedures should have particular emphasis on the currency and effectiveness of liaison networks to ensure that all plans are functional and coordinated.

Further details on auditing, testing and review of emergency management plans can be found in the Australian Emergency Manual **Emergency Risk Management: Applications Guide** and the ANCOLD **Guidelines on Dam Safety Management** (1994). Regulators may also have specific requirements relating to audit, testing and review of emergency management plans.

CHAPTER 4

Emergency Planning Checklist

In a Nutshell...

Planning processes must be based on carefully-devised scenarios and on a clear understanding of community vulnerability considerations, appropriate triggers for emergency action and the needed requirements for responses to emergencies.

Introduction

Effective protection of communities from flood hazards requires that plans exist to address all the activities needed to respond to an emergency. In the case of floods affected by dams, these activities may need to be addressed in several plans including those of dam owners and/or emergency management agencies. Requirements for adequately preparing these plans are outlined in the documents in the References section but, when checking the adequacy of the integration of these plans, as a minimum, the issues identified in this chapter should be addressed.

This chapter provides checklists to guide the various elements of the planning process.

Establishing the Context

The authority for planning, the appropriate incident control agency and the responsibilities for planning must be identified at the outset.

Scenario Analysis

The **emergency plan** developed by the dam owner will be based on credible dam emergency scenarios and could include:

- operational flood releases that endanger life or property,
- events which could develop into an emergency situation (the development of an extreme storm),
- imminent dam-break situations and the identification of possible measures which may mitigate or prevent these situations, or
- actual dam breaks and immediate response actions.

Emergency plans should be checked to see that all credible scenarios have been considered including the sequencing and development of events leading to an emergency.

Description of Floods

The dam owner will generally be in a position to supply information on the characteristics of floods passing through or generated by each dam. Floods which need consideration include:

- significant operational floods,
- Sunny Day Failure floods at full supply level,
- Dam Crest Flood (DCF) or Imminent Failure Flood (IFF), with and without dam break, and
- Probable Maximum Flood (PMF), with and without dam break.

For each flood, the information should include:

- areas affected (as inundation maps showing depth and velocity),
- peak water levels (as profiles along flood path showing impact sites),
- travel times (as arrival times of initial rise, peak water level and indicative recession times), and
- for potential dam-failure events, the size and rate of development of the assumed breach.

Description of Community Vulnerability

Using the inundation maps, community vulnerability should be assessed and include the identification of:

- persons affected by floods in terms of:
 - depth and velocity of floodwaters (including the impacts of levee failure or overtopping),
 - available flood warning and notification times,
 - prior experience with flooding,
 - susceptibility and resilience,
 - duration of exposure,
 - mobility,
 - special needs,
 - resources,
 - preparedness for emergencies, and
 - communication.
- evacuation routes and their susceptibility to flooding.

Community vulnerability, and its assessment, is described in more detail in the Australian Emergency Manual **Emergency Risk Management: Applications Guide**.

Dam Safety Triggers

As scenarios develop, actions will need to be taken to implement emergency measures. The triggers for such actions should be defined in the emergency plans and might include triggers based on:

- rainfall depth and intensity,
- earthquake occurrence,
- reservoir water level,
- seepage flow,
- seepage turbidity,
- deformation and cracking,
- controls malfunction (flood gates and valves),
- operator incapacity,
- loss of access,
- loss of communication,
- operational flood releases,
- controlled failures (fuse plugs),
- hillside instability,
- terrorism/sabotage, and
- upstream dam failures and flood releases.

Warning and Notification Protocols

The emergency plans should define warning and notification protocols, identifying who has to be notified and under what circumstances. The plans should include:

- notification procedures (who does what, when and how, including message format, content etc),
- persons requiring notifications,
- essential content of notifications,

- advisory notification,
- warning notification,
- evacuation notification, and
- emergency declarations.

Management of an Emergency

As events escalate, the management of an emergency situation could change. The plans should identify:

- who is in control and when,
- who does what, when and how, and
- the conditions that trigger a change.

Situation Monitoring

The successful execution of an emergency plan requires knowledge of the emergency situation at any time, particularly at the dam. Plans should identify key issues that are needed to monitor the emergency, especially:

- identification of experts,
- situation monitoring arrangements,
- an understanding of relevant triggers, and
- the reliability of field communications.

Evacuation

The key element to reduce loss of life in a dam-break situation is the evacuation of the population at risk. The evacuation procedures will usually be incorporated into the flood emergency management plan and should address:

- evacuation warnings,
- evacuation routes,
- traffic management,

- access control,
- location of evacuation centres including:
 - assembly areas
 - emergency relief centres,
- transport resources,
- special needs, and
- initiation of recovery.

Communications

Communications are very important in emergency situations. Poor communications will interfere with the effectiveness and efficiency of the operations and increase community stress. The emergency management plans should include allowances for:

- status reporting during the emergency,
- community advice and awareness of the situation,;
- media involvement,
- on-going public awareness of the planning process, and
- field communications and back up (people and equipment).

Information Presentation

Emergency plans should be as clear and succinct as possible. Sections of the community find diagrammatic information to be more understandable than text descriptions. Where possible, in addition to explanatory text, emergency plans could be summarised in diagrammatic form or in flowcharts.

Acronyms and Glossary

DCF: Dam Crest Flood

A flood which reaches the crest of a dam wall.

DSEP: Dam Safety Emergency Plan

EAP: Emergency Action Plan

Full Supply Level

The level of the water surface when a reservoir is at maximum operating level, excluding periods of flood discharge.

IFF: Imminent Failure Flood

A flood which, if exceeded, will cause a dam to fail.

PMF: Probable Maximum Flood

An estimation of the largest flood that could occur at a particular location. Such a flood would result from the most severe combination of meteorological and hydrological conditions as these are currently understood.

References

Australian Emergency Manuals Series:

Manual 5 **Emergency Risk Management—Applications Guide**

Manual 19 **Managing the Floodplain**

Manual 20 **Flood Preparedness**

Manual 21 **Flood Warning**

Manual 22 **Flood Response**

Australian National Committee on Large Dams (ANCOLD) (1994). **Guidelines on Dam Safety Management.**

Australian National Committee on Large Dams (2000). **Guidelines on Assessment of the Consequences of Dam Failure.**

Australian National Committee on Large Dams (2000). **Guidelines on Selection of Acceptable Flood Capacity for Dams.**

Australian National Committee on Large Dams (2001). **Guidelines on the Environmental Management of Dams.**

Standards Australia (2004). **AS/NZS 460: Risk Management**, Sydney: SAI Global.

Users of this Guide may find it useful to consult Emergency Action Plans, Dam Safety Emergency Plans, Dam Operations and Maintenance Manuals, Dam Owners' Standing Operating Procedures (SOP), Local/Municipal Emergency Management Plans, State/Territory Emergency Management Plans and Flood Emergency Plans.

Australian National Committee on Large Dams (Incorporated) publications are available from the ANCOLD website (www.ancold.org.au)

