

# National Emergency Risk Assessment Guidelines

October 2010



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# 1. Introduction

## 1.1 Background

Emergency events and disasters stem from a range of natural, biological, technological, industrial and other human phenomena and impose significant social and economic costs on Australia. These include: direct damage to property, infrastructure and facilities; financial costs and indirect economic losses; fatalities, injuries and illness; impairment of ecosystems and loss of biodiversity; and social and cultural losses. Between the 1950s and the 1990s the reported global cost of natural disasters increased fifteen fold and by 1999 in Australia the annual cost of large natural disasters alone was estimated at \$1.14 billion (based on data from the period 1967–1999). This upward trend of disaster costs, globally and in Australia, continues and, in 2008 the economic cost of the five most significant Australian events alone exceeded \$2.49 billion.<sup>2</sup>

In response to this trend and to concerns about potential increases in the frequency of severe weather events, a review of Australia's approach to dealing with disaster mitigation and relief and recovery arrangements was commissioned by the Council of Australian Governments (COAG). The review concluded that a new approach to natural disasters in Australia was needed and it provided 66 recommendations and 12 reform commitments to create safer, more sustainable communities by reducing risk, damage and losses from natural disasters in the future. This approach involves a fundamental shift in focus beyond response, relief and recovery towards cost-effective, evidence-based disaster mitigation. To support this approach the report called for a "systematic and widespread national process of disaster risk assessment"<sup>3</sup>

In 2007, the Australian Emergency Management Committee endorsed a National Risk Assessment Framework to support the development of an evidence-base for effective risk management decisions and to foster consistent base-line information on risk. The National Emergency Risk Assessment Guidelines (NERAG) have been developed as one of the first outputs of the

framework's implementation plan. As such, they provide a methodology to support the reform commitments and risk and data objectives recommended by COAG.

In addition to COAG's requirements, there are sound practical, social and economic reasons for having a national approach to the conduct of emergency risk assessments. Primarily these reasons include:

- improving understanding of emergency risk issues and ensuring that risk treatment measures provide a sound return on investment
- standardising risk assessments and the development of alternative risk reduction proposals
- increasing transparency so that assessment processes can be followed easily, checked or modified in the light of improved knowledge or information
- improving consistency to allow meaningful comparisons between different geographical areas and/or hazard classes.

These guidelines have been published to meet those needs.

## 1.2 Purpose

This document has been prepared to improve the consistency and rigour of emergency risk assessments, increase the quality and comparability of information on risk and improve the national evidence-base on emergency risks in Australia. The NERAG provide a contextualised emergency risk assessment methodology consistent with the Australian/New Zealand Standard *AS/NZS ISO 31000:2009 Risk management – Principles and guidelines*.

Given the complexity and severity of possible consequences from emergency events, these guidelines have been designed to generate an integrated, comprehensive and objective understanding of emergency risks. The outputs from risk assessments undertaken using the NERAG will improve decision making when allocating scarce resources for risk treatment and emergency preparedness measures.

<sup>1</sup> BTE, 2001, *Economic Costs of Natural Disasters in Australia*, Report 103, Bureau of Transport Economics, Canberra.

<sup>2</sup> Munich Re, 2009, *Topics: Natural Catastrophes 2008 Analyses Assessments Positions Australasia/Oceania version*, Munich, available at [www.munichre.com](http://www.munichre.com).

<sup>3</sup> COAG, 2004, *Natural Disasters in Australia. Reforming Mitigation, Relief and Recovery Arrangements*, Report to the Council of Australian Governments by a high-level officials' group, August 2002, Department of Transport and Regional Services, Canberra.

<sup>4</sup> NRAAG, 2007, *A National Risk Assessment Framework for sudden onset natural hazards*, National Risk Assessment Advisory Group, available at <http://www.ga.gov.au>.

The method used is scalable, has been developed for assessing emergency risks arising from any hazard and is for use at local, regional, state/territory and national levels. Depending on the context of application, any study conducted using the guidelines will necessarily focus on particular hazards of significance and impact classes of importance to the community in question.

The users of the guidelines are likely to be risk study sponsors, team leaders, subject matter experts (e.g. hazard leaders) and facilitators for emergency risk studies. However, the NERAG will meet the needs of a range of stakeholders, including those responsible for developing emergency risk management policy, those accountable for ensuring risk is effectively managed in a community or organisation, specialist risk practitioners who must apply the methodology, and those who evaluate the effectiveness of emergency risk management practices.

### 1.3 Scope

The NERAG provide a methodology to assess risks from emergency events and are principally concerned with risk assessment. They do not focus on risk management or mitigation – nor do they address business continuity processes and practices as outlined *AS/NZS 5050:2010 Business Continuity – Managing Disruption Related Risk*, although outputs from applying the methodology support and benefit these.

The guidelines are not intended to address the entire risk management framework or the risk management process as outlined in *AS/NZS ISO 31000:2009*. However, because they focus on the assessment of risks from emergency events, they ultimately direct the management of emergency risks in line with the international standards for risk management.

The guidelines aim to provide a risk assessment methodology that:

- enables focus on risks in small (e.g. municipal) or large (e.g. regional and/or state and/or national) areas
- is useable for both risk ‘from’ and risk ‘to’ (e.g. risk from bushfire, risk to infrastructure from all or specific sources of risk)

- uses a scenario-based approach
- samples risk across a range of credible consequence levels
- identifies current risk under existing controls and residual risk assuming implementation of additional controls or control improvements
- provides base-line qualitative risk assessments and triggers for more detailed analysis
- allows risk evaluation at varying levels of confidence
- provides outputs that are comparable, which rate risk and suggests means to reduce risk.

Although the COAG review and the National Risk Assessment Framework both focus on sudden onset natural hazards, such as bushfire, earthquake, flood, storm, cyclone, storm surge, debris flow, tsunami, and tornado, not all emergency events are initiated through natural means. Indeed, consequences from emergency events may be similar, regardless of the trigger for a particular event. Therefore, the NERAG takes an all hazards approach and provides a method that is suitable for considering other sources of risk, these could include disease (human, animal and plant), insect/vermin plague, as well as those arising from technological and other anthropogenic sources. These guidelines recognise that specific risk assessment techniques have been developed for detailed analysis of specific hazards. See section 6.4.

Losses to communities can result from exposure to single or multiple events and, for any emergency scenario; multiple sources of risk can impact on communities, as well as lead to consequential or secondary effects. For example, tropical cyclones not only bring both extreme winds and heavy rainfall (as primary sources of risk), but can also cause consequential hazards such as flooding or landslide (secondary sources of risk).

The guidelines’ methodology allows practitioners to address these complexities and its all hazards approach is consistent with contemporary emergency management arrangements and practices.

Although the NERAG focus on risk assessment, they need to be integrated into the overall risk management process<sup>5</sup>. Hence the guidelines also show how to *establish the context*, which develops a common understanding of the scope and purpose of the risk study. It also provides guidance on

<sup>5</sup> *AS/NZS ISO 31000:2009*



treating risks, which involves developing and selecting risk reduction options. *Communication and consultation* and *monitoring and review* processes are also briefly examined in Section 2. Notwithstanding the NERAG content, users of this guideline should obtain a copy of *AS/NZS ISO 31000* for use with this document.

Although the guidelines provide a rigorous methodology for emergency risk assessments, they should not be considered an “operational risk assessment tool”. That is, it is not intended that the approach be used to assess risk to emergency personnel, for example, while undertaking emergency response duties.

## 1.4 Structure

The guidelines provide information on and a methodology for risk assessments including their preparation, conduct and outputs for emergency events. They also provide explicit risk criteria and reporting templates. The accompanying CD provides a copy of this document and relevant templates and tools.

Sections 1 to 3 provide background information. The Introduction in Section 1 is followed by a description of the principles, framework and fundamentals of the risk management process and the role of risk assessment in Section 2. Section 3 outlines the risk assessment methodology for emergency events and the overall process to implement this methodology.

Sections 4 to 8 describe how to:

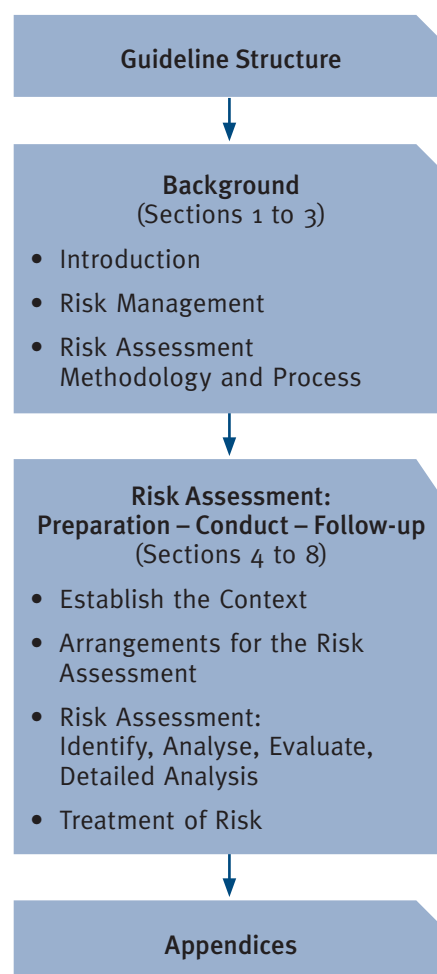
- establish the context
- prepare and conduct a risk assessment for emergency events
- prepare a risk register from the risk assessment
- treat risk (an overview)
- continue to monitor and review risks.

Considerations for more detailed analysis, if deemed required, are presented and a brief description of the implications for treating risks is provided.

Supporting documents are compiled in the Appendices:

- Appendix A – guidance for describing your environment
- Appendix B – criteria for assessing risk treatment options
- Appendix C – a glossary of terms used in the context of emergency risk assessments
- Appendix D – a worked example.

Throughout the guidelines, there is supplementary information in tip boxes (coloured blue), examples (coloured orange) and tool boxes (coloured pale blue). These support understanding concepts, processes and implementation.



## 2. Risk Management

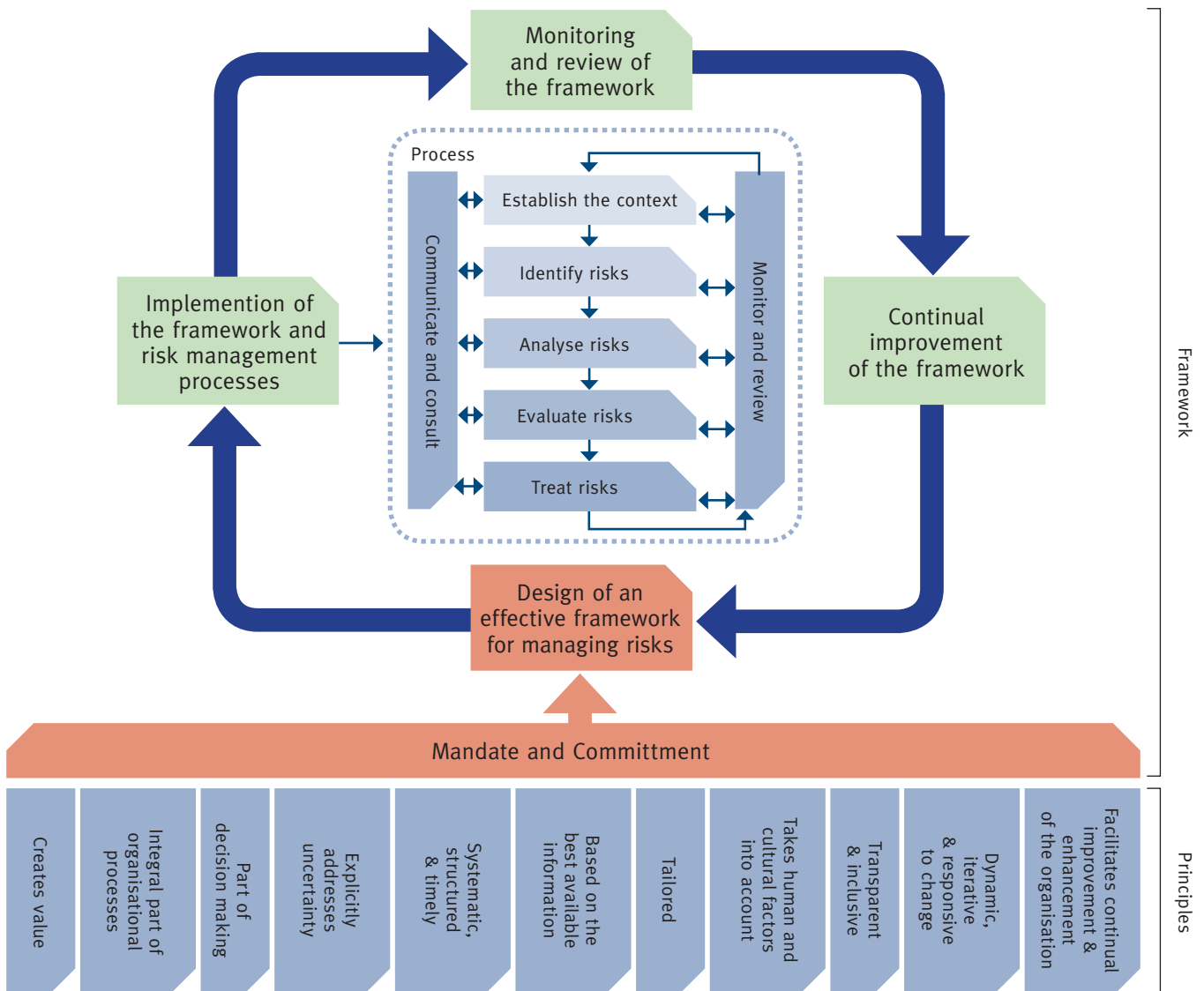
### 2.1 Introduction

In 1995, Standards Australia and Standards New Zealand developed a risk management standard: *AS/NZS 4360:1995 Risk Management*. It emphasised the management of risk rather than the management of hazards. The emergency management sector recognised the value of this approach and contextualised risk management approaches were published by Emergency Management Australia in 2000. The Australian/New Zealand Risk Management Standard was revised and republished in 2004 and has been adopted by many organisations both in and outside Australia as the basis for their approaches to risk management. As a result, in 2005 the International Standards Organisation created an

international standard, based on *AS/NZS 4360:2004 Risk Management*. The international standard *ISO 31000:2009 Risk management – principles and guidelines* extends the risk management process to include principles for risk management and specifies a framework for embedding risk management into standard governance and business practices (both of which were either implicit or only covered partially in *AS/NZS 4360:2004 Risk Management*). The NERAG provide a contextualised approach for the conduct of risk assessments for emergency events and are consistent with Australian and international standards.

Figure 1 provides a representation of the relationships between the risk management principles, framework and process as described in *AS/NZS ISO 31000:2009*.

Figure 1 Risk Management – principles, framework and process



## 2.2 Principles

A number of principles underpin and support effective risk management. These principles are articulated in *AS/NZS ISO 31000:2009* and are consistent with those found in the National Risk Assessment Framework. In applying risk assessment methodology, governments, organisations and communities are to remain cognisant of these fundamentals and must ensure that risk management:

- **Creates and protects value.** Emergency risk management contributes to societal objectives of achieving safer, sustainable communities through protection of people, the environment, the economy, public administration, social capital and infrastructure.
  - **Integrates into all organisational processes.** Emergency risk management is a mainstream activity that is most effective when integrated into standard business practices of organisations, governments and communities.
  - **Informs decision making.** Emergency risk management supports informed decision making and prioritisation of scarce resources for risk reduction activities.
  - **Explicitly addresses uncertainty.** Rigorous emergency risk management continues to provide value when uncertainty exists.
  - **Is systematic, structured and timely.** Consistent, reliable and comparable results are achieved when a systematic, structured and timely approach is taken.
  - **Is based on best available information.** Best available data and information on risks, hazards, exposure and vulnerability are applied from a variety of sources including historical data, forecasts, modelling, observations, community input and expert judgement. Decision makers must, however, be aware of the limitations of data, modelling and the possibility of divergent opinions among experts.
  - **Is tailored.** Emergency risk management methodology takes a fit-for-purpose approach that is aligned with societal needs, context and risk profile.
  - **considers and takes account of human and cultural factors.** The capabilities, perceptions and intentions of individuals and the risk study team must be taken into account in emergency risk management processes.
- **Is transparent and inclusive.** To remain relevant, up to date and effective, emergency risk management must involve stakeholders and, in particular, decision makers in an appropriate and timely manner.
  - **Is dynamic, iterative and responsive to change.** Emergency risk management responds to changing risk profiles and emerging information on hazards, exposure and vulnerability. When monitoring and reviewing of risks is effective, this process can identify when risks emerge, change or disappear.
  - **Facilitates continual improvement.** Effective emergency risk management relies on the development and implementation of strategies that improve a government, organisation or community's risk management maturity. Such an approach underpins a resilient and adaptive community.

## 2.3 The Risk Management Framework

According to *AS/NZS ISO 31000:2009*, the success of risk management depends on “...the effectiveness of the management framework providing the foundations and arrangements that will embed it throughout the organisation at all levels”.<sup>6</sup>

An appropriate framework ensures that information on emergency risks will be adequately reported and used at relevant levels in decision making. The risk management framework is designed to assist integration of risk management and its outputs into mainstream governance and business systems and activities. The key components of an effective risk management framework depicted in Figure 2 include:

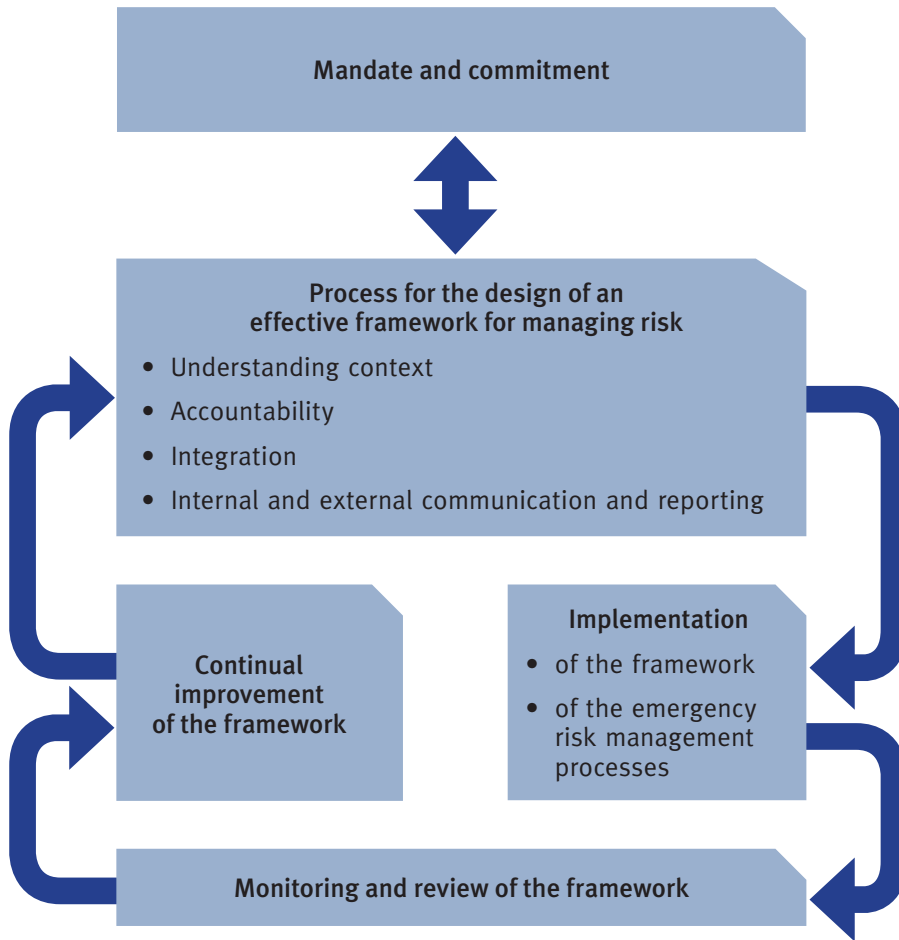
- a mandate and commitment from leaders and managers
- processes for the design of an effective framework for managing risk
- programs to implement the framework and risk management processes
- programs to allow monitoring and review of the framework
- processes for continual improvement of the framework.

Figure 2 shows the relationship between the components of an effective risk management framework. Further detail on each component is available from *AS/NZS ISO 31000:2009*.

<sup>6</sup> ISO, 2009, *ISO 31000 Risk management – principles and guidelines*, International Organisation for Standardisation, Geneva.



Figure 2 Risk Management Framework (adapted from AS/NZS ISO 31000:2009)

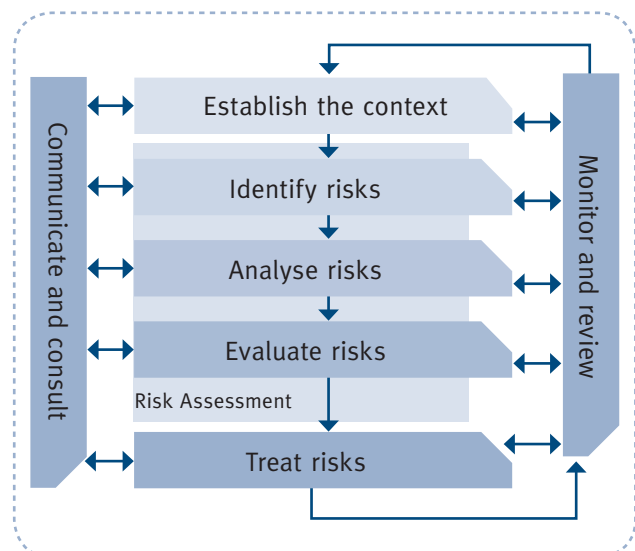


## 2.4 The Risk Management Process

The process for risk management is described in AS/NZS ISO 31000:2009. According to this standard, the process should be integral to management and decision making, integrated into practices and culture and tailored to the community or organisation and its risk profile. In an emergency management context, risk management is a process which involves dealing with risks to the community arising from emergency events. It is a systematic method for identifying, analysing, evaluating and treating emergency risks and takes an iterative approach with well-defined activities, leading to implementation of effective risk-treatment strategies. The risk management process is shown in Figure 3.

The process comprises five main elements: establishing the context, identifying the risks, analysing the risks, evaluating the risks and treating the risks which are supported by two enabling activities – communicating and consulting, and monitoring and reviewing – which apply to each of the major elements of the process.

Figure 3 Risk Management Process – Overview



## **Communicate and Consult**

Communication and consultation are fundamental throughout the risk management process and should take place with internal and external stakeholders during all stages of the process. It is important to ensure that all those who need to be involved (e.g. because they are responsible for the process or have a vested interest) are not only kept informed, but are also invited to contribute to the process, in order to establish a common understanding of how decisions are made. It is also important to consider involving adversarial groups

or stakeholders in this process from the outset to minimise any ongoing unhelpful criticism.

This will enhance the management of risks, because stakeholders may tend to make judgments about risk based on their perceptions. These perceptions can vary due to differences in values, needs, assumptions, concepts and concerns. Because stakeholders' views can have a significant impact on the decisions made, it is important that differences in their perceptions of risk be identified, recorded and addressed early in the risk management process.

## **Establish the Context**

By establishing the context for the management of risks, the basic parameters within which risks shall be managed are defined. The process defines assumptions for the external and internal environment of the organisation or community and the overall objectives of the risk management study. This will be useful in gaining a common understanding of the scope of the process and of the risk criteria against which the risks will be measured. Establishing the context initially involves a number of activities: setting the scope, establishing goals and objectives, defining responsibilities, defining key elements, identifying key activities and processes, and confirming the methodologies. Context setting also confirms evaluation processes, considers decisions that might need to be made and identifies any enabling research, including the resources required for such studies. This process is **critical** for structuring the risk identification, analysis and evaluation steps. Consequently, establishing the context ensures that the approach adopted is fit-for-purpose and is appropriate for the community and its risk profile.

## **Identify Risks**

On the basis of good quality information and thorough knowledge of the organisation or

community (including its internal and external environment), hazards, vulnerabilities and the associated risks are identified and described. Sources of risk, current controls, events and their possible causes, areas of impact and potential consequence are considered. A systematic and comprehensive approach is taken to ensure that no significant risk is inadvertently excluded. For instance it is important that a sufficiently comprehensive pool of expertise is assembled to study all significant causes and emergency scenarios because there are many ways an emergency event can occur. This might involve considering historical information or projections on similar events. Identifying these scenarios may prove useful, because they can lead to reasonable predictions about current and evolving issues. At the conclusion of this phase, all risks of interest are identified and recorded, even if some of those are already known and possibly controlled by existing risk treatment measures.

## **Analyse Risks**

Risk analysis is the element in the process through which the level of risk and its nature is determined and understood. Information from risk analysis is critical to rank the seriousness of risks and to help decide whether risks need to be treated or not. In this phase, control opportunities are also identified. The analysis involves consideration of possible consequences, the likelihood that those consequences may occur (including the factors that affect the consequences), and any existing control that tends to reduce risks. During this phase the level of confidence in the analysis is assessed by considering factors such as the divergence of opinion, level of expertise, uncertainty, quality, quantity and relevance of data and information, and limitations on modelling. At the conclusion of this step, all identified risks are categorised into risk levels and given a risk rating, and statements concerning existing controls and their adequacy are made.

## **Evaluate Risks**

During risk evaluation, the level of risk is compared with the risk criteria which are confirmed at the outset of the process, when the context is established. In addition, the scope and objective of the process itself, stakeholder views, and the cumulative impact of a series of events that could occur simultaneously need to be taken into account.

The desired outcome of the evaluation is a decision concerning which risks need treatment and the treatment priorities. Risk evaluation may also lead to a decision to undertake further analysis. Another outcome might be that neither further analysis nor treatment is required, so that the relevant risk will merely be subject to continuation of existing controls and ongoing monitoring and review.

### **Treat Risks**

Having evaluated all identified risks, risk treatment is the process of selecting and assessing measures to modify risk, and the preparation and implementation of treatment plans, which either provide for new controls and/or modify existing controls. This means identifying and designing alternative appropriate actions for managing the risks, the evaluation and assessment of their results or impact, and the specification and implementation of treatment plans. It is important to consider all direct and indirect costs and benefits, whether tangible or intangible, and measure them in financial or other terms. Also, more than one option can be considered and adopted either separately or in combination. Measures to treat risk can include avoiding, taking or increasing (in order to pursue an opportunity), removing the source of risk, changing (likelihood of consequence), optimising, transferring, sharing or retaining the risk. After the implementation of risk treatment, residual risks must be included in regular monitoring and review activities.

### **Monitor and Review**

One of the critical factors in risk management is to establish ongoing monitoring and reviewing, confirming the effectiveness of existing controls and accounting for changes in circumstances. These activities complete the risk management cycle so that assumptions, methods, data sources, results and reasons for decisions are subject to regular checks. Regular checks assist in keeping the specified action plans relevant and up to date. Quality assurance processes including peer review can support this function. The process should also allow consolidation of further information to improve risk assessments, analysis of lessons learned from events, trends in changes of exposure and vulnerability, detection of these changes and changes in the nature (frequency and severity) of hazardous events. Importantly, responsibilities for checking and monitoring should be clearly defined. The agreed processes and outputs of monitoring

and review should be recorded and reported, and form an important part of the review cycle for an organisation's or community's risk management framework.

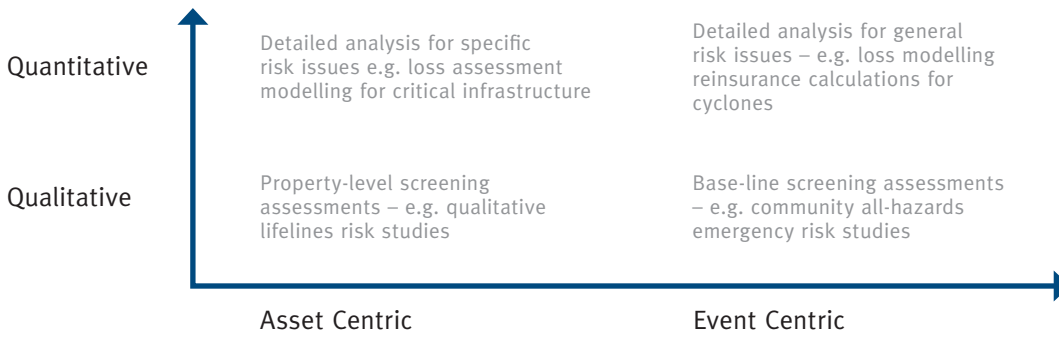
## **2.5 The Role of Risk Assessment**

A sound understanding of the risk of disasters is essential for minimising their consequences. According to *AS/NZS ISO 31000:2009*, risk assessment is defined as the overall process of risk identification, risk analysis and risk evaluation. In other words, it is the process used to describe risk issues and determine risk management priorities by evaluating and comparing the levels of risk against predetermined standards. As such, it forms a critical part of the risk management process. During this process, the likelihood of particular consequences of hazardous events are assessed, taking account of probabilities of an event occurring, impacting on the elements at risk and having specific consequence outcomes. Information on the elements likely to be exposed to the impact of a hazardous event and their vulnerability to that particular hazard is considered as part of this process. Risk assessment allows communities, organisations and governments to understand and measure the risks involved and to decide on the appropriate measures to manage them.

The purpose of risk assessment is to identify, analyse and evaluate risks in a systematic, consistent and objective manner. In Australia, risk assessment models for emergency events can generally be categorised by the complexity of the study and its focus. The complexity can range from simple - mostly qualitative approaches, which are mainly used for screening purposes, to detailed - which often use quantitative models and can involve higher order spatial data analyses and impact modelling. The more complex approaches are often conducted to supplement qualitative approaches. The level of complexity is directed by needs to address uncertainty and the rigour required (e.g. to justify high-cost treatments). The approaches range from asset-centric ("risks to") e.g. "risks to a sewage treatment plant" through to hazard/event-centric ("risks from") e.g. "risks from a one in two hundred year storm event".

Figure 4 provides a conceptual representation of the continuum of approaches available for risk assessment.

**Figure 4 Risk Assessment Approaches – a continuum**



The NERAG provide a national approach for assessing risks from emergency events and can be applied to various levels of complexity and different focuses, depending on need.

Despite the importance of risk assessment as a decision support tool which provides a measure for understanding and comparing significant problems

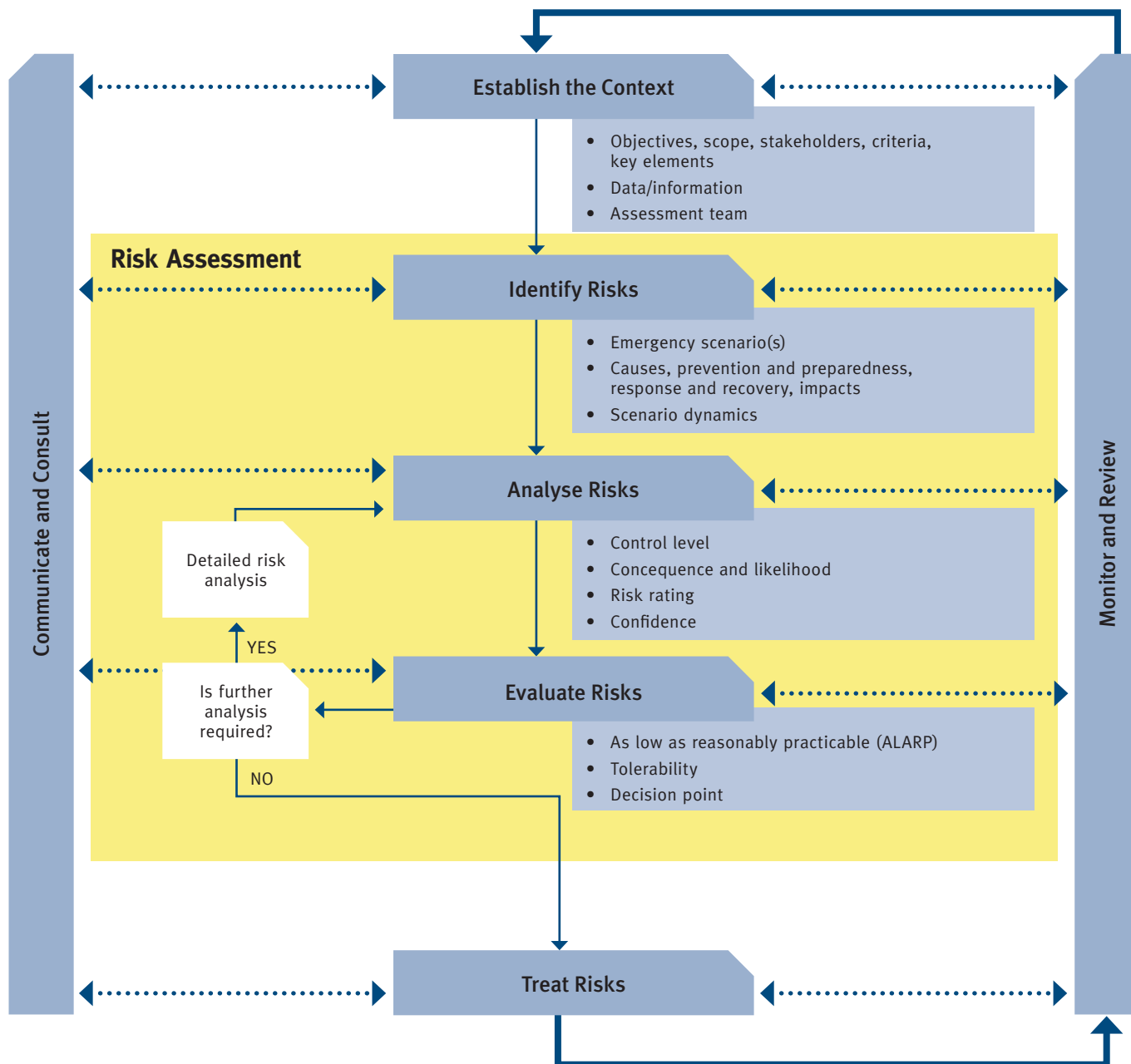
and issues, it is not the only one. It is acknowledged that there are many other approaches that can support decision making, including formalised appreciation processes, project management, issues management, cost-benefit analysis, and root-cause analysis.

### 3. Risk Assessment for Emergency Events

#### 3.1 The Methodology

Figure 5 shows the risk assessment methodology for emergency events, integrated into the risk management process. The approach is expected to yield outputs that rate identified risks and indicate key areas and options for risk treatment measures.

Figure 5 Risk Assessment Methodology for Emergency Events





The methodology is consistent and compliant with *AS/NZS ISO 31000:2009* and reinforces the provision that risk evaluation may “...lead to a decision to undertake further analysis”. To aid this decision, a methodical element is introduced that specifically addresses confidence in the assessment outputs. At this point, it is decided whether or not to undertake detailed analysis to improve confidence or obtain more detailed, robust outputs. Detailed analysis may be valuable where potential losses are high or treatment is expensive.

While following the process of identifying, analysing and evaluating risks, the risk assessment methodology fundamentally adopts a two-stage approach. It is built on a qualitative base-line (screening) assessment, which may be supplemented by detailed (e.g. quantitative) analysis of different complexity levels, if required. That is:

1. A base-line assessment to identify and screen risks quickly. This assessment will follow relatively simple but robust procedures and can be conducted by individuals with varying levels of technical ability and available time.
2. Detailed analysis to increase the confidence in the risk assessment or to justify risk ratings, evaluation or design and implementation of risk treatment strategies. This analysis may require specialist input (e.g. through the use of complex hazard- or event-centric models), but will feed back into the base-line assessment for comparison with those results.

Because this approach allows spatial scaling, the methodology can be used at local, regional, state/territory, and national levels. Other key features of the methodology are listed below.

- Use of a scenario-based approach which is applied consistently throughout the risk assessment process.
- A systematic approach to identify controls and to consider their adequacy. This supports an understanding of potential impacts on the community from single or multiple hazards and the pathways from these hazards to the impacts. This in turn facilitates the identification of risk treatment measures.
- Sampling of risk across a range of credible consequence levels for specific risks. Sampling the likelihoods of a range of credible consequences allows a greater understanding of the nature of a community or organisation’s risk profile for particular sources of risk.

## TIP

It is important that the most appropriate information on the hazard(s) and the community of interest is utilised.

Because emergency events involve dynamic fields such as climate science and geophysics, new information and knowledge becomes available on a continuous basis. An illustrative list of information sources is provided below:

- Bureau of Meteorology  
[www.bom.gov.au](http://www.bom.gov.au)
- CSIRO  
[www.csiro.au](http://www.csiro.au)
- Department of Climate Change  
[www.climatechange.gov.au](http://www.climatechange.gov.au)
- Disaster Assist  
[www.disasterassist.gov.au](http://www.disasterassist.gov.au)
- Emergency Management Australia  
[www.ema.gov.au](http://www.ema.gov.au)
- Geoscience Australia  
[www.ga.gov.au](http://www.ga.gov.au)
- UN International Strategy for Disaster Reduction  
[www.unisdr.org](http://www.unisdr.org)

- A standardised set of consequence and likelihood descriptors to be applied by all users. This approach is taken to allow consistent outputs in the form of ratings of identified risks with an indication of “critical pathways” and risk treatment measures.
- A mechanism to determine the level of confidence in the risk assessment process, in order to identify and communicate uncertainty and to support decision-making about the need for detailed risk analysis, or the selection of risk treatment measures. This mechanism helps to avoid misleading results, e.g. due to subjective perceptions. Undesirable influences in the process can be addressed, thus improving the comparability of results.
- A standardised set of tolerability matrices to be applied by all users during the evaluation process. This approach allows evaluation of risks under various levels of confidence and certainty.

### 3.2 The Process

Emergency risk assessment is most effectively undertaken in a workshop environment, where relevant stakeholders address each key element to generate a comprehensive list of risks associated with the emergency event(s).

Preparation for the workshop will be directed by the context, which will have to be established before the assessment. In order to maximise the efficiency of the process, each team member needs to understand the background of the assessment, the specifics of the relevant emergency scenario, the workshop approach and their role in the process. Therefore, following its careful preparation, the workshop needs to summarise the decisions made, when the context was established, and the collected and reviewed information to develop impact potentials. This approach will “set the scene” for the assessment.

It is important that the workshop is set up to ensure that there is:

- strong technical expertise relevant to the focus of the workshop
- disciplined implementation of the risk assessment process
- quick access to pertinent information and data (e.g. compiled and made available before the workshop)
- a creative thinking environment for the risk study team.

The workshop facilitator should be an experienced, objective person who is not involved in the details of the subject matter and is not part of the risk study team. This will maximise objectivity and help produce outputs on time.

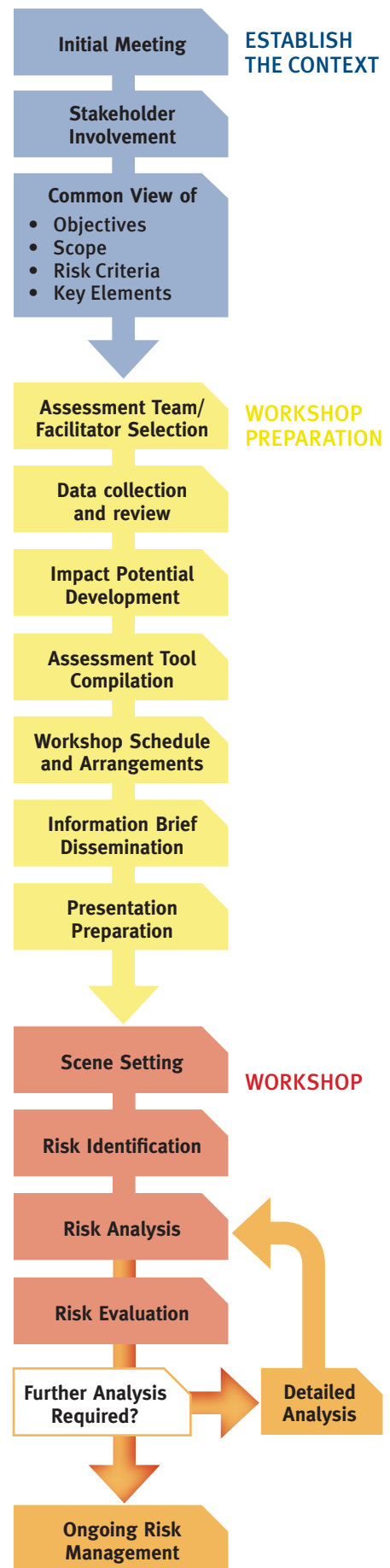
**TIP**

Although a workshop is preferable for risk identification, it is not the only approach that may be adopted. Other approaches are outlined in Standards Australia Handbook 436:2004 Risk Management Guidelines – Companion to AS/NZS 4360:2004 and include:

- structured techniques such as flow charting, design review, Hazard and Operability (HAZOP) studies
- ‘what-if’ and scenario analysis
- checklists.

Independent research coupled with bilateral interviews can also be an effective strategy. Mind maps in a group environment are another useful tool.

Whatever approach is adopted, it is important that the approach is fit-for-purpose.



## 4. Establish the Context

### 4.1 Basic Parameters

Establishing the context is the first step in the NERAG methodology. This step allows an organisation or community to articulate its objectives and define the external and internal parameters to be taken into account when managing risk. The process also sets the scope and risk criteria for the risk study. For risks from emergency events, the emphasis is on ensuring a common understanding of the purpose and objectives, scope and key elements for the risk study before starting the assessment.

When establishing the context, the owners of the process (e.g. emergency management committees at state, regional or local level) need to consider the relevant community environment, including geography, climate, population, industries, essential services and critical infrastructure. Appendix A provides a checklist to consider when describing the environment. This will help in defining or confirming the basic parameters of the risk study (i.e. objectives, scope, stakeholders, risk criteria and key elements).

#### Objectives

A common understanding of the assessment's objectives is paramount in ensuring that all relevant risks are captured. Confirming objectives will support other aspects of the context-setting phase; these include defining the scope, identifying stakeholders and determining key elements.

#### Example of an Objective

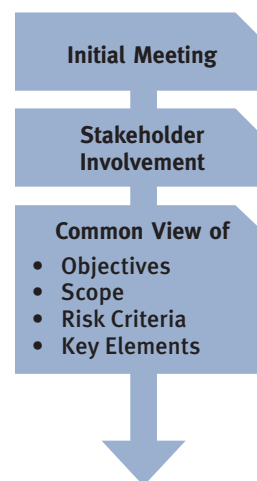
Conduct an assessment of the risks to the community from an East Coast Low in order to direct and prioritise the community's emergency management efforts through prevention, preparedness, response and recovery activities.

#### Scope

The scope of the risk assessment needs to be adequately considered to define the required data. Because the management of risks from emergencies could involve multiple hazards, the definition of scope needs to address the range of hazards for a single event or multiple events, the relevant community including its geographical or jurisdictional boundaries, and timelines to be considered. Accordingly, consideration needs to be given to determine:

- the emergency event(s) to be considered
- the sources of risk to be considered (describing the hazards)
- the impact categories to be considered (describing the elements at risk).

### ESTABLISH THE CONTEXT



#### TIP

For large, complex risk assessments the owners of the process should consider whether they have the resources and time available to commit to each phase of the risk assessment process. There should be a clear understanding of all resource requirements before committing, including an expectation that additional resources/funds may be necessary to treat the risks.

During the scoping stage, the owners of the process might want to consider a range of emergency events and adopt an all hazards approach. Similarly, a risk study may simply be concerned with a single event and address only one hazard or one element at risk. When multiple emergency events and hazards are to be considered, close consideration should be given to the time and resources available to complete the work.

## Example of a Scope

The assessment will address the risks from a **storm surge**, associated with an **East Coast Low**, to the **local community** and consider possible **impacts to people and infrastructure in the municipality**. Storm surges to be considered are **1:100** year and **1:500** year events.

### Stakeholders

Stakeholders can be categorised into three (overlapping) groups: those who may be affected by detrimental impacts from emergency events; those who may contribute specialist knowledge to the process; and those who have jurisdictional authority for the specific hazards and elements at risk. These groups can usually be analysed according to motivations and concerns. However, the main stakeholders of the three groups should be involved in establishing the context and, later, involved in the risk study team in order to ensure substantial stakeholder ownership of the outputs. Stakeholders are typically:

- government and public sector
- non-government organisations
- private sector
- community and individuals.

### Tip

Start with an “initial meeting” of the owners of the process. It is useful and common to then involve stakeholders in focused meetings e.g. to discuss the scope of the risk assessment, or later to prepare the workshop. These “context setting” activities, such as bilateral discussions with risk owners or subject matter experts, community surveys or consultation meetings and workshops, aim at gaining a common view of all relevant matters in order to ensure a well structured and efficient risk assessment.

It is important to consider the jurisdictional authority on either a geographical basis or the relative roles/responsibilities of organisations in the community, including the three spheres of government, NGOs and industry, and the interrelationships of the risk study with bordering areas/jurisdictions.

### Risk Criteria

Risk criteria are used to analyse and evaluate identified risks and will include the following:

- **consequence** level definitions (consider the types of impact that may occur)
- **likelihood** level definitions (consider the likelihood of the consequence)
- **risk level** categories (determine whether the risk is such that further treatment measures are required)
- **confidence** definitions (consider factors impacting on the confidence in the risk study)
- **evaluation** categories (determine acceptability or tolerability of risks).

The NERAG risk criteria are a central and defining characteristic of this publication and are fundamental to the production of comparable risk assessments.

Given the purpose of the guidelines, the NERAG risk criteria comprise a standardised set of descriptors for risk that all users must apply:

- consequence table (refer to Table 2, Section 6.2.3)
- likelihood table (refer to Table 3, Section 6.2.3)
- qualitative risk matrix (refer to Table 4, Section 6.2.3)
- confidence table (refer to Table 5, Section 6.2.4)
- evaluation matrices (refer to Tables 6, 7 and 8, Section 6.3.2).

### Tip

At the outset it may be useful to translate the relative consequences from the consequence table into absolutes to give participants a better idea of the size of the loss. For instance, catastrophic economic loss is defined as > 3% of revenue. Given the revenue of a municipal council of \$10 million, catastrophic economic loss for this council is greater than \$300,000.

## Key Elements

Key elements help to structure the assessment process and maximise its effectiveness. For emergency events, the key elements should be selected in accordance with the scope to focus the attention of the risk study team. However, as a minimum it would be appropriate to select the relevant sources of risk and the categories of impact as key elements of the study. The assessment will then address these key elements one by one, as specified by the relevant community with regard to the emergency event(s) to be considered. If required, subsets of these key elements can be defined to ensure that all important risks will be identified.

## TIP

When considering the key elements for a risk study, consideration needs to be given to particularly vulnerable elements at risk. For instance, in a flood scenario a residential aged-care facility built in a low-lying area within the municipality is likely to present a higher vulnerability to impacts on people than other residential housing assets.

## Example of Key Elements

The scope of the assessment defines the relevant sources of risk and the categories of impact. The following could be selected as key elements and possible subsets for the assessment of risks from an East Coast Low:

### Source:

*Storm surge – breaching of river banks and foreshore dunes, breaking levee banks, dam failure*

### Impacts:

*Damage to infrastructure, including sewage treatment plant, railway line  
Impacts on people, including potential loss of life and displacement*

### Vulnerable communities:

*Low-lying development, including aged-care facility without flood protection*

## 4.2 Reporting

The basis for decisions that define or confirm the objective, scope, stakeholders, risk criteria and key elements of the risk study need to be documented to ensure that the process is transparent and plausible. A reporting template is shown on the next page.

Once established, the context needs to be communicated to and understood by all parties so that the process yields the desired outputs. On this basis, the risk assessment workshop can be prepared with emphasis on selecting the risk study team and collecting and reviewing relevant data to determine potential impacts.

Any temptation to rush the “establish the context” phase should be resisted. The context is fundamental to the risk assessment process and treating this phase dismissively could lead to inappropriate treatment options and adverse feedback from ignored stakeholders.

## TIP

It may be useful for the facilitator to develop a checklist specific to the assessment to ensure that all facets needed for the success of the risk study have been considered. The checklist should include:

- time required for the risk assessment
- sufficient pool of expertise involved in the risk assessment
- sufficient information collected for the risk assessment
- clear description of the risk identification process.



## Example of Reporting Template

### Establish the Context

**Objective:**

Conduct an assessment of the risks to the community from an East Coast Low in order to direct and prioritise the community's emergency management efforts through prevention, preparedness, response and recovery activities.

**Scope:**

The assessment will address the risks of a storm surge associated with an East Coast Low, to the local community and consider possible impacts to people and infrastructure in the municipality. Storm surges to be considered are 1:100-year and 1:500-year events.

**Stakeholders:**

Local Fire Authority, Local Police, Council Representatives (including finance, engineering), Volunteer Emergency Workers, Health Department Representatives, Members of the relevant Business Community, Representatives from the Bureau of Meteorology, Water Authority

**Risk Criteria:**

NERAG consequence / likelihood tables, risk matrix and evaluation matrices

**Key Elements:****Source:**

*Storm surge – breaching of river banks and foreshore dunes, breaking levee banks, dam failure*

**Impacts:**

*Damage to infrastructure, including sewage treatment plant, railway line  
Impacts on people, including potential loss of life and displacement*

**Vulnerable communities:**

*Low-lying development, including aged-care facility without flood protection*

**Justification:**

It was resolved to consider an East Coast Low because we have a history over the last 200 years of significant impacts along the north coast of the region due to these lows. The focus on 1:100- and 1:500-year events will allow us to consider the appropriateness of our measures. We limited the sources of risk to coastal flooding as historical events have repeatedly flooded significant parts of our community. Given the existing settlements and infrastructure, the focus of the risk study is on impacts on people and infrastructure.



## 5. Arrangements for the Risk Assessment

### 5.1 Preparing for the Workshop

Although it is acknowledged that alternative approaches for the identification, analysis and evaluation of risks can be adopted, a workshop is the preferred approach for emergency risk assessments, because it engages stakeholders and gives them a sense of ownership. However, meticulous preparation is paramount to the success of the assessment and should be initiated by the owners of the process, once the context of the study has been established.

Workshop preparation involves a range of desktop activities. Among the most important issues are the selection of the risk study team and the review and collection of hazard and community specific data to develop impact potentials. Here, care should be given to involve people who can provide information about the relevant emergency event and/or the vulnerability of the community or region. It is also recommended that the team members are selected from elements of the community that might be affected, such as owners of critical infrastructure and associated services. Furthermore, individuals familiar with the applicable emergency management arrangements and existing prevention, preparedness, response and recovery measures should form part of the team. In general, all main stakeholders should be represented at the risk study workshop.

When collecting hazard and community specific data, it may be useful to identify and review relevant historical events, which might indicate event trends and (past) vulnerabilities. This is most easily achieved by using the standardised NERAG risk criteria (as identified in tables 2, 3 and 4) for rating the risks that were realised for those events and plotting risk values against the qualitative risk matrix. This might also add value to the assessment by visually putting current risks into historical context specific to the community.

Taking this approach, a risk plot based on historical data describes the consequences from events with an estimated likelihood of occurrence in any one year. Each plot could describe the risk from a particular hazard to a particular impact category and in general would slope down from left to right, indicating that events with high consequences are less likely to occur than events with low consequences. For each historical event a point will appear on the matrix which when combined provide a conceptual representation of the risk profile for particular hazards. Figure 6 provides an example of what this might look like. It is recognised that it may be difficult to produce this when there is limited historical data (which is the case for many hazards in Australia).

#### WORKSHOP PREPARATION



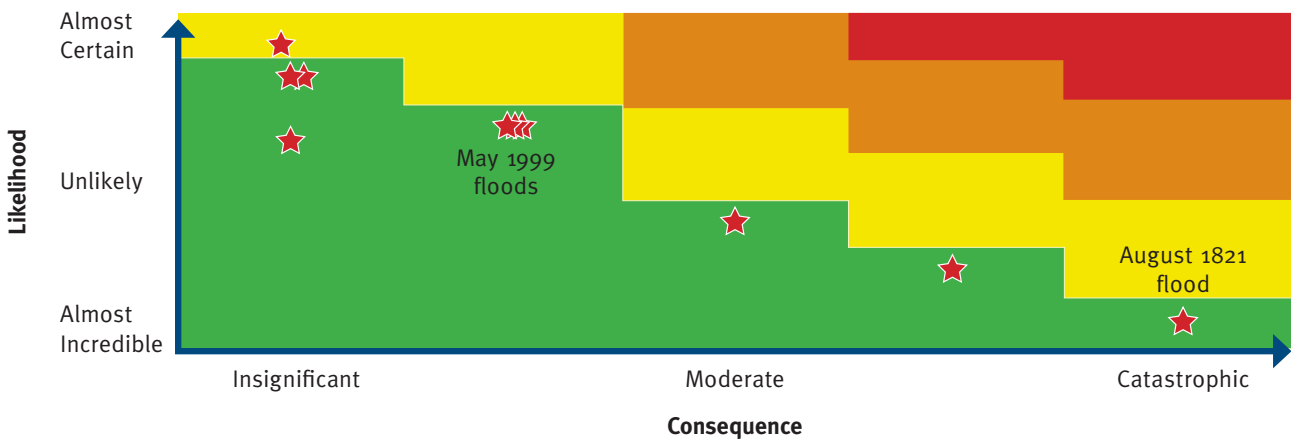
#### TIP

Ingredients for an effective workshop include:

- competent facilitator and scribe
- defined deliverables and method of delivery
- creative thinking to identify risks
- methodical structure to analyse risks (e.g. addressing key elements or identified risks in turns)
- readily available data
- systematic record-taking of issues addressed, agreements etc.
- visibility of proceedings (e.g. presentation tools such as on-screen projections of records)
- team ownership of the process and consensus outputs
- time management, including sufficient break time.

**Figure 6 Example Historical Risk Plot**

Constructed using NERAG risk criteria in preparation for the workshop to support stakeholder understanding of the risk issues for particular sources of risk



The key issues for workshop preparation are:

- establish the assessment context and assign a team leader for the risk study
- draft a realistic implementation plan and schedule
- set up a reliable communication regime
- appoint a facilitator
- select and notify the risk study team members
- distribute relevant information, such as the context of the assessment and the roles to be played by individual team members
- collect and review appropriate information and data on relevant hazard(s) and communities
- develop impact potentials and draft a bow-tie diagram (see Section 6.1.1) for each (single or multiple hazard) event
- compile and adjust assessment tools (e.g. risk register)
- draft a workshop program and schedule (e.g. one or more sessions, possibly parallel)
- arrange for the required resources (e.g. room, projector, recording facilities etc.)
- prepare and distribute an information brief well in advance of the workshop

- prepare a summary presentation to set the scene at the outset of the workshop
- document the process and distribute to workshop attendees and other stakeholders.

Depending on the scope of the assessment, consideration should be given to breaking the workshop into several, possibly parallel, sessions. This is useful when assessing one or more events with multiple hazards in order to address each hazard separately. Also, splitting the process according to the main elements – risk identification, risk analysis and risk evaluation – is often helpful.

### TIP

When selecting a facilitator, the following principles should be taken into account:

- independence
- direct liaison authority
- access to expertise
- capacity to engage with the community
- allocation of adequate resources (time/other).

## 5.2 Undertaking the Workshop

Once the team is assembled and the workshop has started, the formal risk assessment process is underway. The structure of the workshop is driven by the process and usually comprises four phases: setting the scene, identifying risks, analysing risks and evaluating risks.

### Setting the Scene

- summarise and discuss the objective, scope, stakeholders, risk criteria, and key elements of the risk study
- summarise information and data reviewed and present impact potentials
- present the workshop approach and define the roles of individual team members.

### Identifying Risks (see Section 6.1)

- describe relevant (single/multiple hazard) event(s) that might cause an emergency
- describe relevant impacts that an emergency might cause
- discuss the dynamics of the emergency scenario
- summarise risks associated with the impacts in light of the relevant event(s)
- summarise existing prevention and preparedness factors
- summarise existing response and recovery factors
- capture information in a risk register.

### Analysing Risks (see Section 6.2)

- review the risk register to confirm identified risks
- rate existing controls
- assign consequence and likelihood ratings to each risk and determine the risk level
- determine confidence in the process.

### Evaluating Risks (see Section 6.3)

- review the risk register to confirm the analysis of risks
- apply the ALARP principle to determine tolerability
- decide on the need for further analysis or (immediate) treatment before monitoring and review.

The workshop must generate a comprehensive list of risks associated with the relevant emergency event ensuring that no major issues are overlooked. This list needs to include existing controls and to provide an overall rating of each risk, based on the likelihood of particular consequences. In addition, key areas and options for risk treatment should be identified by considering the level of existing controls and the dynamics of the emergency scenario.

In general, facilitators must be mindful of the time allowed for the workshop and ensure that each of the three main elements of the process, identify, analyse and evaluate, is given due consideration. This is important, because the desired amount of time is often not available due to resource constraints. Extensive planning and preparation for the workshop and focused facilitation are therefore crucial to the assessment's success.



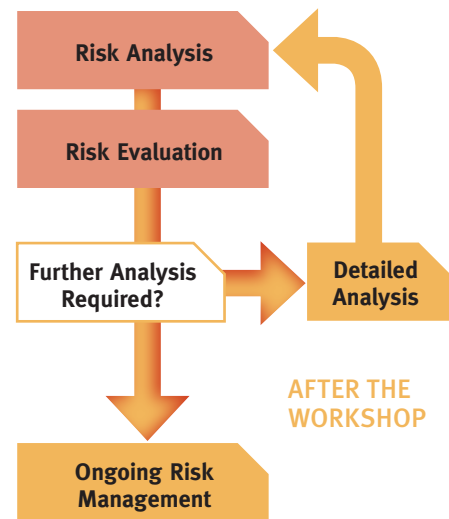
### TIP

The facilitator should ensure that all workshop participants have a clear understanding of the context and are given the opportunity to have input. The context may need to be modified accordingly.

### 5.3 After the Workshop

The assessment is expected to yield outputs that rate identified risks and indicate key areas and options for risk treatment. If the workshop concludes that further analysis is required, the assessment of the relevant risks continues, because those risks will have to be analysed in more detail and subsequently re-evaluated. If, however, the workshop concludes that no further analysis is required, the assessment of the relevant risks is complete. The risks will then be subject to treatment, monitoring and review.

In both cases, the specific action to be undertaken – which may just be monitoring and review should the workshop conclude that neither further analysis nor treatment is required – will depend on the outcome of the risk evaluation.



### 5.4 Responsibilities

All stakeholders in the risk study will need to assume responsibility for their involvement. Key members will be the risk study owner/ sponsor, team leader, subject matter expert, facilitator and participant.

#### Owner/Sponsor

- initiate and oversee the risk study
- provide adequate resources (financial, non-financial)
- ensure realistic timelines.

#### Team Leader

- manage and coordinate the implementation of the risk study.

#### Subject Matter Expert

- provide relevant information, data and expert advice regarding the risk to be assessed.

#### Facilitator

- provide advice on the preparation of the risk assessment
- remain independent of the risk assessment subject matter
- facilitate the risk assessment workshop.

#### Participant

- engage actively in the process
- ensure availability for the entire duration of the study, as required.



## 6. Risk Assessment

### 6.1 Identify the Risks

“Risk identification involves the identification of risk sources, events, their causes and their potential consequences” (AS/NZS ISO 31000:2009). Finding, recognising and describing risks can involve the use of historical data, theoretical or computational analysis, expert opinions and stakeholder needs. This phase reveals the scenario dynamics of potential emergencies in the established context, so that risks can be identified.

Ideally, the identification of risks is facilitated by information and data that is collected, reviewed and prepared for presentation by stakeholders with relevant specialist knowledge when preparing for the workshop. This information should be used in the workshop environment to describe the nature of the relevant sources to be addressed (which could be one or more single or multiple hazard events), with their possible impacts to be considered. An open discussion allows consideration of different perspectives and experiences and significantly contributes to gaining a holistic understanding of the risk, which will be subject to scrutiny during the risk analysis.

#### 6.1.1 Bow-Tie Diagram

In identifying risks, it is important to reveal the interrelationship of sources of risks and impacts. The preferred tool for this is the bow-tie diagram, which can be used to identify: (a) pathways leading to the emergency and the actual impacts; and (b) prevention/preparedness and response/recovery controls. It conceptualises the sources, causes,

controls and impacts of an emergency event, the details of which are then captured in the risk register.

The bow-tie diagram combines advantages of team-based brainstorming and of more structured techniques, such as systems analysis, because it is a graphical representation of the relevant emergency scenario. It depicts the storyline for a loss to the community, which identifies areas that are critical in controlling risk(s). Figure 7 illustrates the bow tie concept and a worked example is provided in the appendices.

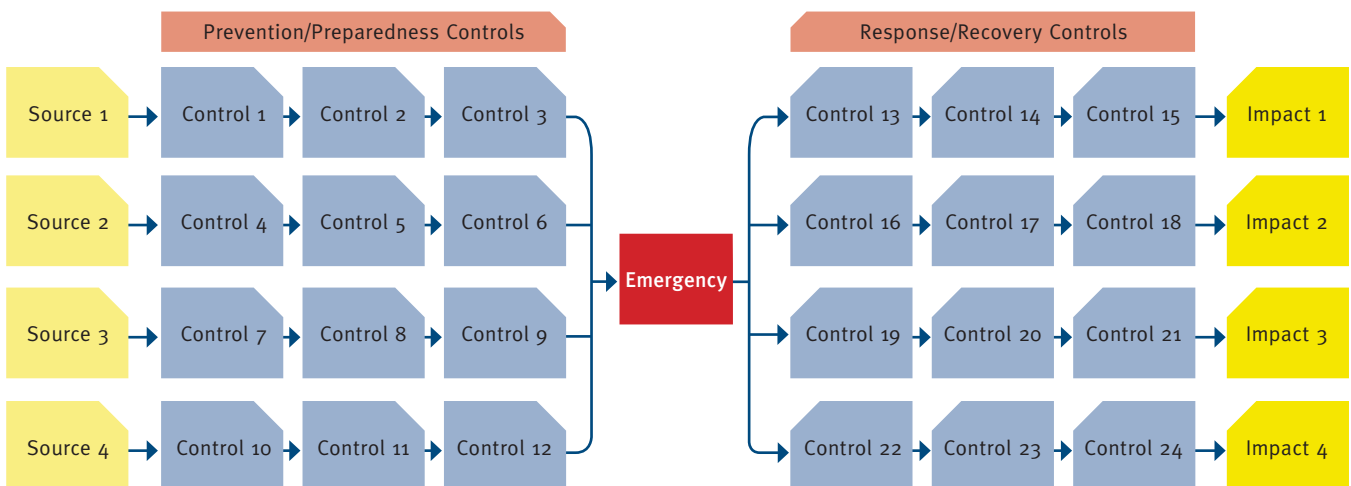
### Inputs and Tools: Risk Identification

- information on hazard and community characteristics as well as impact potentials
- bow-tie diagram
- risk register

### TIP

When identifying risks it is important to consider community vulnerabilities. Because vulnerability means being susceptible to a potential impact, communities that have high exposure to hazards and are less able to adapt are vulnerable. So, depending on the scope of the study, identifying risks will reveal exposed elements at risk and their capacity to cope, in order to prioritise vulnerable (elements of) communities. When appropriate, specific (vulnerable) elements at risk can be used to generate risk statements.

Figure 7 Example of the bow tie diagram



The most appropriate way of constructing a bow-tie diagram for emergencies is to address the five main components of risk<sup>7</sup>:

- **Source**

Sources of emergency risks are the hazards associated with the initiating event. In the bow-tie diagram, the sources are listed on the left-hand side.

## TIP

Typical sources of emergency risks are natural hazards: bushfire, earthquake, flood, storm, cyclone, storm surge, landslide, tsunami, and tornado. However, some hazards may have a number of sources. For instance, floods may result from intense rain, dam failure or snow melt. Lightning strike, arson, non-intentional human causes and infrastructure failure are common causes of bushfire.

- **Cause**

Causes usually describe the mechanisms and conditions for the element at risk to be exposed to a source of risk. In the context of emergency events, these mechanisms and conditions exist due to the characteristics of the environment (e.g. earthquake-prone land) and of the existing prevention and mitigation controls (e.g. design standards). In the bow-tie diagram, the causes are represented by the pathways leading from the source to the incident and further on to the impact.

- **Incident**

Incidents are events when the element at risk is exposed to the source of risk. The incident is the knot of the bow-tie and represents the emergency.

- **Impact**

Impacts describe the consequences for the elements at risk from exposure to the source of risk, that is, the emergency. Levels of impact are defined in a standardised consequence table and are categorised for the elements at risk. In the bow-tie diagram, the impacts on the elements at risk are on the right-hand side of the diagram (in the yellow boxes). Impact categories to be considered are:

- people
- environment

- economy
- public administration
- social setting
- infrastructure.

## TIP

Consideration may also be given to the fact that emergencies may have beneficial long-term consequences for the relevant community, which might (partially) offset immediate or short-term detrimental impacts. Also, consequences beyond the region or jurisdiction of concern may increase or reduce those within the region. In general, any issue raised during the risk identification process – including concerns – can be considered, captured in the risk register and assessed through to the risk evaluation.

These guidelines do not provide explicit guidance on beneficial consequences or opportunities, but methods of adapting risk assessment techniques to deal with benefits and opportunities are discussed in Standards Australia Handbook HB 436:2004.

- **Controls**

Controls are used to manage the causes and thereby either reduce the likelihood of occurrence of the incident or reduce the impact that results from the incident. In the bow-tie diagram, the controls are placed on the pathways (causes) leading from the source to the incident and further on to the impact. For emergency events, prevention and preparedness controls are used to prevent or mitigate exposure of the element at risk or potential impacts, whereas response and recovery controls are used only to mitigate impacts. Documenting existing controls will provide important information for possible control opportunities during risk evaluation and risk treatment.

Where possible, a draft bow-tie diagram should be prepared by the project team before the workshop. It should encompass the sources of risk, the specific emergency, the possible impacts and categories for controls:

- identify the knot of the bow-tie
- list all relevant sources of risk within the scope of the study on the left-hand side of the diagram
- list all relevant impact categories within the scope of the study on the right-hand side of the diagram

<sup>7</sup> HB436:2004 Risk Management Guidelines Companion to AS/NZS 4360:2004

- identify high-level categories for prevention/preparedness controls and relate them to one or more sources of risk by placing them on an imaginary line between the relevant source(s) and the knot of the bow-tie
- identify high-level categories for response/recovery controls and relate them to one or more impact categories by placing them on an imaginary line between the knot of the bow-tie and the relevant impact category
- the bow-tie will be populated with additional data during the workshop.

High-level categories for controls can be determined by the project team which could draw on table 1 (see page 30) or other references including HB436:2004 for inspiration.

## TIP

It is recommended that one bow-tie diagram be prepared for each (single or multiple-hazard) event. The shape and complexity of each bow-tie will depend on the scope of the assessment. For instance, if a single source of risk is to be considered, the left-hand side of the bow-tie will show just one pathway. In contrast, multiple sources will result in multiple pathways leading to the knot (i.e. the emergency).

### 6.1.2 Generate Risk Statements

Risk statements need to be produced for all credible interrelationships between the source(s) of risk and impact categories as defined in the scope and depicted in the bow-tie diagram. They are to be crafted independent of the consequence level, but should include details on the initiating event, including its relative magnitude, where appropriate.

For each risk statement, one or more credible levels of consequence and their likelihood will be determined during the analysis phase. There could be a number of elements at risk from each event, which, depending on the scope of the study might need to be addressed.

Each risk statement should outline:

- the source of risk
- the impact category
- the consequence of the interaction.

For example, the risk statement in the example box deals with damage to infrastructure and service delivery caused by flooding during an East Coast Low.

## Example of Risk Statements

There is the potential that a storm surge resulting from an East Coast Low will cause floods in the coastal areas of the community, which in turn will cause failure of significant infrastructure and service delivery.

There is the potential that a storm surge resulting from an East Coast Low will cause floods in the coastal areas of the community, which in turn will cause impact on the inhabitants.

There is the potential that a storm surge resulting from an East Coast Low will cause floods to low-lying development including an aged care-facility, which in turn will cause impact on the inhabitants.

### 6.1.3 Identify Controls

For each risk statement and for each high-level control category shown in the bow-tie diagram, the risk study team needs to identify specific prevention/preparedness controls and response/recovery controls. The following types of control should be considered:

- behavioural controls – reliance on human action initiated by individuals or groups based on their experience
- procedural controls – reliance on human action in accordance with prescribed approaches within a management system
- physical controls – passive/fixed controls or automatic execution of controls within a management system and not requiring human action.

Table 1 is used to determine the level of control but also provides examples of controls (see p. 31).

### 6.1.4 Risk Register

The risk register serves as the database for the team and is where all relevant information is recorded and documented. According to the staged approach of risk identification, risk analysis and risk evaluation, the register should be completed during each phase of the assessment.

Regular review and monitoring is an integral part of the emergency risk management process and systems should be established and maintained to facilitate this process. The Emergency Management Australia publication, Emergency Risk Management Applications Guide Manual 5, recommends a unique identifier system, whereby an alphanumeric identifier is assigned to each risk. For instance, two letters to identify the community, two digits to identify the nature of the source of risk and two digits to identify the sequential position of the risk.

Refer to the following example of a risk register.

## TIP

It is recommended that one bow-tie diagram be prepared for each (single or multiple-hazard) event. The shape and complexity of each bow-tie will depend on the scope of the assessment. For instance, if a single source of risk is to be considered, the left-hand side of the bow-tie will show just one pathway. In contrast, multiple sources will result in multiple pathways leading to the knot (i.e. the emergency).

### Example of Risk Register (Risk Identification)

#### NERAG RISK REGISTER

**Date:**

**Objective:**

Conduct an assessment of the risks to the community from an East Coast Low in order to direct and prioritise the community's emergency management through prevention, preparedness, response and recovery.

**Scope:**

The assessment will address the risks of a storm surge, associated with an East Coast Low, to the local community and consider possible impacts to people and infrastructure in the municipality. Storm surges to be considered are 1:100 year and 1:500 year events.

Risk Identification					
Risk No.	Risk Statement	Source	Impact Category	Prevention/Preparedness Controls	Recovery/Response Controls
1	There is the potential that a storm surge resulting from an East Coast Low will cause floods in the coastal areas of the community, which in turn will cause failure of significant infrastructure and service delivery.	Storm Surge	Infrastructure	Levee Banks Building Regulations Drainage Maintenance Urban Planning	SES Business Continuity Plans
2	There is the potential that a storm surge resulting from an East Coast Low will cause floods in the coastal areas of the community, which in turn will cause impact on the inhabitants.	Storm Surge	People	Levee Banks Building Regulations Public Education Drainage Maintenance Early Warning System Urban Planning	SES Emergency Shelters Volunteer Organisations Medical Services
3	There is the potential that a storm surge resulting from an East Coast Low will cause floods to low lying development including an aged care facility, which in turn will cause impact on the inhabitants.	Storm Surge	People	Building Regulations Public Education Drainage Maintenance Early Warning System	SES Emergency Shelters Volunteer Organisations Medical Services Evacuation Arrangements

## 6.2 Analyse the Risks

“Risk analysis is the systematic process to understand the nature of and to deduce the level of risk” (AS/NZS ISO 31009:2009). The level of risk is determined by identifying the likelihood of particular consequences occurring.

### Inputs and Tools: Risk Analysis

- bow-tie diagram
- risk register
- control table
- standardised NERAG risk criteria

The choice of analysis method is usually determined by the context and available resources, and may be qualitative, semi-quantitative and quantitative. Put simply, qualitative methods employ simple mechanisms (matrix, nomogram) to use people’s experience to provide a rating of risks. In contrast, quantitative methods generally include complex mathematical calculations of risk based on frequency and probability of failures as well as the physics of the underlying hazard. Experience has shown that qualitative assessments and mathematical data are seldom in harmony. Semi-quantitative methods therefore aim at combining the advantages of qualitative and quantitative methods.

*Risk analysis may be undertaken to varying degrees of detail depending upon the risk, the purpose of the analysis, and the information, data and resources available. Analysis may be qualitative, semi-quantitative or quantitative or a combination of these, depending on the circumstances. The order of complexity and costs of these analyses, in ascending order, is qualitative, semi-quantitative and quantitative. In practice, qualitative analysis is often used first to obtain a general indication of the level of risk and to reveal the major risk issues. Later it may be necessary to undertake more specific quantitative analysis on the major risk issues. (Standards Australia Handbook HB 436:2004).*

Given the purpose of these guidelines, the risk assessment methodology for emergency events is built on a qualitative base-line (screening) assessment, which will follow relatively simple but robust procedures. Should this analysis and the subsequent evaluation of risks identify a need for

further analysis, more detailed analytical methods of different complexity levels may be adopted to supplement the process.

The base-line assessment deduces the level of risk by following a systematic process, whereby the risk register derived from the bow-tie diagram, as well as an assessment of the control level and the application of the standardised NERAG risk criteria, will provide a consistent analysis of emergency risks. Each risk in the risk register will be subject to review and rating in line with the following approach.

### 6.2.1 Reviewing the Risk Register and Bow-Tie Diagram

Review of the risk register and the bow-tie diagram aims at confirming that all relevant risks have been identified. Questions to ask at this stage include:

- Have all trivial issues been screened out?
- Have all duplicates been drawn together?
- Have prevention/preparedness controls been identified for all sources of risk?
- Have response/recovery controls been identified for all impact categories?

### 6.2.2 Control Level

A systematic assessment of controls regarding their effectiveness highlights weaknesses and directs actions for their improvement. If used in combination with the bow-tie diagram, it also provides valuable information about how to manage risks by identifying treatment options through focusing on critical pathways; that is, pathways without controls in place or pathways with controls which are vital (i.e. most relied on).

The control level should be assessed as part of the risk analysis before rating the risks. As a starting point, it is useful to prompt team discussions for each identified risk on the following control characteristics.

#### Dependability

- How reliable is it?
- If it breaks down, how long will it be out of service?
- Will it work even if other controls are failing?
- Will it survive an incident?

#### Practicality

- Is it a proven control?
- Does it comply with a known standard?



- Is there something about the emergency event, community or other criteria that will prevent it being effective?

### **Monitoring**

- Is there a management process to track and measure control performance?
- How will any deterioration be detected early?

### **People Involvement**

- Is there any way people can undermine this control?
- Do they understand its importance?
- Are operators competent and properly trained?

Following this discussion, the tool for rating is the control table (Table 1), which ranks the effectiveness for different types of control. It defines three levels for behavioural, procedural and physical controls and can be used to address both community and state processes. As indicated in the table, behavioural and procedural controls may achieve high ratings, taking into account that a resilient community, through its ability to cope, is not disabled in crisis situations, but mobilises to deal with them.

The rating for each control needs to be recorded in the risk register.



**Table 1 Control Table**

Level of Control	Behavioural Controls <i>Reliance on human action initiated by individuals or groups based on their experience.</i>	Procedural Controls <i>Reliance on human action in accordance with prescribed approaches within a management system.</i>	Physical Controls <i>Passive/fixed controls or automatic execution of controls within a management system and without requiring human action.</i>
1	Immature organisation High turnover of staff High proportion of new population within community History of control failure	Documented procedure (no document control) One-off competency assessment against procedure One-off conformance and outcome evaluation	Designed to specific performance criteria (availability, reliability) Implemented to design criteria
2	Organisation with well-understood roles and responsibilities Skilled and trained staff Community with communication and interaction between all population groups History for minor control failures Staff have holistic understanding of the impact of one control's failure on another	Document control system Periodic competency assessment against the procedure Defined performance outcomes Periodic conformance auditing including management reporting of audit outcomes	Designed in relation to the element at risk to be protected Managed as part of a preventative maintenance system System-generated notification in the event of activation and failure
3	Mature organisation with clear and documented roles and responsibilities Experienced and skilled staff Well-established community with high level of awareness and/or education involving all population groups No history of any control failures and demonstrated ability to learn from the past	Management system includes rules and protocols (access, authority levels, expected control range) Continuous performance checks Management reporting of conformance Documented management follow-up of deficiencies Management system subject to external accreditation and auditing	Control covered by a rigorous change management regime Deliberate actions required for disabling control Failures managed as part of maintenance system and given higher priority for resolution Maintenance system differentiates between critical and non-critical tasks Documented management follow-up of system deficiencies





### 6.2.3 Risk Criteria

Risk analysis aims at assigning each identified risk a rating in accordance with the agreed risk criteria. It assumes that the emergency scenario, as depicted in the bow-tie diagram, arises. The analysis therefore relies on a realistic understanding of the scenario dynamics; that is, of all causes that may result in an emergency, the impacts that may arise from the exposure, and relevant controls that are in place.

The risk criteria are centred on two parameters: consequence and likelihood. Each risk is assigned credible consequence levels and for each of these consequence levels likelihood ratings are determined. Combined, the likelihood and consequence ratings are used to determine the risk. The outcome must be a set of risk ratings, which reflects the team's assessment of the risk level.

#### Consequence Rating

The risk study team needs to be mindful that there could be a range of credible levels of consequence for each risk statement. Using the standardised consequence table (Table 2), each credible consequence level is to be recorded in the risk register. In the emergency context, this is a rating for the potential outcome once the "incident" has occurred. An independent rating is to be applied for all relevant impact categories (see 6.1.1). Table 2 shows the consequence criteria for the base-line assessment of risks from emergency events.



## TIP

When selecting a range of credible consequences, the consequences chosen will vary for each impact category such as people or infrastructure. For some risks, all consequence ranges as defined in the consequence table may be credible, but for other risks, only a few may be credible. It is possible that consequence levels, which have one or more levels between them, are credible. For instance, a risk may result in a moderate or major consequence for one impact category but a moderate or catastrophic consequence for another.

## Examples of Credible Consequence Levels

There is the potential that a storm surge resulting from an East Coast Low will cause floods in the coastal areas of the community, which in turn will cause failure of significant infrastructure and service delivery.

#### Credible consequence levels:

*Infrastructure: Catastrophic – Long-term failure of significant infrastructure*

*Infrastructure: Moderate – Mid-term failure of service delivery affecting some parts of the community*

There is the potential that a storm surge resulting from an East Coast Low will cause floods to low-lying development including an aged-care facility, which in turn will cause impact on the inhabitants.

#### Credible consequence levels:

*People: Major – Multiple loss of life*

*People: Moderate – Isolated cases of loss of life*

*People: Minor – Isolated cases of serious injuries*

**Table 2 Consequence Table**

Consequence Level	People	Environment	Economy	Public Administration	Social Setting	Infrastructure
Catastrophic	Widespread multiple loss of life (mortality > 1 in ten thousand), health system unable to cope, displacement of people beyond ability to cope	Widespread severe impairment or loss of ecosystem functions across species and landscapes, irrecoverable environmental damage	Unrecoverable financial loss > 3% of the government sector's revenues <sup>1</sup> , asset destruction across industry sectors leading to widespread business failures and loss of employment	Governing body unable to manage the event, disordered public administration without effective functioning, public unrest, media coverage beyond region or jurisdiction	Community unable to support itself, widespread loss of objects of cultural significance, impacts beyond emotional and psychological capacity in all parts of the community	Long-term failure of significant infrastructure and service delivery affecting all parts of the community, ongoing external support at large scale required
Major	Multiple loss of life (mortality > 1 in one hundred thousand), health system over-stressed, large numbers of displaced people (more than 24 hours)	Severe impairment or loss of ecosystem functions affecting many species or landscapes, progressive environmental damage	Financial loss 1-3% of the government sector's revenues <sup>1</sup> requiring major changes in business strategy to (partly) cover loss, significant disruptions across industry sectors leading to multiple business failures and loss of employment	Governing body absorbed with managing the event, public administration struggles to provide merely critical services, loss of public confidence in governance, media coverage beyond region or jurisdiction	Reduced quality of life within community, significant loss or damage to objects of cultural significance, impacts beyond emotional and psychological capacity in large parts of the community	Mid- to long-term failure of significant infrastructure and service delivery affecting large parts of the community, initial external support required
Moderate	Isolated cases of loss of life (mortality > than one in one million), health system operating at maximum capacity, isolated cases of displacement of people (less than 24 hours)	Isolated but significant cases of impairment or loss of ecosystem functions, intensive efforts for recovery required	Financial loss 0.3-1% of the government sector's revenues <sup>1</sup> requiring adjustments to business strategy to cover loss, disruptions to selected industry sectors leading to isolated cases of business failure and multiple loss of employment	Governing body manages the event with considerable diversion from policy, public administration functions limited by focus on critical services, widespread public protests, media coverage within region or jurisdiction	Ongoing reduced services within community, permanent damage to objects of cultural significance, impacts beyond emotional and psychological capacity in some parts of the community	Mid-term failure of (significant) infrastructure and service delivery affecting some parts of the community, widespread inconveniences
Minor	Isolated cases of serious injuries, health system operating within normal parameters	Isolated cases of environmental damage, one-off recovery efforts required	Financial loss 0.1-0.3% of the government sector's revenues <sup>1</sup> requiring activation of reserves to cover loss, disruptions at business level leading to isolated cases of loss of employment	Governing body manages the event under emergency regime, public administration functions with some disturbances, isolated expressions of public concern, media coverage within region or jurisdiction	Isolated and temporary cases of reduced services within community, repairable damage to objects of cultural significance, impacts within emotional and psychological capacity of the community	Isolated cases of short- to mid-term failure of infrastructure and service delivery, localised inconveniences
Insignificant	Near misses or minor injuries, no reliance on health system	Near misses or incidents without environmental damage, no recovery efforts required	Financial loss < 0.1% of the government sector's revenues <sup>1</sup> to be managed within standard financial provisions, inconsequential disruptions at business level	Governing body manages the event within normal parameters, public administration functions without disturbances, public confidence in governance, no media attention	Inconsequential short-term reduction of services, no damages to objects of cultural significance, no adverse emotional and psychological impacts	Inconsequential short-term failure of infrastructure and service delivery, no disruption to the public services

<sup>1</sup> As reported in the annual operating statement for the relevant jurisdiction, organisation and community

## Impact Category Definitions

People	Relates to the direct impacts of the emergency on the physical health of people/individuals and emergency services' (i.e. health system) ability to manage  Mortality defined as the ratio of deaths in an area to the population of that area; expressed per 1000 per year
Environment	Relates to the impacts of the emergency and its effects on the ecosystem of the area, including fauna and flora
Economy	Relates to the economic impact of the emergency on the governing body as reported in the annual operating statement for the relevant jurisdiction, and Industry Sectors as defined by the Australian Bureau of Statistics
Public Administration	Relates to the impacts of the emergency on the governing body's ability to govern
Social Setting	Relates to the impacts of the emergency on society and its social fabric, including its cultural heritage, resilience of the community
Infrastructure	Relates to the impacts of the emergency on the area's infrastructure/lifelines/utilities and its ability to service the community  Long-term failure = Repairs will take longer than 6 months  Mid- to long-term failure = Repairs may be undertaken in 3 to 6 months  Mid-term failure = Repairs may be undertaken in 1 to 3 months  Short- to mid-term failure = Repairs may be undertaken in 1 week to 1 month  Short-term failure = Repairs may be undertaken in less than 1 week

### Likelihood Rating

Following the determination of one or more credible levels of consequence for each risk statement, their likelihood needs to be determined. Likelihood is the "chance of something happening" (AS/NZS ISO 31000:2009). Using the standardised likelihood table, each credible consequence of each risk statement is assigned a qualitative likelihood rating to be recorded in the risk register. In this sense a risk curve is sampled across the range of credible levels of consequence for a range of credible scenarios.

Table 3 shows the likelihood criteria for the base-line assessment of risks from emergency events. It describes the frequency of an incident and the probability of its associated consequences. In addition, the table expresses the occurrence of a source of risk and particular consequences in terms of average recurrence interval and annual exceedance probability.

**Table 3 Likelihood Table**

Likelihood Level	Frequency	Average Recurrence Interval	Annual Exceedance Probability
Almost Certain	Once or more per year	< 3 years	> 0.3
Likely	Once per ten years	3 – 30 years	0.031 – 0.3
Possible	Once per hundred years	31 – 300 years	0.0031 – 0.03
Unlikely	Once per thousand years	301 – 3,000 years	0.00031 – 0.003
Rare	Once per ten thousand years	3,001 – 30,000 years	0.000031 – 0.0003
Very Rare	Once per hundred thousand years	30,001 – 300,000 years	0.0000031 – 0.00003
Almost Incredible	Less than once per million years	> 300,000 years	< 0.0000031

## TIP

There are a number of ways that the chance of an event occurring can be expressed. Exceedance statistics, as they are commonly called, are used in planning and management to define a level of acceptable risk; the likelihood of occurrence is balanced against the costs of mitigating the risk. Many terms are used interchangeably at times, including Annual Exceedance Probability (AEP), Return Period, Average Recurrence Interval (ARI), probability and frequency.

Return period usually refers to the average time between events of a certain magnitude, while exceedance probability indicates the chance that an event of a particular magnitude will occur in a certain period of time.

It is strongly recommended that hazard be considered in terms of probability because the use of ARI and “return periods” can lead to confusion in the minds of some decision makers and members of the public. Although the terms are simple, they are sometimes misinterpreted to imply that hazard events, with the associated magnitude, are only exceeded at regular intervals, and that they are referring to the elapsed time to the next exceedance.

It is therefore preferable to express the rarity of an event in terms of AEP. With appropriate information, emergency events of different magnitude can be put into this context.

To put a 1% AEP into perspective, this is an event which has a one per cent chance of occurring or being exceeded every year. As the time period is increased, the chance of an event of this magnitude occurring or being exceeded increases as indicated in the table below. There is also a possibility that more than one of these extreme events could occur in the same year. The table below provides a summary of probabilities of 1% AEP events occurring across different timeframes<sup>8</sup>.

Chance of 1% AEP occurring	In a single year	In a 10-year period	In a 50-year period	In a 100-year period
Not occurring	99%	90.4%	60.5%	36.6%
Only once	1%	9.1%	30.5%	37.0%
Twice		0.4%	7.6%	18.5%
Three times		0.01%	1.2%	6.1%
More than three times			0.2%	1.8%

It is important to note that the likelihood rating refers to “the chance of something happening” i.e. the consequence occurring. Therefore, information not only on the occurrence of an emergency event, related spatial information concerning the emergency event and the community has to be taken into account, but also the adequacy of the existing controls.

- **Occurrence of an emergency event**

The chance of an event occurring can be expressed in many ways. The likelihood table offers two units that can be used, depending on the availability of data: Average Recurrence Interval (ARI), expressing the likelihood of occurrence of a given hazard event as once in every x years; and the Annual Exceedance Probability (AEP), expressing the likelihood of occurrence of a given hazard as probability of this hazard event being equalled or exceeded in any one-year period.

- **Spatial information**

Spatial information needs to be considered since the area potentially impacted by a particular

hazard (e.g. storm) does not necessarily correlate with the geographical boundaries of the risk assessment. Likewise, information on propagation, such as the capacity of a bushfire to spread, relevant to the elements at risk needs to be taken into account. Relevant information is to be collected for the emergency event and the elements at risk and may also include local historical data as well as projections.

- **Adequacy of the existing controls**

The control level and the risk rating determine the adequacy of existing controls. When several controls are in place, the interaction of these controls and their cumulative adequacy has to be considered. Two questions should be addressed for each risk:

- Are controls in place, which are likely to be appropriate?
- Do these controls have back-ups?

<sup>8</sup> For mathematically independent events; that is, for hazard events unrelated to earlier events



Other factors to consider, when necessary, are the timeframe of the assessment and the lifetime of the elements at risk. These parameters need consideration because the longer their duration, the greater the chance of an incident and its associated consequences being experienced at some stage during that period. For instance, the chance of a hazard with a 1% AEP occurring in a certain year is small (i.e. 1%). However, if a timeframe of 100 years is considered, then it is much more likely that the hazard event will occur at least once during that time (i.e. 63.4%). Obviously, the same can be illustrated for the lifetime of the element at risk. Also, temporal factors which might influence the likelihood of a consequence, such as peak traffic hours, may have to be taken into account.

The risk study team needs to assign a likelihood rating for each consequence considering all of the above factors and using Table 3.

### Risk Rating

The qualitative risk matrix (Table 4) combines a level of consequence with a level of likelihood to determine a level of risk. The risk level, together with the confidence in the overall assessment process and other factors, will determine the need for detailed analysis and inform the treatment of risks.

Using the risk matrix, all risk levels are to be recorded in the risk register.

## Example of Likelihood Rating

The likelihood rating for the risk of multiple loss of life in low lying developments including an aged-care facility:

### Occurrence of an emergency event:

*Occurrence of a 1:100 year storm surge from an East Coast Low*

*Likelihood rating “possible”*

### Spatial information:

*Regional estimates of the extent of an East Coast Low correlate with the area being considered*

*Likelihood rating is not reduced: “possible”*

### Adequacy of the existing controls:

*The PP/RR controls for loss of life were mostly rated at level 2 and the risk study team felt the controls would have some effect in preventing a major consequence*

*Likelihood rating is reduced to “unlikely”*

### Likelihood Level:

*The likelihood rating for the risk of multiple loss of life in low-lying developments including an aged-care facility was determined as “unlikely”.*

**Table 4** Qualitative Risk Matrix

Likelihood Level	Consequence Level				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Medium	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Possible	Low	Low	Medium	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium
Very Rare	Low	Low	Low	Low	Medium
Almost Incredible	Low	Low	Low	Low	Low

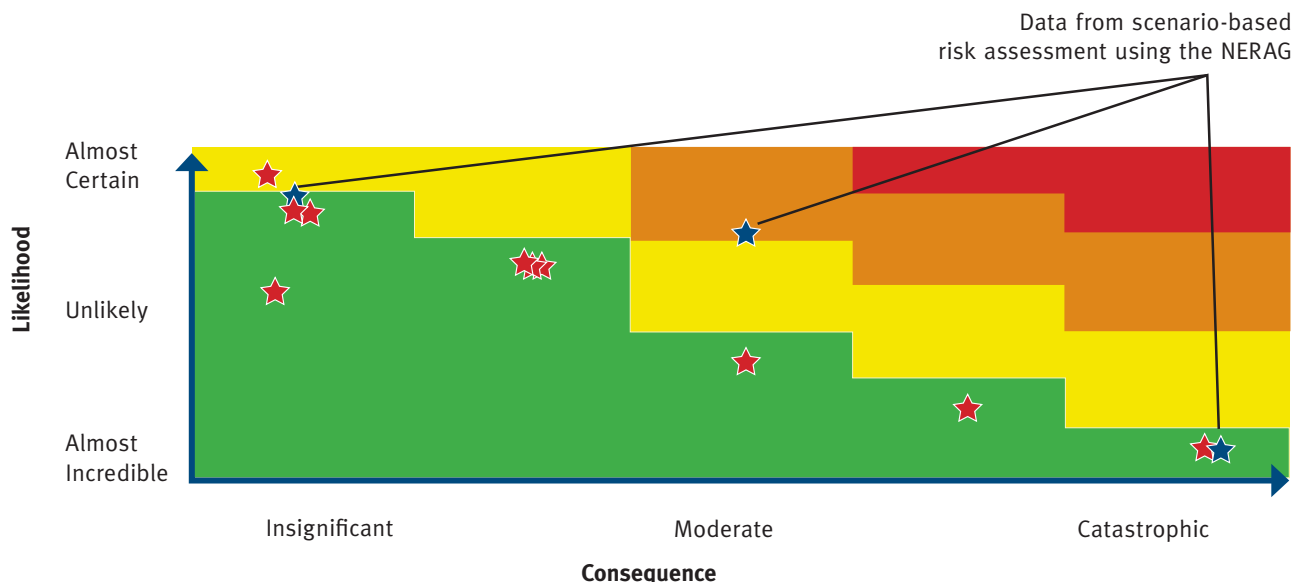
Where a range of credible consequences have been identified, the resulting risk ratings can be shown pictorially as a risk plot, overlain on the risk matrix. If historical data was used to generate a risk plot before undertaking the risk assessment, both could be shown together for comparison purposes although both datasets cannot be combined to form one risk plot because they were derived by different methods and for different times of occurrence.

To prepare a risk plot for a particular source of risk and a particular impact class, plot points on the matrix based on the agreed likelihoods and consequences for the event analysed, using the scenario-based approach in the NERAG. Plot additional points for other scenarios considered. Avoid extending plots beyond the area of the scenarios considered.

Figure 8 below shows a typical risk plot with synthetic data derived during the risk study using the NERAG plotted for three credible consequence levels along with data from ten historical events for comparison.

The plot can be useful in conceptualising risk and also for identifying outliers in risk ratings. Such outliers may prompt the team to review and check the data that led to the particular risk rating. In this example this plot indicates that the highest risk is associated with moderate consequence. Given its derivation from historical risk ratings the team may decide to review the inputs to this risk value before proceeding.

**Figure 8 Example Risk Plot – comparing historical risk information and risk data from current study**



#### 6.2.4 Confidence

The outputs generated by the risk assessment are used to determine possible action. Before decisions are made, however, the risk study team needs an indication of the robustness of the approach. To achieve this, the level of confidence in the risk assessment process will be used to identify and communicate uncertainty. Confidence helps to avoid misleading results, because influences in the process (such as subjective perceptions or a lack of data) may be addressed, thus contributing to the comparability of outputs. Assessing confidence is a proxy for sensitivity analysis and will support the decision concerning whether there is a need for more detailed risk analysis.



Confidence assessments can focus on factors such as divergence of opinion among experts, uncertainty, quality and availability of data and information as they relate to scenarios, controls, credible consequence levels and assessed likelihoods and risk ratings. The tool to determine the level of confidence is shown in Table 5. The table defines three levels (low, moderate and high) for three confidence criteria:

- **Data/information**

This criterion addresses both the availability and quality of data, and information relevant to the hazard and community. The data may also cover information on the sources of risk as well as the exposure, vulnerability and/or resilience of the community and its concerns. In addition, it may include projections of future developments, such as climate change and demographics, and timelines of interest.

- **Team knowledge**

This criterion addresses the knowledge of the risk study team of the emergency event or type of hazard and the risk assessment process. It includes the expertise and skills acquired through experience or education.

- **Agreement**

This criterion addresses the level of agreement in the risk assessment and includes team consensus on data interpretation, assignment of risk criteria ratings etc. It is to be judged purely on technical grounds.

**Table 5 Confidence Table**

Confidence Criteria	Low Confidence	Moderate Confidence	High Confidence
Data/Information	Neither community nor hazard specific; anecdotal only	Community or hazard specific; validated historical or scientific	Community and hazard specific; validated historical and scientific
Team knowledge	Neither hazard nor process (risk assessment) specific	Hazard or process specific	Hazard and process specific
Agreement	Neither on interpretations nor on ratings	On interpretations or ratings	On interpretations and ratings

The ratings for each of the above confidence criteria will help rate confidence in the overall risk assessment process. This rating will be conducted for each risk at the end of the risk analysis phase. It will be recorded in the risk register in order to communicate uncertainty and to support the decision-making process concerning the need for detailed risk analysis, or the selection of risk treatment measures. In general, if the overall confidence in the process is low, further analysis might be warranted, and a more detailed analysis may need to be conducted. But if the risk study team feels that the information and results are robust and in line with the objectives of the risk assessment, the conclusions from the assessment would feed into the risk management process without further analysis.

Depending on the significance of the decision, the confidence rating should be assessed in conjunction with an external party or otherwise validated by a third party, such as through peer review or other validation mechanism.

### 6.2.5 Risk Register

At this stage of the risk assessment process the risk study team will have identified and analysed the risks. The findings should now be recorded in the risk register (refer to the example risk register following).

## Example of Risk Register (Risk Analysis)

### Risk Statement:

*There is the potential that a storm surge resulting from an East Coast Low will cause floods to low-lying development including an aged care-facility, which in turn will cause impact on the inhabitants.*

### Control Level:

*The risk study team felt the controls associated with preventing a major consequence were generally less effective than for moderate consequence events.*

### Credible Consequence Levels:

*Major (Risk ID 3.1) – Moderate (Risk ID 3.2) – Minor (Risk ID 3.3)*

### Confidence Level:

*Major Consequence – Moderate Confidence, lack of historical event data for major consequence events*

*Moderate Consequence – High Confidence, data validated.*

*Minor Consequence – High Confidence, data validated.*

## NERAG RISK REGISTER

### Date:

### Objective:

Conduct an assessment of the risks to the community from an East Coast Low in order to direct and prioritise the community's emergency management through prevention, preparedness, response and recovery.

### Scope:

The assessment will address the risks of a storm surge, associated with an East Coast Low, to the local community and consider possible impacts to people and infrastructure in the municipality. Storm surges to be considered are 1:100 year and 1:500 year events.

Risk Analysis								
Risk No.	Level of Existing PP Controls	Level of Existing RR Controls	Consequence	Likelihood	Risk	Confidence Level		
3.1	Building Regulations	2	SES	2	Major	Unlikely	Medium	Moderate
	Public Education	1	Emergency Shelters	NA				
	Drainage Maintenance	2	Volunteer Organisations	1				
	Early Warning System	2	Medical Services	3				
			Evacuation Arrangements	2				
3.2	Building Regulations	2	SES	2	Moderate	Possible	Medium	High
	Public Education	1	Emergency Shelters	2				
	Drainage Maintenance	3	Volunteer Organisations	1				
	Early Warning System	2	Medical Services	3				
			Evacuation Arrangements	2				
3.3	Building Regulations	2	SES	2	Minor	Possible	Low	High
	Public Education	1	Emergency Shelters	2				
	Drainage Maintenance	3	Volunteer Organisations	1				
	Early Warning System	2	Medical Services	3				
			Evacuation Arrangements	2				

## 6.3 Evaluate Risks

“Risk evaluation is the process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude is acceptable or tolerable” (AS/NZS ISO 31000:2009). Its purpose is to assist decision making on which risks require further detailed analysis and/or need treatment, and the priority for implementation of measures to modify risk.

The evaluation of risks from emergency events takes into account the risk identification and analysis, as summarised in the bow-tie diagram and risk register. In addition, the ALARP (As Low As Reasonably Practicable) principle is applied to define boundaries between risks that are generally intolerable, tolerable or broadly acceptable. The risk evaluation will conclude by deciding whether each risk needs further analysis or treatment.

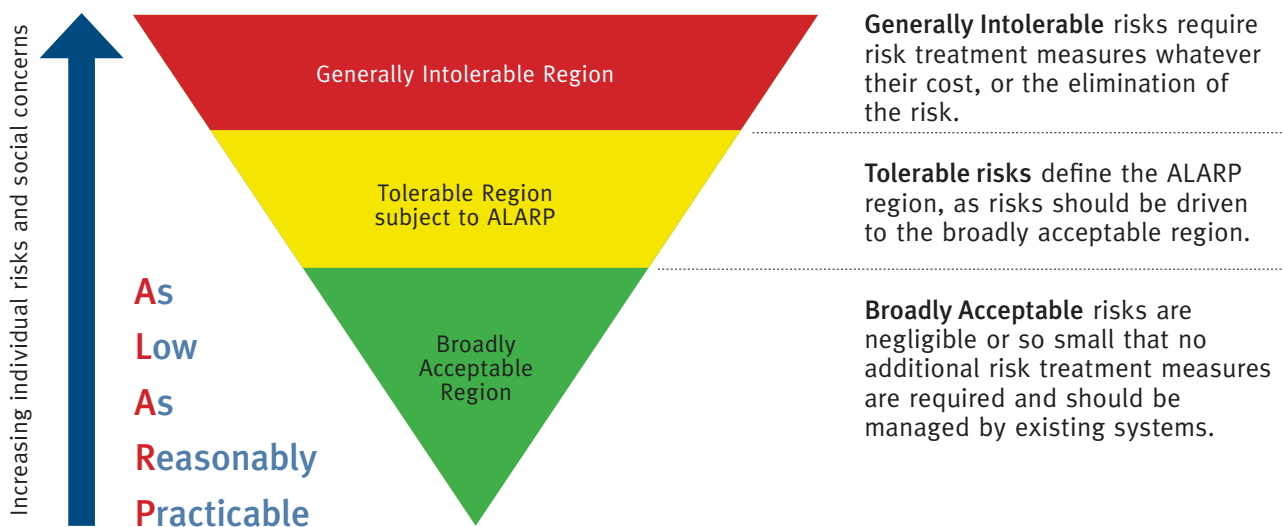
### Inputs and Tools: Risk Evaluation

- risk register
- ALARP principle
- tolerability rating

#### 6.3.1 ALARP Principle

The ALARP principle will help to prioritise a risk hierarchy and determine which risks require action and which do not. Those that are broadly acceptable naturally require little, if any, action while risks that are at an intolerable level require attention to bring them to a tolerable level. It is entirely appropriate and accepted practice that risks may be tolerated, provided that the risks are known and managed.

Figure 9 ALARP Principle



For a risk to be acceptable it needs to fall in the broadly acceptable region of the ALARP diagram above. Some risks may be tolerated, subject to being as low as reasonably practicable, and these fall within the tolerable region (subject to ALARP). Two factors to be considered when determining whether the risks are intolerable, tolerable subject to ALARP or broadly acceptable are the risk rating and the confidence level.

Their interrelationship is shown in the tolerability matrices on p. 40. The output of their use is to be recorded in the risk register.

### 6.3.2 Risk Tolerability

The following tolerability matrices should be used depending on the level of confidence for a particular risk issue.

**Table 6 Evaluation Table – High Confidence Level**

Likelihood Level	Consequence Level				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Yellow	Yellow	Yellow	Red	Red
Likely	Green	Yellow	Yellow	Yellow	Red
Possible	Green	Green	Yellow	Yellow	Yellow
Unlikely	Green	Green	Yellow	Yellow	Yellow
Rare	Green	Green	Green	Yellow	Yellow
Very Rare	Green	Green	Green	Green	Yellow
Almost Incredible	Green	Green	Green	Green	Green

**Table 7 Evaluation Table – Moderate Confidence Level**

Likelihood Level	Consequence Level				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Yellow	Yellow	Red	Red	Red
Likely	Yellow	Yellow	Yellow	Red	Red
Possible	Green	Yellow	Yellow	Yellow	Red
Unlikely	Green	Green	Yellow	Yellow	Yellow
Rare	Green	Green	Yellow	Yellow	Yellow
Very Rare	Green	Green	Green	Yellow	Yellow
Almost Incredible	Green	Green	Green	Green	Yellow

**Table 8 Evaluation Table – Low Confidence Level**

Likelihood Level	Consequence Level				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost Certain	Yellow	Yellow	Red	Red	Red
Likely	Yellow	Yellow	Red	Red	Red
Possible	Yellow	Yellow	Yellow	Red	Red
Unlikely	Green	Yellow	Yellow	Yellow	Red
Rare	Green	Green	Yellow	Yellow	Yellow
Very Rare	Green	Green	Yellow	Yellow	Yellow
Almost Incredible	Green	Green	Green	Yellow	Yellow

	Intolerable
	Tolerable subject to ALARP
	Broadly Acceptable



### 6.3.3 Demonstration of ALARP

For risks considered tolerable subject to ALARP, control implementation or improvement opportunities need to be considered, particularly for those pathways that are critical. For instance, if only one prevention or mitigation control is identified for a source, this control will be critical and therefore needs to be of appropriate adequacy and/or supported by other controls. Also, low control levels assigned during the risk analysis may indicate weaknesses and a need for greater attention and improvement.

The risk evaluation needs to consider whether any control implementation or improvement opportunity would shift the risk rating, hence indicating key areas and options for risk treatment. For this, assuming that the control implementation or improvement has been completed and satisfies the adequacy requirements, each risk is re-assigned qualitative consequence and likelihood ratings to determine the level of residual risk (assuming control opportunities are implemented). This hypothetical residual risk rating is recorded in the risk register.

### 6.3.4 Decision Point

At this stage, the workshop will have generated a comprehensive risk register, which has undergone scrutiny during the analysis, and review during the evaluation. The Decision Point concludes the risk evaluation stage and a decision is made as to what further action might need to be taken for each risk.

The Decision Point is to decide whether further analysis is required. In deciding, the following need to be taken into consideration:

- external factors that may affect the assessment which could have been included
- the level of uncertainty as assessed by the confidence rating.

Further analysis should be considered if it will increase the confidence in the risk assessment and result in a different decision being made.

#### TIP

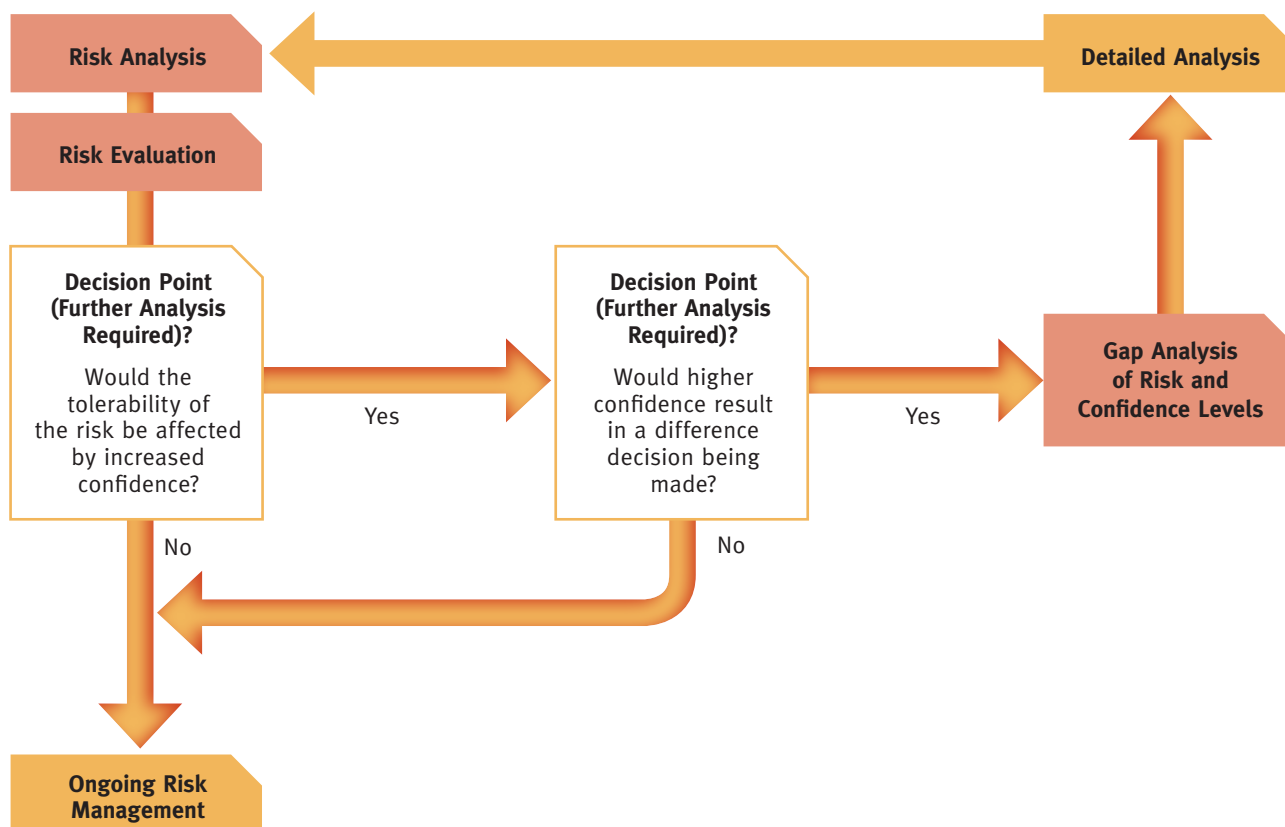
At the decision point, the facilitator will need to address any comments captured during the process, because they might influence the decision. Also, the facilitator may need to determine whether further workshopping is required to supplement this base-line assessment (e.g. by use of a different, more suitable suite of information).

#### TIP

After a risk has been determined as being tolerable subject to ALARP, the risk study team needs to examine whether the risk is in fact ALARP. This is done by determining whether control opportunities can reduce the risk. For this, the implementation or improvement of controls is assumed and the risk is re-rated according to the process for risk analysis. The residual risk is then recorded in the risk register. If the rating is reduced, clearly these risks are not ALARP and must move through to risk treatment. If, however, the re-rating shows no change in risk level, these risks can be considered ALARP and are therefore only subject to ongoing monitoring and review.



The flowchart below demonstrates how to determine whether further analysis is required.



The outcome of this is the allocation of each evaluated risk to one of the following groups:

- **Risks requiring further analysis and subsequent re-evaluation**

The rationale for placing risks in this group will guide the purpose and desired outputs of the analysis. For these risks, the risk assessment continues in the form of a revised base-line assessment or a detailed analysis.

- **Risks requiring (immediate) treatment with certainty about the treatment measure**

A summary of the risk evaluation, that is, information contained in the risk register, will provide guidance about key areas and options for risk treatment. For these risks, the risk assessment is completed, because they will be treated and subject to monitoring and review during the ongoing risk management process.

- **Risks (currently) requiring neither further analysis nor treatment**

For these risks, the risk assessment is complete. They will be subject to monitoring and review during the ongoing risk management process.

### 6.3.5 Risk Register

At this stage the risk study team will have generated a complete risk register (refer to the following example risk register).

## Example of Risk Register (Risk Evaluation)

### Risk Statement:

*There is the potential that a storm surge resulting from an East Coast Low will cause floods to low-lying development including an aged-care facility, which in turn will cause impact on the inhabitants.*

### Further Actions:

*As implementing reasonably practicable control opportunities can reduce the risk level, both major and moderate consequence risks (Risk IDs 3.1 and 3.2) are currently not ALARP.*

### NERAG RISK REGISTER

#### Date:

#### Objective:

Conduct an assessment of the risks to the community from an East Coast Low in order to direct and prioritise the community's emergency management through prevention, preparedness, response and recovery.

#### Scope:

The assessment will address the risks of a storm surge, associated with an East Coast Low, to the local community and consider possible impacts to people and infrastructure in the municipality. Storm surges to be considered are 1:100 year and 1:500 year events.

#### Risk Evaluation

Risk No.	Tolerability	Treatment Strategies	Residual Consequence	Residual Likelihood	Residual Risk	Further Action
3.1	Tolerable subject to ALARP	Design and install Levee Banks Improved Evacuation Plans for aged care facility Training for Emergency Services in evacuation of aged community	Major	Rare	Medium	Treatment required, no further analysis
3.2	Tolerable subject to ALARP	Design and install Levee Banks Improved Evacuation Plans for aged care facility Training for Emergency Services in evacuation of aged community	Moderate	Rare	Low	Treatment required, no further analysis
3.3	Acceptable					No further treatment or analysis required



## 6.4 Detailed Analysis for Risk Assessment

AS/NZS ISO 31000:2009 points out that “in some circumstances, the risk evaluation may lead to a decision to undertake further analysis” and this is reflected in the two-stage approach adopted by the NERAG. Following a qualitative base-line (screening) assessment, a more detailed (e.g. quantitative) analysis of different complexity levels may be conducted, if required. The decision about the need for such analysis will be made at the decision point during risk evaluation.

A rigorous base-line assessment will often be sufficient to identify, analyse, evaluate and treat risks. However, some risks may require more detailed analysis before the need for treatment, or the nature of appropriate treatment measures, can be determined. While qualitative methods cannot generally be excluded for detailed analysis, it is more likely that semi-quantitative or quantitative methods would be used at this stage. However, time and effort expended in detailed analysis is time and effort diverted from treating the risk and will sometimes result in the same decisions. Detailed analysis should focus on risks, for which the initial qualitative analysis does not provide sufficient information for a reasonable decision to be made on the level of risk or the efficacy of proposed treatment strategies.

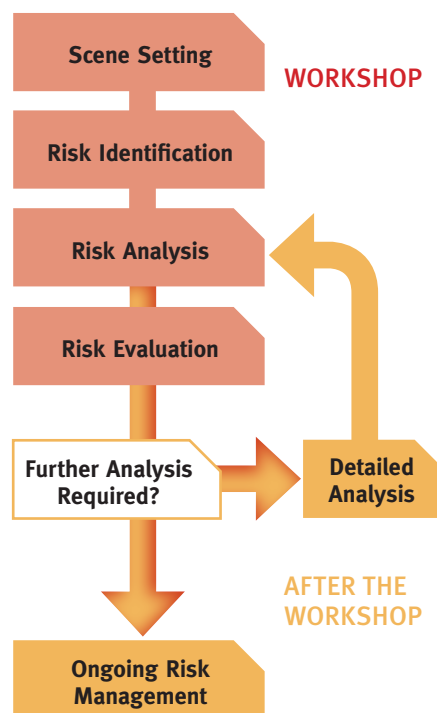
### Planning a Detailed Analysis

For the purposes of the NERAG, it is critical that the risk assessment provides measurable and consistent information on risk. Therefore, in planning to conduct a detailed analysis for one or more particular risks, the risk study team will need to conduct a gap analysis to highlight those areas deficient in the base-line assessment and to identify the desired outputs of the detailed analysis.

In general, the outputs required from a detailed risk analysis need to offer sufficient information to allow the risk study team to make informed decisions that enable realistic treatment options to be developed.

In planning a detailed analysis, risk study teams should also consider whether the analysis can provide outputs that support risk treatment implementation. Given their common use in decision making and in instruments that provide strategic risk treatments (e.g. regulation or land use planning schemes) for different hazards, outputs that could be considered include:

- mapping of geospatial information on the hazard for various magnitude events
- life loss risk for the person most at risk
- asset loss risk in terms of average annualised damage
- absolute probable loss from the most severe credible consequence.



### Examples of gap analysis for detailed risk assessment

Low confidence in the risks from storm surge is due to uncertainty in the physical size (or magnitude) of a 1% (1:100) event: *Undertake detailed analysis of the temporal distribution of storm surges.*

Low confidence in the risks from storm surge is due to uncertainty in where the flooding will occur: *Undertake detailed analysis on the spatial distribution of storm surges.*

Low confidence in the risk of storm surge is due to uncertainty in vulnerability of communities to a given-size flood: *Undertake vulnerability analysis of the local communities.*

## Example – outputs from detailed analyses which support both risk assessment and treatment implementation

### Geospatial mapping of hazards

Many planning authorities throughout Australia consider the annual exceedance probability of a hazardous event occurring with respect to design life and characteristics of a development, to make decisions on land use without appealing directly to acceptable or tolerable thresholds. For example, the New South Wales Planning Circular PS 07-003 (2007) recommends only 1% AEP flood events be considered with margin for a 0.5 m freeboard in planning.

New Zealand has guidelines which codify this approach for landslide hazards. Under the *Guidelines for Assessing Planning Policy and Consent Requirements for Landslide Prone Land (2006)*, New Zealand assigns differing annual exceedance probabilities for events that are likely to cause structural failure across five classes of development. This guides mapping efforts in risk studies.

### Life loss

In making decisions on particular developments in high risk areas, quantification of life loss risk can support decision making. For example, the Australian Geo-Mechanics Society (AGS) *Guidelines for Landslide Risk Management (2007)* sets a tolerable threshold of life loss risk at  $1 \times 10^{-5}$  per annum for life loss for the person most at risk for development on new slopes, and a tolerable threshold for development on existing slopes (i.e. infill) at  $1 \times 10^{-4}$ . These thresholds have been adopted by many planning authorities as thresholds for life loss risk from geotechnical hazards.

### Economic loss and casualties

Economic loss is often measured and reported using Average Annualised Damage as a common currency for comparability. This measure has its limitations and the ratio of maximum probable loss to average annualised loss is also an important indicator for comparing risks. More important are absolute loss estimates, such as expected damage and casualties at defined extreme events e.g. 1:500 design events. This approach is commonly used in the context of building codes, along with the measures of average annualised damage and casualties.

**Table 9 Selected Techniques for Detailed Analysis on Hazards**

Type of Analysis	Technique	Characteristics
Inventory	Hazard distribution analysis	Analyses distribution and classification of hazards. Useful methodology for landslide risks among others.
	Hazard activity analysis	Analyses temporal changes in hazard patterns.
	Hazard density analysis	Calculates hazard density in terrain units or as isopleth map. Maps density of hazards such as cyclone, earthquake, and landslide over particular areas.
Heuristic	Hazard precursor analysis	Uses in-field expert opinion in zonation. The precursor event is measured through the conditional probability that the actual event would result (also known as event tree analysis).
	Qualitative map combination	Uses expert based weighting values of parameter maps. Useful for landslide risks.
Statistical	Bivariate statistical analysis	Calculates importance of two contributing factors in combination.
	Multivariate statistical analysis	Calculates prediction formula from a data matrix. Useful for landslide, flood, earthquake and can analyse effects on people, infrastructure, etc. from the resulting event.
	Probabilistic (magnitude/ frequency analysis)	Calculates prediction from inventory and time period.
Deterministic	Safety factor analysis	Applies relevant precursor and initiation models.



For detailed analysis of life loss and property impacts there are a number of methodologies and approaches which may be applied. For example, *AS/NZS ISO 13824:2009 Bases for design of structures – General principles on risk assessment of systems involving structures* provides a general framework and procedures for identifying hazards and estimating, evaluating and treating risks of structures and systems involving structures. Methodologies are also presented for risk optimisation analysis, which take account of fatalities and economic loss models, hazard and vulnerability estimates as well as costs for prevention/mitigation.

For some hazards and impact categories, specific methodologies have been developed to support detailed analysis. For example, the 2002 Commonwealth Government publication, *Environmental Health Risk: Guidelines for assessing human health risks from environmental hazards*, provides specific approaches and tools for considering environmental and population health risks.<sup>9</sup>

Due to the specialist knowledge usually required for detailed analysis, contact with external consultants and exchanges of information and cooperation with relevant third parties should be considered at

this stage. These exchanges aim to assemble and analyse additional information on hazards, exposure, controls and consequences leading to a more objective appraisal of risks, a reduction in subjective input and an improved capability to evaluate risks. Involving external personnel extends the skills base of the stakeholders and may provide new insights into risk.

Providers for conducting detailed analysis may come from a number of different areas:

- small niche/specialist providers
- large multi-discipline providers
- academic/research institutes
- specialist government agencies.

### **Re-Analysis and Re-Evaluation**

The results from the detailed analysis feed back iteratively into the base-line risk assessment. After considering outputs from the detailed analysis, the risk study team needs to finalise the assessment of the relevant risk(s) by re-analysing them in line with the standardised NERAG risk criteria. The re-evaluation of the risk(s) should include specialists in detailed analysis to compare the results with the earlier risk assessment.

Re-analysis and re-evaluation of the risk(s) must be recorded in the risk register.



<sup>9</sup> DOHA, 2002, *Environmental Health Risk: Guidelines for assessing human health risks from environmental hazards*, Department of Health and Ageing, available from <http://www.health.gov.au>.

# 7. Treat Risks

## 7.1 Risk Treatment Process

Risk treatment is “...the process to modify risk” (AS/NZS ISO 31000:2009). Risk treatment aims to determine and implement the most appropriate action(s) in response to the identified need to treat risks. Once implemented, risk treatments provide for the controls.

In order to ensure that the causes of the risks, rather than just the symptoms, are treated, a comprehensive understanding of the risks, on one hand, and the efficiency and effectiveness of the treatment measure on the other, is required. Hence, information gathered and considered during the risk assessment process will have implications for risk treatment.

In general, a four-step process, outlined below, is used for risk treatment.

### 1. Formulating risk treatment objectives for identified risk treatment needs.

Refer to the risk assessment, namely:

- scenario dynamics as represented in the bow-tie diagram
- control opportunities (implementation or improvement) considered during risk analysis and risk evaluation
- categorisation of risks during the risk evaluation.

### 2. Identifying, developing and designing options for risk treatment.

This process is based on a review of underlying factors that influence treatment effectiveness.

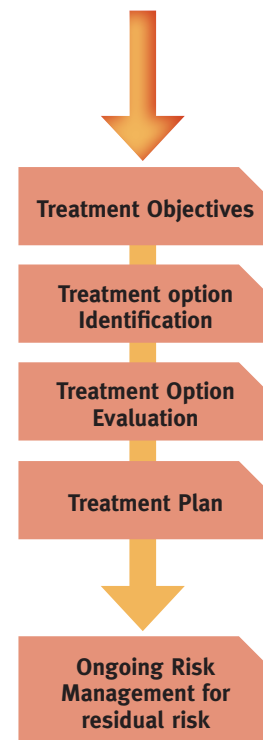
Risk treatment options could include one or more of:

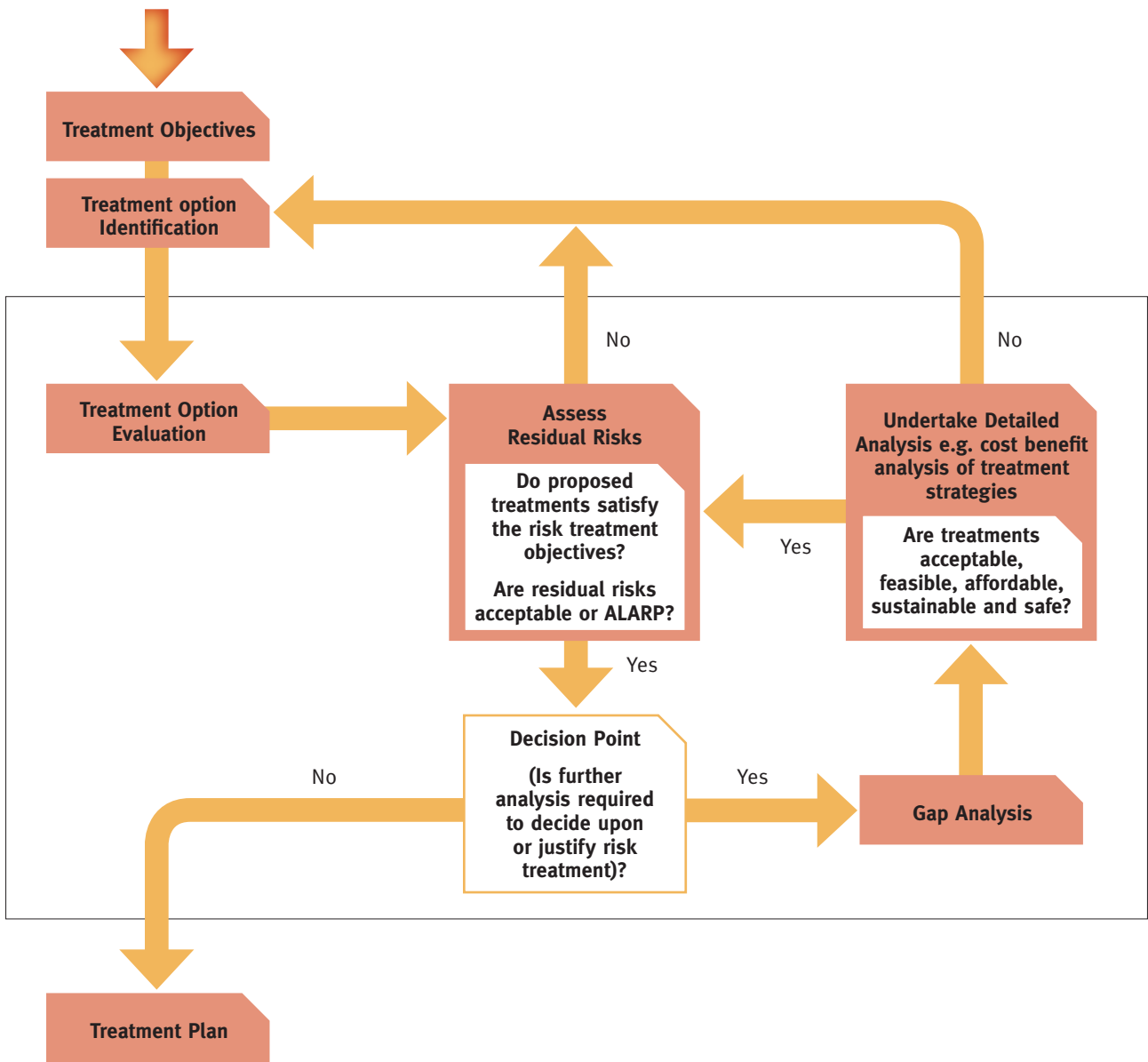
- avoidance of the risk
- removing a risk source
- changing the likelihood of:
  - an initiating event or source of risk occurring
  - a hazard impacting on elements at risk
  - consequences occurring should a source of risk cause a hazard to impact on elements at risk
- sharing the risk
- retaining the risk by informed decision.

### 3. Evaluation of risk treatment options. This is based on:

- first-pass cost-benefit analysis
- treatment effectiveness
- revisiting and/or extending risk analysis
- acceptance of residual risks.

In general, the selection of treatment options will be based on the trade-off between the level of risk and the cost of reducing the risk, using a variety of tools and subsequent sensitivity tests. Where the treatment options are expensive, difficult or lengthy to implement or not popular with the local community, further detailed analysis of treatment options to achieve the desired modification of risk should be considered.







4. **Developing the risk treatment plan and acceptance of residual risks.** The purpose of the treatment plan is to document how the chosen options will be implemented. The treatment plan should include:

- details on why particular treatments were selected
- anticipated benefits from treatment actions
- the proposed actions
- resource requirements
- responsibilities
- timing and schedule
- performance measures
- reporting and monitoring requirements.

An important and discrete step in this process is to assign responsibility for risk treatment actions. This may require direct bilateral consultation and negotiation between responsible entities. The criteria in Appendix B may prove useful when developing a risk treatment plan.

The risk treatment process is described in detail in *AS/NZS ISO 31000:2009* and Standards Australia Handbook *HB 436:2004*.

## 7.2 Further Analysis for Risk Treatment

In planning a further analysis for risk treatment, the risk owners will generally need to conduct a gap analysis to highlight deficiencies in information upon which to make a decision. This is particularly the case when treatment options have economic, financial, project or political implications.

### Example of gap analysis for risk treatment

Cost of building levee banks to protect all communities is grossly disproportionate to the risk benefit achieved: *undertake control efficiency assessment of the benefits of levee banks and undertake a cost-benefit analysis to prioritise locations for levee construction.*

The intent of detailed analysis is to support decision making and to ensure that the benefit to the community outweighs the costs (this is a fundamental principle). Treatment of the risk should also be proportional to that risk. A sensitivity check on selected options will also identify the most effective treatments and provide a degree of confidence in treatment decisions.

For government agencies, there will be state and national requirements that will influence the development of a planned detailed analysis of risk treatment options. For example, if strategic treatment options are proposed (such as regulation) there are nationally agreed approaches, endorsed by COAG, for evaluating regulatory courses of action.<sup>10</sup>

A number of quantitative approaches exist to assist in detailed analysis of risk treatment options including:

- regulatory impact assessments
- cost-benefit analysis
- measuring business compliance costs
- assessing effects on competition.

Detailed advice on these quantitative approaches (risk analysis, measurement of business compliance costs and assessment of competition effects) is included in the appendices to the *COAG Best Practice Regulation* guide, which is available from <http://www.coag.gov.au>.

<sup>10</sup> COAG, 2007, *Council of Australian Governments – Best Practice Regulation – A Guide for Ministerial Councils and National Standard Setting Bodies*, Council of Australian Governments, available from [http://www.coag.gov.au/ministerial\\_councils/](http://www.coag.gov.au/ministerial_councils/).

## **Appendices:**

**Appendix A** Describing Your Environment

**Appendix B** Some Criteria for Assessing Risk Treatment Options

**Appendix C** Glossary of Terms

**Appendix D** Worked Example



## Appendix A – Describing Your Environment

Describing Your Environment	
Geography	The physical environment and location of your community within the state or territory. Include boundaries, major geographic features, vegetation cover, general land use patterns and proximity to hazards. Geoscience Australia has data that may assist in this.
Climate and Weather	Describe the climate and seasonal weather patterns in your area. You may find it useful to access resources such as Bureau of Meteorology, but the importance of local knowledge cannot be overstated. Some relevant situations to address are flood, storm-tide levels.
Population	Population statistics, including distribution and growth, general demographics; cultural, religious, and language considerations; socioeconomic status; mobility. Australian Bureau of Statistics is a good source of information.
Community Capacity	Description of the community's capacity (human and physical) to contribute to the prevention of disasters, such as volunteer brigade, level of experience in dealing with disasters (frequency and magnitude).
Industry	Description of main industry or predominant industry type, and the facilities associated with each industry.
Public Buildings, Spaces & Events	Identify any public locations where people gather, including shopping centres, parks, libraries, sporting complexes, educational facilities. Also describe any recurring or planned inaugural events. Geoscience Australia maintains a national exposure database which may provide additional detail.
Critical Infrastructure	Identify locations of health (hospitals) and emergency services (fire, ambulance, and police), government buildings and facilities, major roads, rail, airports.
Essential Services	Electricity, water, gas supply, sewerage, telecommunications.
Hazardous Sites	Identify sites that produce or store hazardous materials that by content and/or location have potential to be a risk to the community.

Reproduced from *Queensland Disaster Management Planning Guidelines 2005* (Queensland Government, Department of Emergency Services).

## Appendix B – Some Criteria for Assessing Risk Treatment Options

Criteria	Questions
Cost	Is this option affordable? Is it the most cost effective?
Timing	Will the beneficial effects of this option be quickly realised?
Leverage	Will the application of this option lead to further risk-reducing actions by others?
Administrative efficiency	Can this option be easily administered or will its application be neglected because of difficulty of administration or lack of expertise?
Continuity of effects	Will the effects of the application of this option be continuous or merely short term?
Jurisdictional authority	Does this level of government have the legislative authority to apply this option? If not, can higher levels be encouraged to do so?
Effects on the economy	What will be the economic impacts of this option?
Effects on the environment	What will be the environmental impacts of this option?
Risk creation	Will this option itself introduce new risks?
Equity	Do those responsible for creating the risk pay for its reduction? When the risk is not man-made, is the cost fairly distributed?
Risk reduction potential	What proportion of the losses due to this risk will this option prevent?
Political acceptability	Is this option likely to be endorsed by relevant governments?
Public and pressure group reaction	Are there likely to be adverse reactions to implementation of this option?
Individual freedom	Does this option deny basic rights?

Reproduced from *Emergency Risk Management Applications Guide, Manual 5* (Emergency Management Australia, 2004).

## Appendix C – Glossary of Terms

<b>ALARP</b>	As Low As Reasonably Practicable.
<b>Community</b>	A group of people with a commonality of association and generally defined by location, shared experience or function.
<b>Consequence</b>	Outcome of an event affecting objectives.
<b>Control</b>	Measure that is modifying risk. This may be an existing process, policy, device, practice or other action that acts to minimise negative risk or enhance positive opportunities. The word “control” may also be applied to a process designed to provide reasonable assurance regarding the achievement of objectives.
<b>Control (adequacy) assessment</b>	Systematic review of processes to ensure that controls are still effective and appropriate.
<b>Elements at risk</b>	The population, buildings and civil engineering works, economic activities, public services and infrastructure etc. exposed to sources of risk.
<b>Emergency</b>	An event, actual or imminent, which endangers or threatens to endanger life, property or the environment, and which requires a significant and coordinated response.
<b>Event</b>	Occurrence or change of a particular set of circumstances.
<b>Frequency</b>	A measure of the number of occurrences per unit of time.
<b>Hazard</b>	Source of potential harm.
<b>Impact</b>	See “consequence”.
<b>Likelihood</b>	Chance of something happening. It is used as a general description of probability and may be expressed qualitatively or quantitatively.
<b>Loss</b>	Any negative consequence or adverse effect, financial or otherwise.
<b>Mitigation</b>	Measures taken in advance of a disaster aimed at decreasing or eliminating its impact on society and environment.
<b>Monitor</b>	Continual checking, supervising, critically observing or determining the status to identify change from the performance level required or expected. Monitoring is often applied to residual risks, controls, the risk management framework or risk management processes.
<b>Organisation</b>	Group of people and facilities with an arrangement of responsibilities, authorities and relationships.
<b>Preparedness</b>	Arrangements to ensure that, should an emergency occur, all those resources and services which are needed to cope with the effects can be efficiently mobilised and deployed.
<b>Prevention</b>	Regulatory and physical measures to ensure that emergencies are prevented, or their effects mitigated.
<b>Probability</b>	A measure of the chance of occurrence expressed as a number between 0 and 1. “Frequency” or “likelihood” rather than “probability” may be used in describing risk.
<b>Recovery</b>	The coordinated process of supporting emergency-affected communities in the reconstruction of the physical infrastructure and restoration of emotional, social, economic and physical wellbeing.
<b>Residual Risk</b>	Risk remaining after risk treatment. Following implementation of risk treatment, residual risk can also be referred to as retained risk.
<b>Resilience</b>	The capacity of a system, community or society, potentially exposed to hazards, to adapt by resisting or changing, in order to reach and maintain an acceptable level of functioning and structure. This is determined by the degree to which the social system is capable of organising itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures. <sup>11</sup>
<b>Response</b>	Actions taken in anticipation of, during, and immediately after, an emergency to ensure its effects are minimised and that people affected are given immediate relief and support.
<b>Risk</b>	The effect of uncertainty on objectives. For emergency risk assessments the effect is usually a negative deviation from the expected and is characterised by hazardous events and the likelihoods of particular consequences.

<sup>11</sup> UN/ISDR, Geneva 2004.

<b>Risk Analysis</b>	Process to understand the nature of risk and to determine the level of risk.
<b>Risk Assessment</b>	The overall process of risk identification, risk analysis and risk evaluation.
<b>Risk Criteria</b>	Terms of reference against which the significance of risk is evaluated.
<b>Risk Evaluation</b>	Process of comparing the results of risk analysis with risk criteria to determine whether the risk and/or its magnitude are/is acceptable or tolerable.
<b>Risk Identification</b>	The process of finding, recognising and describing risks.
<b>Risk Management</b>	Coordinated activities to direct and control a community or organisation with regard to risk.
<b>Risk Management Process</b>	The systematic application of management of policies, procedures and practices to the tasks of communicating, consulting, establishing the context, and identifying, analysing, evaluating, treating, monitoring and reviewing risk.
<b>Risk Reduction</b>	Actions taken to lessen the likelihood, negative consequences, or both, associated with a risk.
<b>Risk Register</b>	A list of risk statements describing sources of risk and elements at risk with assigned consequences, likelihoods and levels of risk.
<b>Risk Treatment</b>	Process of selection and implementation of measures to modify risk. The term “risk treatment” is sometimes used for the measures themselves.
<b>Source of Risk</b>	An element which alone or in combination has the intrinsic potential to give rise to risk.
<b>Stakeholders</b>	Those people and organisations that can affect, be affected by, or perceive themselves to be affected by a decision or activity.
<b>Susceptibility</b>	The potential to be affected by loss.
<b>Vulnerability</b>	The conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards. <sup>12</sup>

<sup>12</sup> UN/ISDR, Geneva 2004.

## Appendix D – Worked Example

### 1. Context of the Risk Study

**Objective:**

*Conduct an assessment of the risks to the community from an East Coast Low in order to direct and prioritise the community's emergency management efforts through prevention, preparedness, response and recovery activities.*

**Scope:**

*The assessment will address the risks of a storm surge, associated with an East Coast Low, to the local community and consider possible impacts to people and infrastructure in the municipality. Storm surges to be considered are 1:100-year and 1:500-year events.*

**Stakeholders:**

*Local Fire Authority, Local Police, Council Representatives (including finance, engineering), Volunteer Emergency Workers, Health Department Representatives, Members of the relevant Business Community, Representatives from the Bureau of Meteorology, Water Authority*

**Risk Criteria:**

*NERAG consequence/likelihood tables, risk matrix and evaluation matrices*

**Key Elements:**

Source:

*Storm surge – breaking levee banks, dam failure*

Impacts:

*Damage to infrastructure, including sewage treatment plant, railway line*

*Impacts on people, including potential loss of life and displacement*

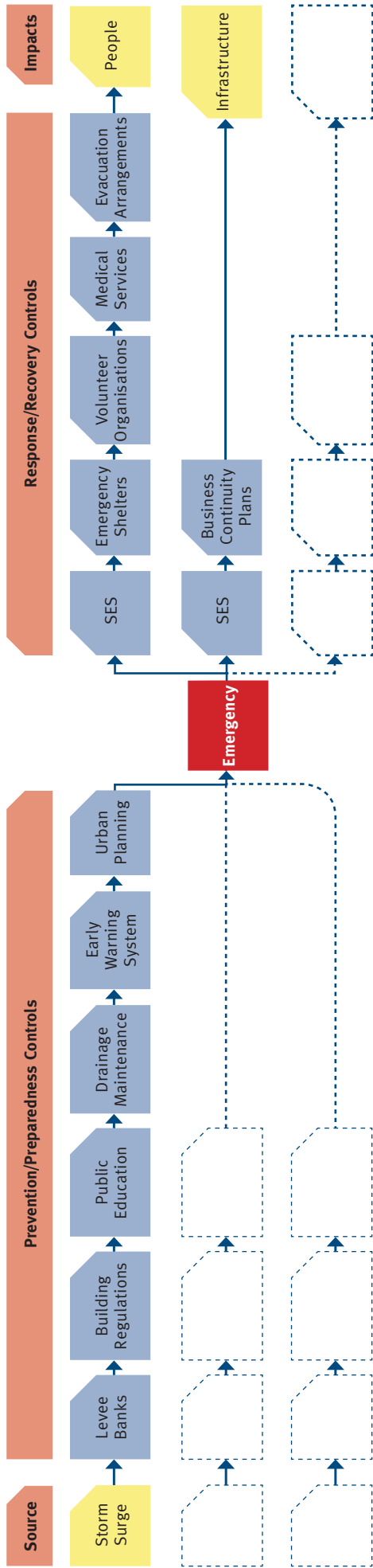
Vulnerable communities:

*Low-lying development, including aged-care facility without flood protection*

**Justification:**

*It was resolved to consider an East Coast Low because we have a history over the last 200 years of significant impacts along the north coast of the region. The focus on 1:100- and 1:500-year events will allow us to consider the appropriateness of our measures. We limited the sources of risk to storm surge as historical events have repeatedly flooded significant parts of our community. Given the existing settlements and infrastructure, the focus of the risk study is on impacts on people and infrastructure.*

## 2. Bow-Tie Diagram



## 3. Consequence and Likelihood Rating

### Examples of Credible Consequence Levels

*There is the potential that a storm surge resulting from an East Coast Low will cause floods in the coastal areas of the community, which in turn will cause failure of significant infrastructure and service delivery.*

Credible consequence levels:

*Infrastructure: Catastrophic – Long-term failure of significant infrastructure*  
*Infrastructure: Moderate – Mid-term failure of service delivery affecting some parts of the community*

*There is the potential that a storm surge resulting from an East Coast Low will cause floods to low-lying development including an aged-care facility, which in turn will cause impact on the inhabitants.*

Credible consequence levels:

*People: Major – Multiple loss of life*  
*People: Moderate – Isolated cases of loss of life*  
*People: Minor – Isolated cases of serious injuries*

### Example of Likelihood Rating

*The likelihood rating for the risk of multiple loss of life in low-lying developments including an aged care facility:*

*Occurrence of an emergency event:*

*Occurrence of a 1:100 year storm surge from an East Coast Low Likelihood rating “possible”*

*Spatial information:*

*Regional impact forecasts of an East Coast Low correlate with the area being considered Likelihood rating is not reduced: “possible”*

*Adequacy of the existing controls:*

*The PP/RR controls for loss of life were mostly rated as being level 2 and the risk study team felt the controls would have some effect in preventing a major consequence Likelihood rating is reduced to “unlikely”*

*Likelihood level:*

*The likelihood rating for the risk of multiple loss of life in low-lying developments including an aged-care facility was determined as “unlikely”.*

## 4. Risk Register

### NERAG RISK REGISTER

Date: XX XXX XXXX Assessment Team:

#### Objective:

Conduct an assessment of the risks to the community from an East Coast Low in order to direct and prioritise the community's emergency management through prevention, preparedness, response and recovery.

#### Scope:

The assessment will address the risks of a storm surge, associated with an East Coast Low, to the local community and consider possible impacts to people and infrastructure in the municipality. Storm surges to be considered are 1:100-year and 1:500-year events

#### Risks:

Risk Identification						Risk Analysis						Risk Evaluation							
Risk No.	Risk Statement	Source	Impact Category	Prevention / Preparedness Controls	Recovery / Response Controls	Risk No.	Level of Existing PP Controls	Level of Existing RR Controls	Consequence	Likelihood	Risk	Confidence Level	Risk No.	Tolerability	Treatment Strategies	Residual Consequence	Residual Likelihood	Residual Risk	Further Action
1	There is the potential that a storm surge resulting from an East Coast Low will cause floods in the coastal areas of the community, which in turn will cause failure of significant infrastructure and service delivery.	Storm Surge	Infrastructure	Levee Banks Building Regulations Drainage Maintenance Urban Planning	SES Business Continuity Plans														
2	There is the potential that a storm surge resulting from an East Coast Low will cause floods in the coastal areas of the community, which in turn will cause impact on the inhabitants.	Storm Surge	People	Levee Banks Building Regulations Public Education Drainage Maintenance Early Warning System Urban Planning	SES Emergency Shelters Volunteer Organisations Medical Services														
3	There is the potential that a storm surge resulting from an East Coast Low will cause floods to low-lying development including an aged-care facility, which in turn will cause impact on the inhabitants.	Storm Surge	People	Building Regulations Public Education Drainage Maintenance Early Warning System	SES Emergency Shelters Volunteer Organisations Medical Services Evacuation Arrangements	3.1	Building Regulations 2 Public Education 1 Drainage Maintenance 2 Early Warning System 2	SES 2 Emergency Shelters NA Volunteer Organisations 1 Medical Services 3 Evacuation Arrangements 2	Major	Unlikely	Medium	Moderate	3.1	Tolerable subject to ALARP	Design and install Levee Banks Improved Evacuation Plans for aged-care facility Training for Emergency Services in evacuation of aged community	Major	Rare	Medium	Treatment required, no further analysis
						3.2	Building Regulations 2 Public Education 1 Drainage Maintenance 3 Early Warning System 2	SES 2 Emergency Shelters 2 Volunteer Organisations 1 Medical Services 3 Evacuation Arrangements 2	Moderate	Possible	Medium	High	3.2	Tolerable subject to ALARP	Design and install Levee Banks Improved Evacuation Plans for aged-care facility Training for Emergency Services in evacuation of aged community	Moderate	Rare	Low	Treatment required, no further analysis
						3.3	Building Regulations 2 Public Education 1 Drainage Maintenance 3 Early Warning System 2	SES 2 Emergency Shelters 2 Volunteer Organisations 1 Medical Services 3 Evacuation Arrangements 2	Minor	Possible	Low	High	3.3	Acceptable				No further treatment or analysis required	



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