RISK MANAGEMENT FRAMEWORK FOR WATER PLANNING AND MANAGEMENT

Government of South Australia
Department of Environment,
Water and Natural Resources

CONTENTS

DEPARTMENT OF ENVIRONMENT, WATER AND NATURAL RESOURCES

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1 INTRODUCTION 5

1.1 Purpose and scope 5
1.2 Context 6
1.3 Objectives 6

2 RISK MANAGEMENT FRAMEWORK 9

2.1 Standard Guidelines 9
2.1.1 Principles 9
2.1.2 Risk management process 9

3 COMMUNICATION AND CONSULTATION 11

3.1 Internal communication 11
3.2 External consultation and community engagement 11

4 MONITORING AND EVALUATION 12

4.1 Monitoring and evaluation of the risk management process 12
4.2 Linkages with MERI frameworks 12

5 ESTABLISHING THE CONTEXT 14

5.1 Internal context 15
5.2 External context 15
5.3 The need for a risk assessment and its objectives 16
5.4 Risk criteria 17
5.4.1 Risk categories 17
5.4.2 Risk assessment methods 17

6 RISK ASSESSMENT 19

6.1 Risk Identification 19
6.2 Risk Analysis 20
6.2.1 Controls analysis (assessing the effectiveness of current controls) 20
6.2.2 Confidence in the results of a risk assessment 21
6.3 Risk evaluation 22

7 RISK TREATMENT 24

8 OUTCOMES AND REVIEW 25

8.1 Outcomes hierarchy for the Framework 25
8.2 Review of the Framework 25

9 GLOSSARY 26
10 REFERENCES 28
APPENDIX 1: RISK ASSESSMENT AND TREATMENT SELECTION TOOLS 30
Risk Identification tools 30
Risk Analysis Tools 30
Risk Evaluation/Treatment Tools 33

1 INTRODUCTION

1.1 Purpose and scope

This Risk Management Framework for Water Planning and Management (the Framework) is a high-level document which sets out the general context and process for risk assessments in the area of water planning and management in South Australia. This includes risk assessments at all planning scales and for both prescribed and non-prescribed resources. It covers management activities such as scientific investigations, monitoring, implementation and compliance.

Further work and resources are required to apply the Framework in the areas where risk management is required. The approach recommended is non-prescriptive and sensitive to different resourcing and knowledge levels. The Risk Management Policy and Guidelines for Water Allocation Plans (the Policy and Guidelines) provides an example of how the Framework has been used to develop a tailored approach to risk management as it applies to water allocation planning.

The Framework focuses on risks to natural resources, to community values and to the effective operation of management actions. It does not address generic project risks associated with budgets, timelines, skill shortages or risks to an organisation. Such risks are addressed through corporate risk management frameworks.

Figure 1 below illustrates the intended purpose and scope of the Framework. Similar to the example of a corporate risk management framework illustrated, the Framework needs to be applied through the development of policies, guidelines and/or processes for specific water planning and management activities. For example, the Policy and Guidelines is used and tested when undertaking individual risk assessments for water allocation plans.

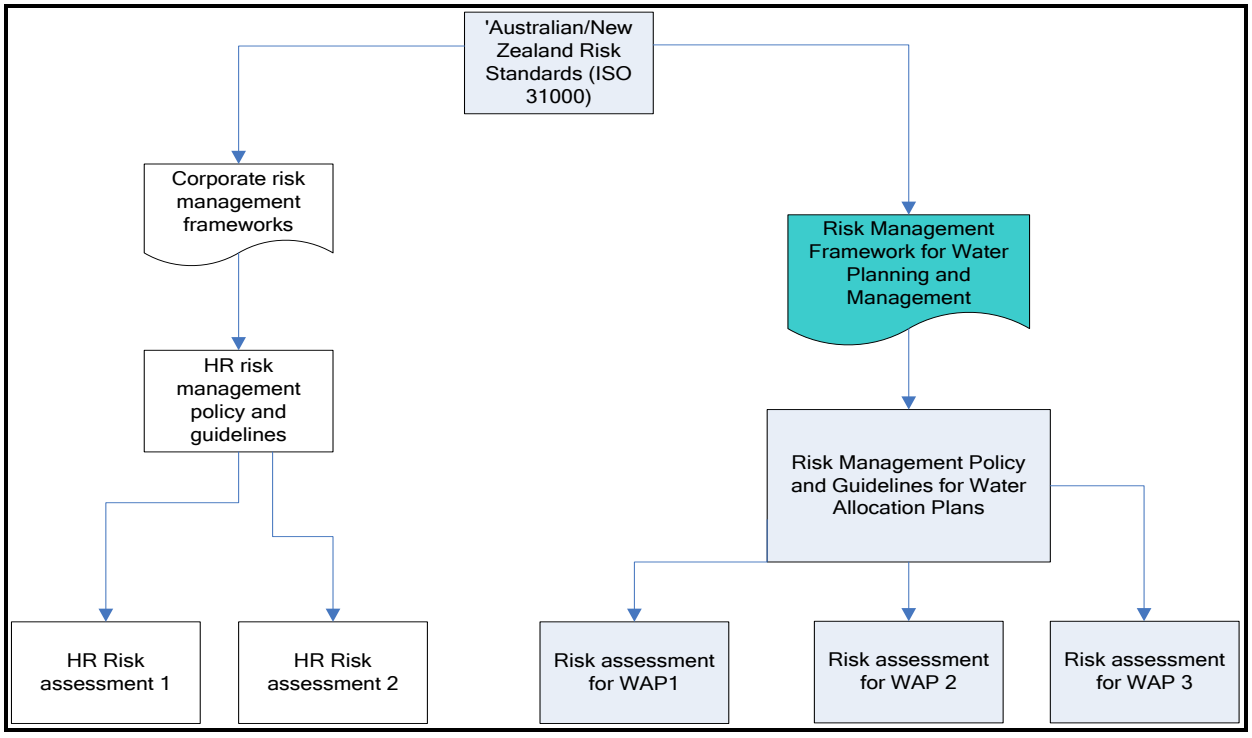


Figure 1. Purpose and scope of the Framework

1.2 Context

In water planning, risk management provides a useful tool for assessing risks to natural resources, to community values and to management objectives. Ultimately water planning in South Australia aims to ensure that there are always sufficient and sustainable water resources for our health, our economy, our environment and our lifestyle. Risk assessment aims to facilitate informed decision making for sustainable outcomes.

Currently, there are a range of drivers that support or require a risk approach to water planning and management in South Australia (see Table 1). At the national level the principal water policy agreement is the 2004 National Water Initiative (NWI), which is Australia's blueprint for water reform. The NWI is a key driver for the development of water management policy and practices including risk in South Australia.

In addition the *Water Act 2007* (Cwth) requires the identification of the risks to the condition, or continued availability, of the Murray-Darling Basin (the Basin) water resources. The risks dealt with must include the risks to the availability of the Basin water resources that arise from the following:

(a) the taking and use of water (including through interception activities)
(b) the effects of climate change
(c) changes to land use
(d) the limitations on the state of knowledge on the basis of which estimates about matters relating to the Basin water resources are made.

At the state-planning level, the State NRM Plan 2012-2017 introduces the NRM Standard to support better decision-making. The NRM Standard includes risk management as one of the seven principles for effective, high quality NRM practice. Regional-level NRM plans must be consistent with the State NRM Plan (Section 75(4)) and must therefore address risks to the natural resources of the region.

The *Natural Resources Management Act 2004* (NRM Act) also requires that Regional NRM Boards prepare water allocation plans for each of the prescribed water resources in their region (Section 76(1)). The NRM Act does not explicitly require a risk assessment within water allocation plans, however many of the requirements in Section 76 can be supported through a risk-based approach. This is explored further in the Policy and Guidelines.

As part of the Department of Environment, Water and Natural Resources (DEWNR) commitment to water planning and management reform, risk management and risk-based approaches are considered key elements to achieve improvements in the efficiency and effectiveness of water planning and management activities.

1.3 Objectives

The objectives of this Framework are to develop an integrated risk management approach for water planning and management that:

1. Provides a common language for risk management and fosters collaboration across water planners and managers within South Australia to incorporate the best available science and policy initiatives into water plans

2. Supports current water planning and management reform objectives in South Australia
3. Informs and shapes national water planning and management techniques for risk management
4. Provides a broad framework that is usable for the incorporation of risk principles and techniques into water planning and management.

Table 1: Drivers for Risk Management

Legislation/national & international agreements	Strategic plans	Regional/medium-term plans	Operational arrangements/Monitoring projects
- *Water Act 2007* - *Natural Resources Management Act 2004* - Ramsar Convention - Biodiversity Convention - Intergovernmental Agreements (e.g. National Water Initiative, Lake Eyre Basin, Border Groundwaters Agreement) - *Environment Protection and Biodiversity Conservation Act 1999*	- South Australia's Strategic Plan - Water for Good - Murray-Darling Basin Plan - State NRM Plan - Regional Demand and Supply Statements - The South Australian Planning Strategy	- Regional NRM Plans - Water Allocation Plans - Development plan/regulations - Regional development plans - Land and water management plans - independent planning process for situations where water demand is predicted to exceed supply	- State and condition monitoring: o Groundwater o Surface water o Water dependent ecosystems. - Annual irrigation reporting - Wastewater management controls - Licence conditions and operational procedures - Land clearance controls - Annual reporting by NRM Boards - Compliance checks - Community monitoring - External monitoring (SA Water, EPA)

blue : national/intergovernmental

red: international

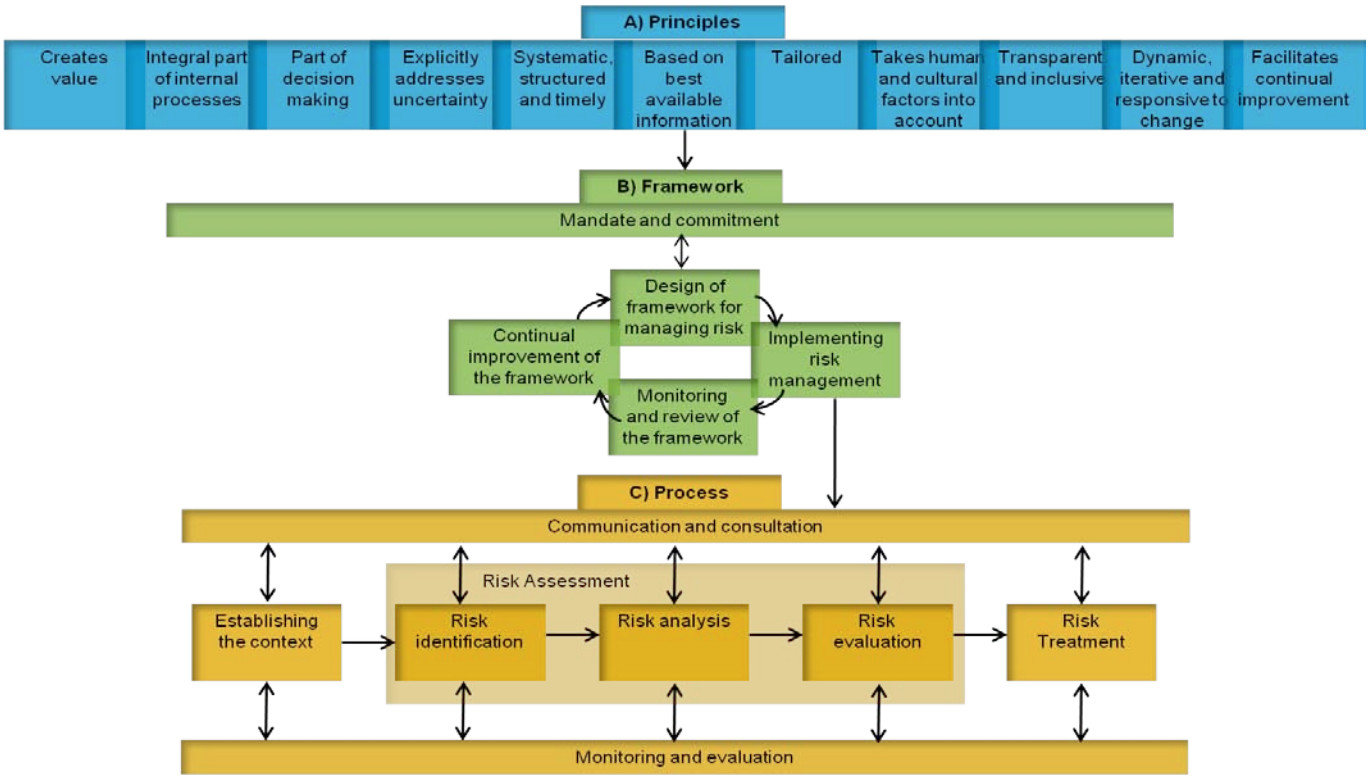
black: state level or DEWNR/NRM Board internal

green: related but external planning and operational processes

2 RISK MANAGEMENT FRAMEWORK

2.1 Standard Guidelines

The Australian and New Zealand Standard for risk management (AS/NZS ISO 31000: 2009) provides for the management of any form of risk in a systematic, transparent and credible manner within any scope and context. They include overarching principles and a clear process for carrying out risk management (see Figure 2). This Framework uses the standard as its backbone.



Source: AS/NZS IS031000: 2009

Figure 2. Principles, Framework and Process diagram for Risk Management AS/NZS ISO 31000: 2009

2.1.1 Principles

The principles contained in part A of the diagram clearly align with those for water planning and management reform. Using a risk-based approach to water planning facilitates the implementation of a structured, timely and systematic approach to water planning and management which is dynamic, iterative and involves community participation where appropriate.

2.1.2 Risk management process

Part C of the diagram shows the seven integrated steps to be undertaken during the risk management process. This Framework provides the details and information necessary to undertake these steps. Sections 3–7 of this Framework corresponds to each of these process steps:

Section 3: Communication and Consultation

Section 4: Monitoring and Evaluation

Section 5: Establishing the context

Section 6: Risk Assessment

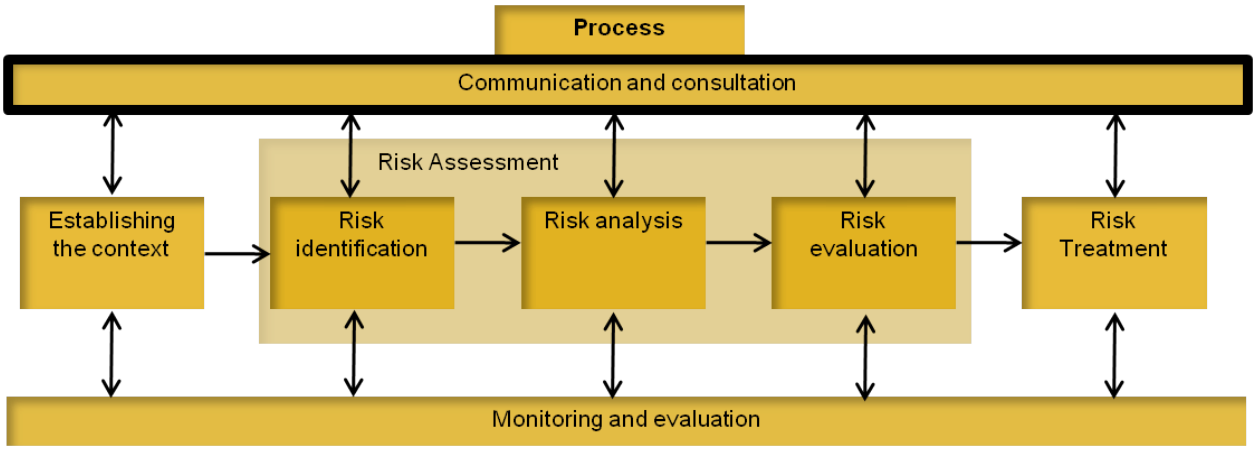
6.1 Risk Identification

6.2 Risk Analysis

6.3 Risk Evaluation

Section 7: Risk Treatment.

3 COMMUNICATION AND CONSULTATION



Communication and consultation is the key to effective risk management and must be undertaken throughout the risk management process.

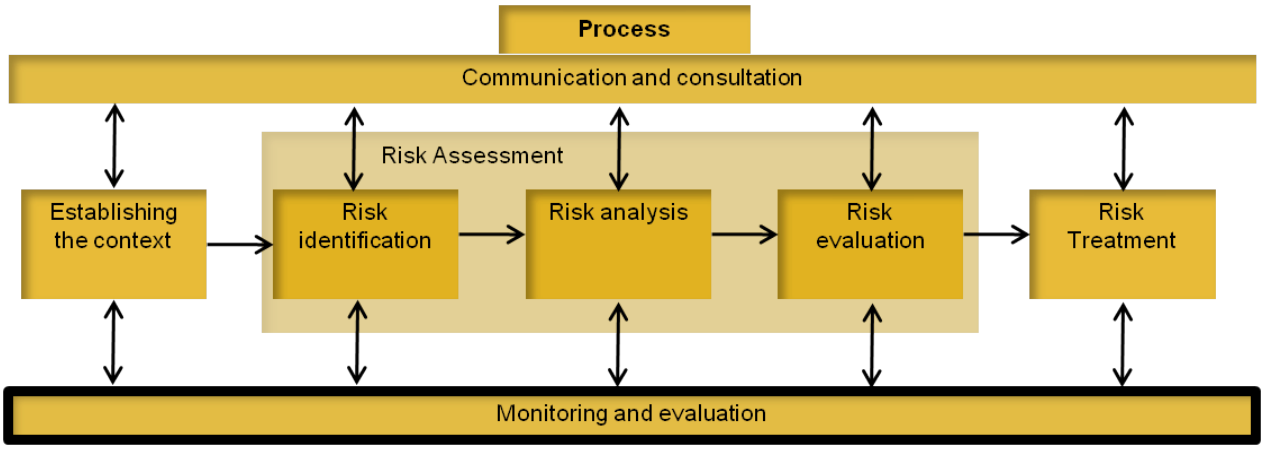
3.1 Internal communication

Communication and consultation is integral at all stages of the process particularly where multiple teams or divisions are involved. For the purposes of this Framework and the Risk Management Policy and Guidelines for Water Allocation Plans, the Department of Environment, Water and Natural Resources (DEWNR) and the NRM Boards are considered to be internal stakeholders. Communication at each step of the process is essential to ensure understanding by all parties and therefore the effectiveness of each step. Communication may take the form of meetings, discussion papers, presentations or workshops.

3.2 External consultation and community engagement

Consultation with external stakeholders may or may not take place at each stage of the process. It is likely that all stakeholders will have input at the context-setting and identification phase but not necessarily at the assessment or treatment stage. The level of consultation and community engagement required should be specific to the particular task required and agreed upon as part of establishing the context.

4 MONITORING AND EVALUATION



4.1 Monitoring and evaluation of the risk management process

In accordance with the diagram in Figure 2, the following monitoring and evaluation processes are required for risk management in water planning and management:

- Monitoring and evaluation of this Framework (as shown by Figure 2, part B).
- Monitoring and evaluation for risk management processes established in accordance with this Framework (as shown by Figure 2, part C).

The South Australian NRM Standard includes monitoring, evaluation and adaptive management as one of the seven principles for effective, high quality NRM practice. The development and implementation of monitoring and evaluation for risk management may be guided by existing monitoring, evaluation, reporting and improvement (MERI) frameworks and guidelines that are relevant for water planning and management and NRM. Relevant frameworks include the Australian Government NRM MERI Framework (Australian Government, 2009), the NRM Reporting Framework (DEWNR, in preparation) and the MERI Guidelines for Water Allocation Plans (DEWNR, in preparation).

In accordance with existing MERI frameworks, it is suggested that monitoring and evaluation undertaken for risk management address the following two objectives:

- Provide for governance and compliance reporting thus contributing to overall transparency and accountability of risk management
- Provide for ongoing learning and improvement thus contributing to adaptive management of risk management undertakings.

4.2 Linkages with MERI frameworks

The components of risk management and MERI frameworks are complementary, as they contribute to each other's objectives in the following ways:

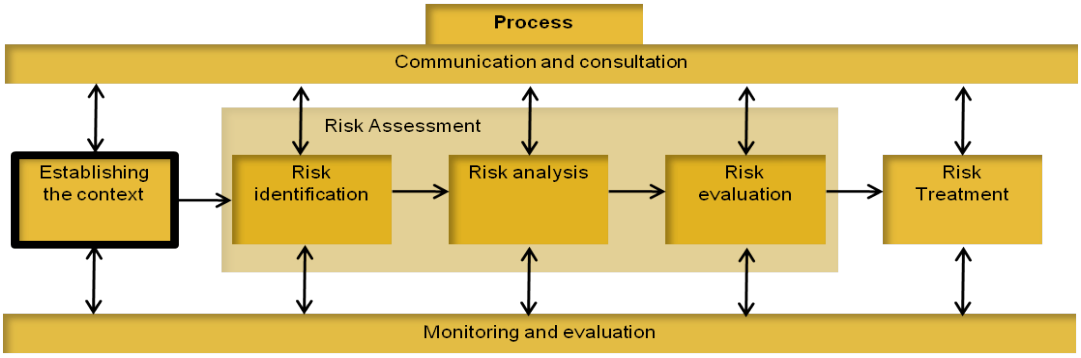
- The policies, templates and tools promoted by MERI frameworks may be used to address both the governance and adaptive management requirements of risk management in water planning and management.
- Risk management components, such as risk assessments, enable more effective MERI by providing for targeted evaluation questions, monitoring programs and evaluation and reporting processes.

Since MERI processes contribute to the achievement of the objectives of the risk management framework and risk management processes, it is suggested that monitoring and evaluation undertaken on behalf of risk management references and utilises MERI policies and tools where appropriate.

Program logic is a particularly useful tool in existing MERI frameworks, as it helps planners model and communicate how an intervention, such as a policy or an on-ground activity, is understood to produce results. A key element of program logic is the 'outcomes hierarchy', which plots a chain of expected consequences arising from planned NRM activities or policies. Outcomes are mapped according to a timeframe over which they are anticipated to occur; with shorter term outcomes contributing to longer term outcomes through assumed cause-effect relationships (see Figure 4 in Section 8 for an example). The same cause-effect relationships can be utilised in risk assessments.

The Australian Government has published guidelines for developing and using program logic in NRM (see nrmonline.nrm.gov.au/catolog/mql:2164).

5 ESTABLISHING THE CONTEXT



Risk management is highly dependent on the context within which it is framed and so establishing the context is of primary importance.

It also enables subsequent risk assessments to be tailored and focussed. Without a clear context it is difficult to effectively undertake and communicate the assessment of risk. The steps to be taken in this process are set out below. Each step may only require a short statement or diagram:

1. Determine the internal and external stakeholders and the dependencies/culture within and between them (internal and external context).
2. Establish why a risk assessment is needed.
3. Establish the context in which the assessment fits within the broader resource management and planning process.
4. Establish the objectives of the risk assessment with stakeholders.
5. Determine the risk criteria:
    a. Describe the risk categories to be measured and the scale and timeframe over which they operate.
    b. Determine the method to be used for the risk assessment: based on time, cost, complexity and resource issues.
    c. Determine the criteria by which it will be decided if a risk is acceptable or tolerable or needs treatment. For example all risks assessed as being 'high' would need ongoing management/ monitoring.
6. Determine the location of outputs from each stage of risk assessment products e.g. risk identification may be recorded in a risk register.
7. Determine the roles and responsibilities in the risk management process.

Depending on the size and complexity of the task, the detail required to establish the context may differ. Information should be documented and stored in locations identified in step 6 above and referred to at all subsequent stages of the process.

5.1 Internal context

The internal context for risk management for water planning and management revolves around the core business areas within DEWNR and the NRM Boards. Figure 3 is not exhaustive but identifies where key planning and operational processes are likely to require risk management.

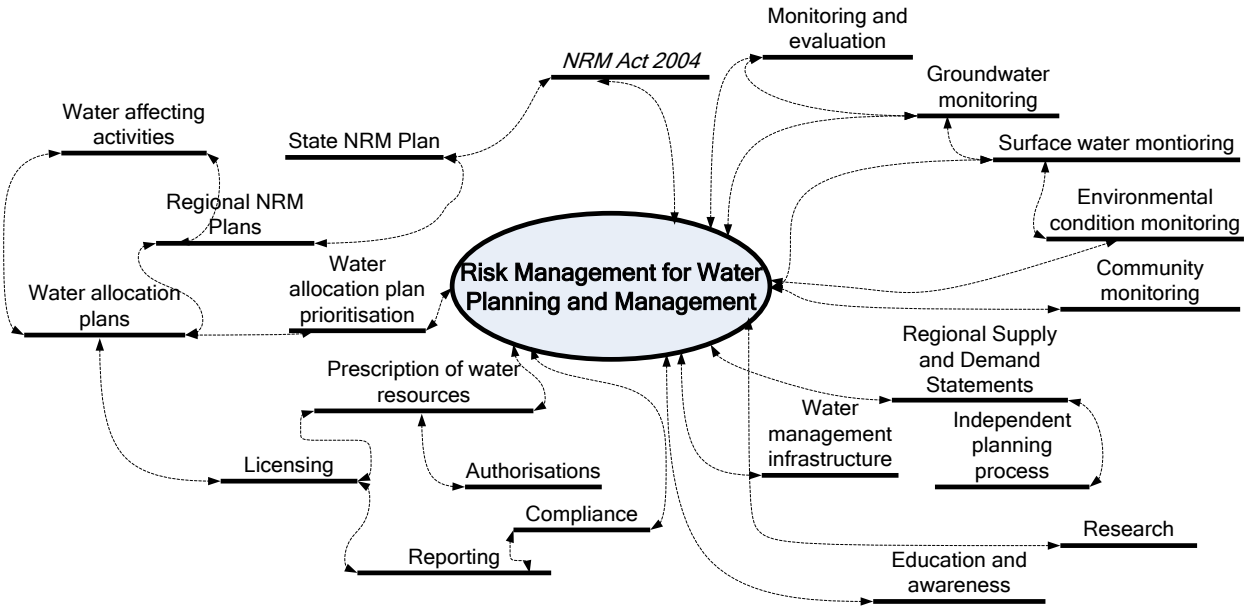


Figure 3. Internal context for risk management for water planning and management

5.2 External context

Within water planning and management in South Australia, some of the external partners to DEWNR and NRM Boards for risk management are shown in Table 2 below:

Table 2: External partners for risk management

SA Government Agencies	Commonwealth Institutions	Other external partners
Department of Manufacturing, Innovation, Trade, Resources and Energy	Bureau of Meteorology	Aboriginal groups
Department of Planning, Transport and Infrastructure	Commonwealth Environmental Water Office	Community and industry groups
Department of the Premier and Cabinet	Department of Sustainability, Environment, Water, Population and Communities	Goyder Institute for Water Research
Environmental Protection Authority	Murray–Darling Basin Authority	Intergovernmental committees e.g. Border Groundwaters Agreement, Lake Eyre
Primary Industries and Regions SA (PIRSA)	National Water Commission	SA Water
SA Health		

The explicit linkages with external partners will need to be more clearly articulated as the individual risk assessment processes take shape. Table 1: Drivers for Risk Management is also useful to assist in identifying the external context for water planning and management, as well as the broader context in which the risks assessment fits.

5.3 The need for a risk assessment and its objectives

The need for a risk assessment can often be linked back to triggers such as degradation of a resource. Objectives can be highly targeted or broad, for example, objectives identified for risk assessments for water allocation planning are to:

- Provide opportunity for community identification of risk and incorporation of their concerns in decisions about trade-offs between social, economic and environmental concerns
- Sustainable and SMART (Specific, Measurable, Achievable, Realistic, Time-bound) management of the resource
- Direct resources where they are needed most
- Meet state/national obligations – have compliant plans
- More transparently assess the social, economic and environmental risks
- Prioritise issues for monitoring and compliance

- Document information used in the decision making process regarding trade-offs between users
- Enable learning and transfer of information for the next iteration of the water allocation plan.

5.4 Risk criteria

This step in the context-setting stage is likely to require the most time and effort, as it involves decisions on the categories of risks, the risk assessment methods, and the criteria for tolerability. If done well, the foundational work undertaken in this step of establishing the context will ensure the risk assessment process will run smoothly. However, it is quite common that some aspects of this step are re-visited when the actual risk assessment is undertaken.

5.4.1 Risk categories

This process may help to direct the area responsible for assessing a particular risk category, for example, the stakeholders with expertise of a more technical nature may be assigned the responsibility for assessing the risks to the resource, while community input is more important for another category.

Table 3 is not intended to be comprehensive but provides a helpful guide to identify the categories into which many risks may be grouped:

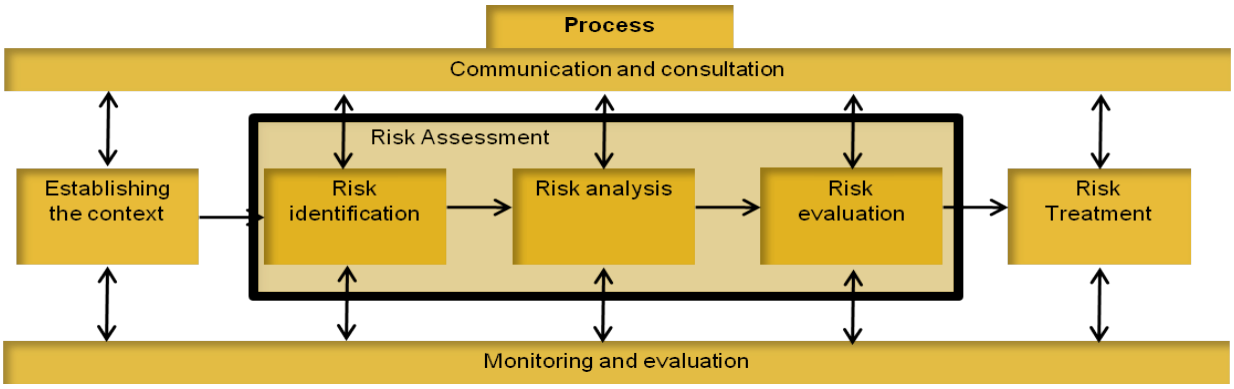
5.4.2 Risk assessment methods

Appendix 1 provides a discussion of methods for risk assessment and selection of treatments.

Table 3: Risk Categories

Risk assessment	Examples of categories of risk	Examples of sources of risk
Risks to the resource	Adverse water quantity/rate/availability Adverse water quality (including salinity) Poor health of water dependent ecosystems	Climate change/variability Drought, fire, flood Feral animals and plants Interception Land management practices
Risks to community values	Economic development curtailed (irrigation and other industry) Water for human consumption Community amenity degraded Recreational opportunities e.g. fishing Water for spiritual/cultural or religious use	As above plus: Adverse water quality Unsustainable levels of take Inefficient use Lack of cooperation or understanding by government Location of taking or using water
Risks to the effective operation of the plan	Perception that plan is overly prescriptive, poses a high financial or administrative burden on water users, is inequitable or does not reflect stakeholder input	Public support or input
	Policy does not deliver the outcome sought or there are adverse effects	Policy risk
	Plan does not meet legal requirements, policies are challenged on the basis of inconsistency with legislation	Legal risk
	Practitioners are not capable of implementing the plan	Implementation risk
	The public does not comply with the policies of the plan	Compliance risk
	Events occur which cause the policies within the plan to be inappropriate and lead to adverse outcomes for environmental, social or economic reasons e.g. bushfire, extreme flooding, prolonged drought	Extreme events

6 RISK ASSESSMENT



"The purpose of risk assessment is to provide evidence based information and analysis to make informed decisions on how to treat particular risk and how to select between options" IEC/FDIS 31010, 2009.

6.1 Risk Identification

Risk identification is the process of finding, recognising and describing risks including deciding on the important values and risks to those values. The appropriate identification of risk largely depends on ensuring the appropriate people are included in the risk identification process.

Steps for successful risk identification involve:

1. Identifying risks according to the categories determined through establishing the context.
2. Making sure key stakeholders have identified risks relevant to them.

Risks should be identified in a manner that is transparent and retrievable i.e. through a risk register**.** Carefully constructed risk statements which avoid stating only consequences or sources of risk will aid in the appropriate assessment of risk.

Risk statements can have the following form:

'There is the potential that [*risk source*] leading to [*event*] in turn leads to [*consequence*]'

Where:

- A *risk source* is an element which alone or in combination has the intrinsic potential to give rise to risk.
- An *event* is an occurrence or change of a particular set of circumstances.
- A *consequence* is the outcome of an event affecting objectives and may be expressed quantitatively or qualitatively.

For example, when assessing risks to resources the terms 'adverse water quality' or 'nutrient run-off from agricultural land' may intuitively be considered a risk. However a more helpful and easily assessed risk statement would read:

*'There is a risk that water use for irrigation will lead to nutrient run-off which will result in nitrogen levels reaching **x** level at **y** time and at **z** location (and potentially for **e** duration).'*

The scale of location will be appropriate to the spatial scale in question and the consequences and likelihood can be specifically assessed.

6.2 Risk Analysis

Risk analysis is the process to comprehend the nature of risk and to determine the magnitude of the risk or risk level. The level of risk is a function of the consequence and likelihood of risk and may be expressed as scores, probabilities or qualitative descriptors.

Risk analysis may be qualitative, quantitative or a combination of both depending on the time and resources available. Quantitative methods are based on data such as salinity levels, water levels and models. Quantitative methods are generally more robust than more subjective, qualitative methods but often require more resources.

A method needs to be chosen based on the complexity of the task and the resources available. Potential methods include cost-benefit analysis, bow-tie diagrams, comparative risk analysis and Bayesian Belief Networks. The appropriate method will be determined by the particular type of risks to assess. Complex, integrated risk assessments are more suited to techniques such as Bayesian Belief Networks. However, where each risk is assessed independently and not in conjunction with other risks, techniques such as comparative risk analysis using risk matrices may be used.

In order to select an appropriate tool, practitioners should:

1. Consider the complexity of the assessment required. This may be based on:
    - the size of the resource;
    - the number of users; and
    - its environmental, social and/or economic value.
2. Consider whether quantitative or qualitative approaches will be required.
3. Determine what is possible with the funds available.

For further detail regarding selection of risk analysis tools, see Appendix 1.

6.2.1 Controls analysis (assessing the effectiveness of current controls)

An important step of risk assessment is an analysis of current controls. The steps involved include:

- identifying the existing controls to the risks.
- determining whether the current controls are modifying risk to a level that is tolerable (determined at the context-setting stage).
- identifying whether the controls are operating in the manner intended and can be demonstrated to be effective (see Table 4and Table 5).

Current control measures are already in place in most areas. These may either be within current legislation, plans, policies or management actions (see Table 1).

Both the degree of implementation and effectiveness of the control measures affect either the level of consequence or likelihood of the risk in question. These levels may be assessed in terms of percentage (as set out below).

Table 4. Assessment of the level of implementation of control measures

Implementation	Percentage
Complete implementation	>95%
Mostly complete	75–95%
Partially complete	30–75%
Mostly incomplete	5–30%
Not implemented	<5%

Table 5. Assessment of the effectiveness of current controls

Effectiveness	Level of effectiveness of control	Percentage
Controlled	Total control or mitigation of risk	>95%
Mostly controlled	Risk is controlled in most circumstances	75–95%
Partially controlled	Risk controlled in some circumstances	30–75%
Mostly uncontrolled	Risk is mostly uncontrolled by measures	5–30%
Not controlled	Controls do not mitigate the impacts of the risk	<5%

It is recognised that not all controls may require such rigorous assessments. It may be prudent to choose several key areas for this assessment.

6.2.2 Confidence in the results of a risk assessment

Risk assessment revolves around future events and therefore aims to understand the uncertainties in achieving objectives more clearly. Understanding the level of confidence associated with the risk assessment itself is necessary to be able to communicate transparently with stakeholders.

To address uncertainty associated with knowledge gaps for quantitative and qualitative assessments, it is useful to provide a level of confidence associated with the assessments that have been undertaken. Table 6 shows categories of certainty for the type of data used. This information will help to inform the level of confidence that can be placed in the assessment and

inform which areas need further investigation and monitoring and the design of other treatments.

A low confidence level may trigger a repeat of the risk assessment with a different group of people or development of a monitoring/research program. Confidence levels will also affect the choice of other treatments, in particular policies, for example, any policy to address climate change risks in the areas of water planning and management will need to be designed in a robust manner that will result in effective outcomes across a number of scenarios, given the inherent uncertainty in this area (Bates et al., 2010).

Table 6. Description of the levels of confidence associated with data available (adapted from Australian Emergency Management Committee, 2010)

Confidence criteria	Low confidence	Moderate confidence	High confidence
Data/information	Not location specific; anecdotal evidence only, not tested	Location specific (regional scale); validated historical or scientific evidence	Location specific (local scale); validated historical or scientific evidence based on specific hypothesis testing
Team knowledge	Neither risk source, risk assessment process or location specific	Risk source or process and location specific	Risk source and process and location specific
Agreement	Neither on interpretations nor on risk levels	On interpretations or risk levels	On interpretations and risk levels

6.3 Risk Evaluation

Risk evaluation is where the decision is made whether a risk requires treatment or is acceptable given the current controls in place.

In some circumstances it may be deemed that further information is required to fully comprehend the nature of the risk. This is likely to be the case where further information would provide greater confidence of the likelihood, or severity of consequence, of the risk. In some circumstances this will be able to take place immediately and in others will be part of the ongoing monitoring of the resource or community performance.

The final stage of risk evaluation is the 'decision point' where it is decided whether or not treatment is required on the basis of the risk evaluation. Risks which have been evaluated as 'not tolerated' will need to be treated. The first step in determining risk treatments should be based on an agreed trigger for treatment determined by the tolerability of risk identified at the context-setting stage.

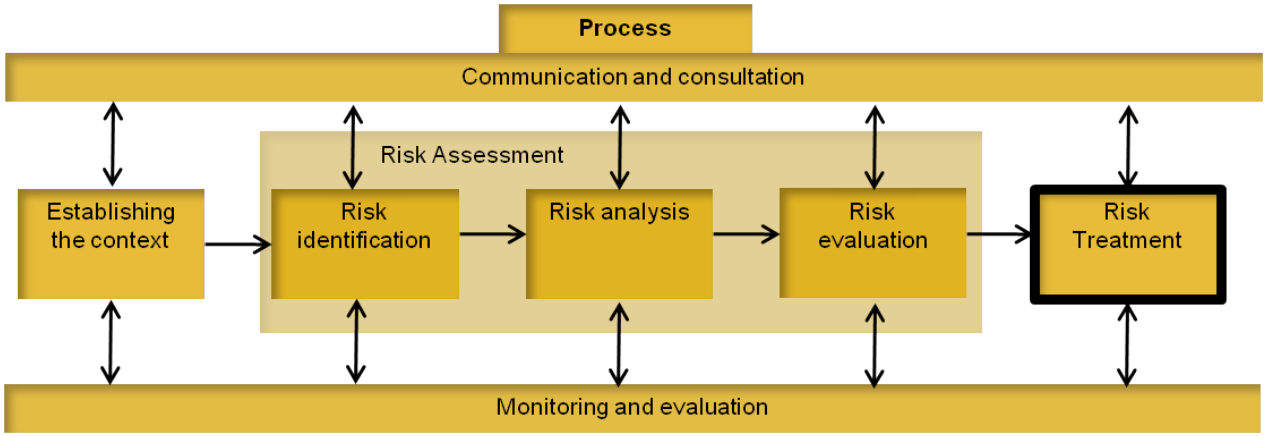
Table 7 provides an example which helps support this decision. In this table it has been decided that a risk-level of 'Medium' or above requires treatment. 'Low level' risks are tolerated. 'Medium level' risks need to be investigated for treatment and 'High level' risks require immediate actions and are not tolerated.

Table 7. Requirements for risk treatment

Level of risk	Treatment required?*	Tolerability
Low	**No**. Continue with current operational policies and level of monitoring/management	Tolerated
Medium	**Yes.** Investigate and where practicable, implement policies to reduce risk, increase monitoring intensity, prioritise further research to reduce knowledge gaps	Some tolerability
High	**Yes.** Take action immediately, monitor and manage intensively	Not tolerated

* Examples only - qualifying words such as 'intensity' need to be defined by users

7 RISK TREATMENT



Risk treatment is the process to modify risk and involves the actions taken to reduce or avoid risk. It involves selecting the appropriate treatment from several options and will likely involve stakeholder input.

Risks that have unacceptable consequences determined by risk evaluation will need to be treated or avoided. Treatments may range from risk avoidance and risk acceptance through to specific targeted treatments. Risk treatment may include either preventative and abatement options or both depending on the risk. This may include treatment measures to reduce either the likelihood or the consequences of the risk. Risk treatment choice tools have been outlined in Appendix 1.

Treatments in the area of water planning and management could include:

- On-ground actions (e.g. building infrastructure, planting vegetation, fencing off watercourses)
- Policy instruments (rules, conditions, incentives, disincentives, setting limits, education)
- Monitoring, pilots, research.

8 OUTCOMES AND REVIEW

8.1 Outcomes hierarchy for the Framework

Figure 4 is based on the outcomes models recognised within the national NRM MERI framework. It recognises the Framework as a *foundational activity* which influences higher level outcomes.

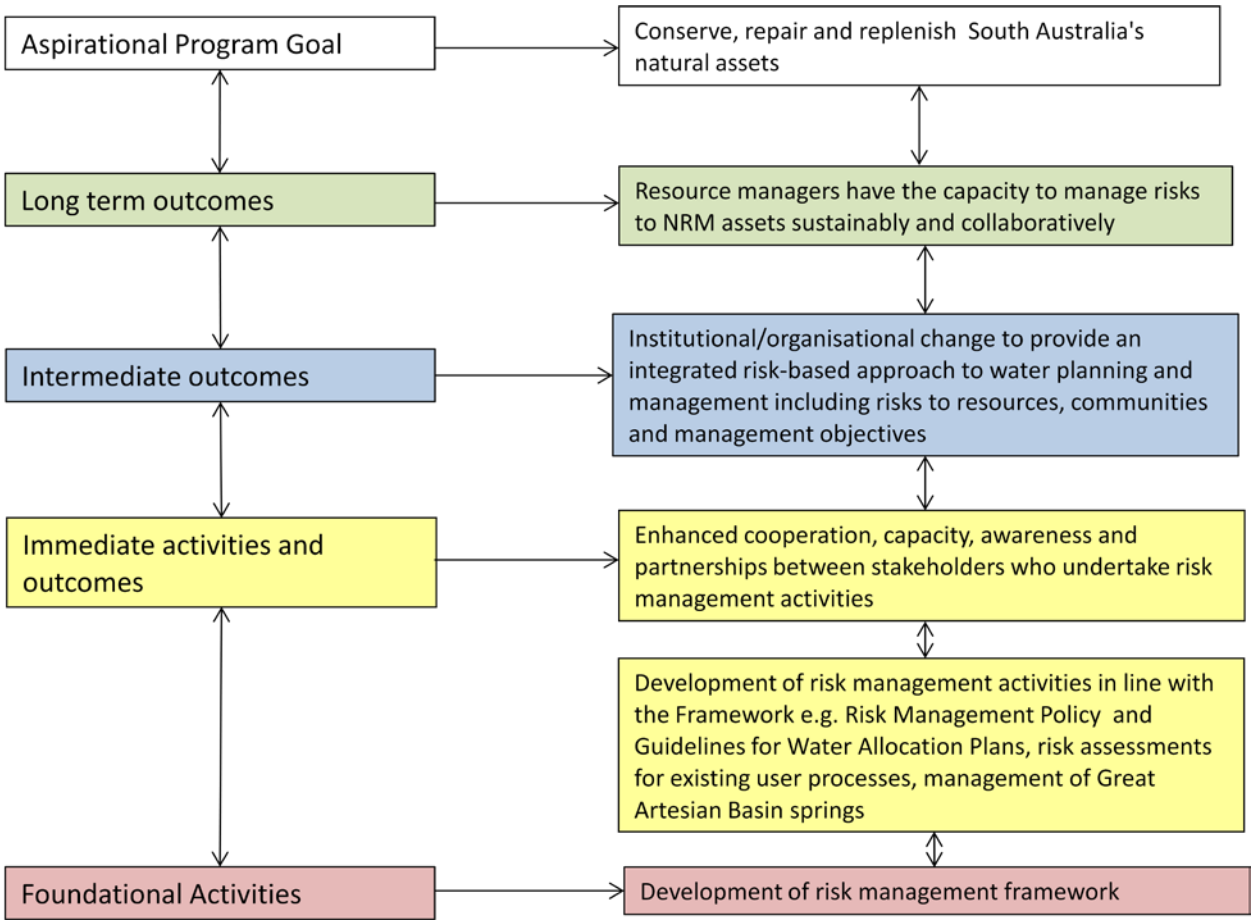


Figure 4. Outcomes hierarchy for the Risk Management Framework for Water Planning and Management

8.2 Review of the Framework

This Framework brings together the existing arrangements for assessing risks in the areas of water planning and management to provide a clear, structured process with a common language to be applied to all management activities and plans requiring risk assessment. It is recognised that South Australia's water management arrangements are currently under reform and review of this Framework within two years will be necessary to determine how the fit-for-purpose risk processes in line with the Framework are taking shape and how progress toward outcome goals is being made.

9 GLOSSARY

Adaptive management: an active culture of reflection comprising effective evaluation, appropriate communication for all project participants and provision of mechanisms for incorporating learning into planning and management (Australian Government, 2009).

Control: the measure that is currently modifying risk e.g. policies, processes etc.

Consequence: the outcome of an event affecting objectives

Level of Risk: magnitude of a risk, or combination of risks, expressed in terms of the combination of consequences and likelihood

Likelihood: the chance of something happening

Probability: measure of the chance of occurrence

Residual Risk: risk remaining after risk treatment

Risk: effect of uncertainty on objectives

Risk Acceptance: informed decision to take a particular risk

Risk Analysis: process to comprehend the nature of risk and to determine the level of risk

Risk Assessment: overall process of risk identification, risk analysis and risk evaluation

Risk Avoidance: informed decision not to be involved in, or to withdraw from, an activity in order not to be exposed to a particular risk

Risk Categories: overarching categories of risk which may include several sources of risk

Risk Criteria: terms of reference against which the significance of risk is evaluated

Risk Governance: the organisational arrangements governing who undertakes risk management activities

Risk Identification: process of finding, recognising and describing risks

Risk Management: coordinated activities to direct and control an organisation with regard to risk

Risk Management Framework: set of components for designing, implementing monitoring, reviewing and continually improving risk management throughout the organisation

Risk Management Process: systematic application of management policies, procedures and practices to the activities of communicating, consulting, establishing the context and identifying, analysing, treating, monitoring and reviewing risk

Risk Owner: person or entity with the accountability and authority to manage risk

Risk Register: record of information about identified risks

Risk Tolerability: A willingness to live with a risk so as to secure certain benefits in the knowledge that the risk has been evaluated and is being managed

Risk Treatment: process to modify risk

Sources of Risk: the contributing factors to overarching risk categories, also known as risk factors*

*the Basin Plan refers to 'risk factors', however for convention under this Framework it will be known as 'sources of risk'

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APPENDIX 1: RISK ASSESSMENT AND TREATMENT SELECTION TOOLS

The risk assessment and treatment selection tools in this section are described under headings which relate to their primary function. However, many of them can be used for multiple purposes.

Risk Identification tools

Workshops and meetings

The identification of risks in a workshop or meeting allows the input of individuals to be incorporated together. It has the added benefit of developing relationships between stakeholders and providing clear and open communication lines. For complex or potentially volatile situations a professional facilitator may be beneficial.

Brainstorming/Card–storming

This technique may be used in a workshop to enable complex information to be gathered. This is particularly appropriate where a participatory process is required. It provides a structured, visual approach which allows common understanding of the positions reached.

Conceptual Models

A conceptual model aids the identification of risks that may interact with each other and may be particularly appropriate for conceptualising and identifying risks to resources. For example, risks to water dependent ecosystems involve complex and interrelated factors such as extraction, climate change and salinity.

A conceptual modelling tool, called *Concept*, has been developed by the eWater CRC as part of the eWater toolkit. *Concept* allows a conceptual model of a system to be built but has the added benefit of providing the ability to model how particular elements of the model may interact with each other. It is designed for use by scientists and policy makers. Further information can be found at http://www.toolkit.net.au/Tools/Concept.

Individual identification

In some situations it may be appropriate for individuals to identify risk. This may be done prior to a more participatory process outlined below, in areas that require highly expert judgement or simple processes which do not involve many stakeholders. This type of situation is rare.

Risk Analysis Tools

Comparative risk analysis (Consequence and likelihood table)

Complexity level = low

Resources = low

Ability to analyse interrelated risks = low

Comparative risk analysis (CRA) is a common tool used in many types of risk assessment and involves the use of a matrix which identifies categories or levels of consequence and likelihood. Likelihood and consequence categories may be defined in terms of a qualitative descriptor e.g. 1 = rare and 5 = almost certain for likelihood; and 1 = insignificant and 5 = catastrophic for consequence. The applicability of these categories needs to be carefully assigned to the type or category of risk being assessed. Generic scores or statements are rarely appropriate and should be defined for each risk assessment given the specific circumstance. These categories and levels need to be clearly documented and at the very least be associated with quantifiable, measurable levels or outcomes.

Table 8. Example of a risk ranking matrix for Comparative Risk Assessment

	Consequence level				
Likelihood level	**Insignificant 1**	**Minor 2**	**Moderate 3**	**Major 4**	**Catastrophic 5**
Almost certain 5					
Likely 4					
Possible 3					
Unlikely 2					
Rare 1					

Low risk level = green; Medium risk level = yellow; High risk level = red

The benefits of the CRA approach are that it is relatively simple and requires few resources. Conversely it can over-simplify complex issues and often requires highly subjective judgements to be made. When using CRA, it is important to transparently record the information used to determine a certain risk level.

Bow-tie analysis

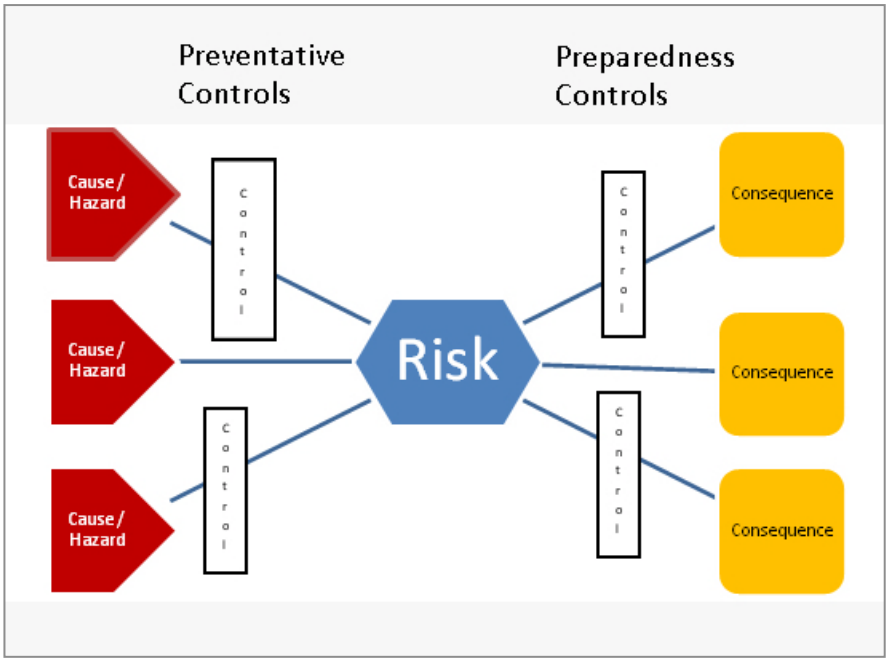
Complexity level = low

Resources = low

Ability to analyse interrelated risks = low

Bow-tie analysis involves the creation of a visual tool known as a bow-tie diagram (see Figure 5).

Bow-tie diagrams are used to display risks with a range of possible causes and consequences and also identify current controls that are in place to prevent the risk. This type of analysis is particularly useful where defined 'events' can be recognised and has been promoted as the recommended tool for analysing emergency risk in Australia (Emergency Management Committee, 2009).



Source: www.reliancerisk.com.au/2010/12/09/using-bow-tie-analysis-to-simplify-risk-management/

Figure 5. Example of a bow-tie diagram

The benefits of the bow-tie diagram are that they provide a simple representation of the pathway of risk with controls and mitigation measures identified. Although some quantification of risk may be possible, this is not a strength of bow-tie analysis. Bow-tie diagrams focus on control measures which may not be appropriate for more complex or exploratory applications where clear controls are not immediately and easily identifiable.

Bayesian Belief Network

Complexity level = high

Resources = high

Ability to analyse interrelated risks = high

Bayesian Belief Networks (BBNs) use a graphical model to represent a set of variables and their probabilistic variables. They are useful in a wide range of applications and allow the user to map causal relationships and predict the consequences of particular management actions. They allow learning about a system given prior expectations and actual outcomes. They are therefore a powerful adaptive management tool (Nyberg et al., 2006). Where risks are complex or have integrated consequences, BBNs provide a tool by which the interaction between risks and their sources can be analysed and expressed in percentages of likelihood.

This approach has the benefit of providing an ongoing model which identifies how risks to the resource may interact and, depending on the way the model is constructed, a tool for assessing how the choice of different management options may affect an overall system. This method was used in the risk assessments for the Guide to the Proposed Basin Plan (October 2010).

Difficulties in using BBNs are that they require particular skills that are increasingly becoming more common in the field of water management but are by no means universally available.

They may require up-front resources to set up but over longer periods of time provide the structure for learning and implementing new information. Engaging consultants with specific BBN skills may be required.

Risk Evaluation/Treatment Tools

Workshops

Workshops are likely to be appropriate where evaluation of particular treatments need to be communicated and agreed upon by a variety of stakeholders. Having an agreed set of criteria against which to evaluate treatments is essential. They may be the final stage of risk evaluation where technical evaluation has occurred prior to the workshops, and clear options can be presented and consensus may be formed. Workshops may also include the presentation and application of techniques outlined below.

Bayesian Belief Networks

BBNs can be created to provide a tool which supports decisions of appropriate risk treatments. They can also incorporate expert knowledge where data is unavailable or inappropriate for the situation (Nyberg et al., 2006). BBNs can be designed to immediately calculate and display results when changes to components of the net are made.

When using BBNs it is recommended that an expert practitioner runs the models but that a diverse range of stakeholders be involved in the updating and decision-making process.

Cost benefit analysis

Cost benefit analysis (CBA) is an appropriate method of risk evaluation, particularly where monetary values can be assigned to risk treatment options, involving the weighing up of total benefits with total costs to choose the best option.

It is an appropriate method for risk evaluation to determine whether a risk should be treated and to determine the best treatment option available.

The Commonwealth *Handbook of Cost Benefit Analysis* (2006) (the Handbook) is a detailed guide to planning and undertaking a CBA. A brief overview of some key steps is provided below. The Handbook should be used in conjunction with this Framework and the steps of risk identification and analysis should be clearly defined.

The steps outlined in the Handbook should be undertaken for all CBAs. However the level of detail or depth employed in a CBA may vary depending on resources. Undertaking a full CBA can be a resource-intensive process. For this reason, it is important to consider what resources will be required for undertaking a CBA, and whether or not these costs will outweigh the benefits that will arise from doing the CBA. The resources required to undertake a CBA will be influenced by a number of factors including:

- the number of risks included in the analysis
- what information is currently available that can assist in assigning monetary values to costs and benefits
- what further work or investigations would be required to source the necessary information to allow assignment of monetary values to benefits and costs.

The full process for undertaking a CBA for risk evaluation incorporates the following steps:

- Identify costs and benefits of treatments
- Quantify/value costs and benefits
- Calculate net present value
- Sensitivity test for uncertainty
- Consider equity issues and intangibles
- Report.

Further information about tools for risk assessment can be found in the risk management standard IEC/FDIS31010, 2009.