NWI Policy Guidelines for Water Planning and Management

Risk Assessment Module

- **Introduction**

Water planning is a key mechanism for identifying the environmental, social and economic objectives for managing water resources. Effective water plans establish the rules for sharing water between all users so that the water resource is managed in a way that optimises the total sum of the benefits and services it can provide, without stressing the resource or the environment that depends on it.

There is an inherent need to ensure the objectives of water plans are consistent with the broader natural resource management objectives. Potential and emerging threats to the resource, such as climate change, need to be taken into account in providing certainty of access for all uses and users.

'Planning is an unnatural process; it is much more fun to do something. The nicest thing about not planning is that failure comes as a complete surprise, rather than being preceded by a period of worry and depression' – Sir John Harvey-Jones

- **Why a risk-informed approach to water planning and management?**

Water is a valuable resource. It provides a range of benefits and services for humans and the greater environment. These include things such as drinking water and public health services, food crop irrigation, and providing for the health of our environment.

Water is a limited resource. The water available from a single river offtake, aquifer or other source is often used to provide several different services or benefits. The amount of water available at any time to provide these services can vary, and particularly when the amount of water available is low, there could be several competing uses for the limited amount. In these cases, some form of prioritisation is required to determine:

- how the water resource may best be used and shared among competing users, or
- what other actions could be taken to help allow water managers to continue providing all or some of those services.
  What is a risk-informed approach to water planning and management?

- **Risk management is a process concerned with setting objectives and then developing a plan to meet them**

Risk is 'the chance of something happening that will have an impact on objectives'. Generally, risk is a function of the *likelihood* of an event occurring in the future and the *consequence* of that event in terms of its impact on the objectives.

Risk management is 'the … processes and structures that are directed towards realising potential opportunities whilst managing adverse effects'.

(AS/NZS 4360:2004)

When the objectives for water resource use have been set, a *risk management* approach lends itself to developing a plan to meet those objectives. A large part of this is identifying, assessing and managing the things that might threaten the ability to meet those objectives. This way, more time and effort may be directed to monitor, mitigate or respond to the

things that may pose the highest overall risks, and to ensure that management is targeted at the appropriate part of the water system.

- **What do I need to consider in a risk-informed approach to water planning and management?**

What are the risks to the resource and the objectives of the plan?

What is the probability of those risks occurring?

What are the consequences to the resource and the objectives of the plan if they do occur?

What are the measures I can employ to mitigate the sources of the risks and their consequences?

- **Purpose of this module**

This module is intended as a guide only, and it does not provide prescriptive methods for how to implement a risk-based approach as part of a water management plan. It should be read in conjunction with the main body of the guideline document it sits within.

The guidance notes outline the generic steps that a water planner may undertake to incorporate risk management principles into a water resource management plan. These notes have been developed with a high degree of reference to AS/NZS 4360:2004 Risk Management, but with a water planning focus.

THE RISK MANAGEMENT PROCESS

- **General**

The risk management process is detailed below. Generically, risk management is an iterative, but not necessarily linear, ongoing process underpinned by internal and external consultation where:

- The context and goals of the management exercise are set.
- The things that can threaten the achievement of the objectives are identified.
- The level of risk posed by each of the threats is assessed or examined by considering the likelihood and consequences of the threatening events occurring.
- The risks are evaluated and prioritised, and options for managing (or treating) the risks are identified.
- The risk treatments or management options are implemented.
- The success (or otherwise) of the management strategies is monitored and reviewed.
- And the entire process is repeated periodically or as needed.

The Risk Management Process

AS/NZS 4360:2004

Some commentary on how each step of this process can relate to water planning is provided below.

- **Establishing context and goals**

To establish the *context*, the water plan should contain a description of the water system that is to be the subject of the water plan. Principles and considerations for describing the water resource and its use and users are included in section **Error! Reference source not found.** of the main guidelines. In summary, the water system description should be a stocktake of what is currently known about the system, both now and in the future. A key activity involves identifying and describing the benefits and services that the water resources provide. Identifying these is important because the overarching goal of water planning is to optimise the overall level of the benefits provided by the water resource, while using it sustainably; that is, without compromising the ability to continue realising the benefits the water provides.

Goals (or *objectives*) for managing the water resource and how the water resource shall be used can then be set within this context. Most objectives will have associated outputs, such as those that are described in terms of flow and volume targets for delivery to various locations under a variety of water availability scenarios.

The principle is that by meeting the objectives, the use of the water resource will be optimised. In setting the objectives, a consideration of existing water sharing arrangements, regulations or legislation and the 'trade-offs' between competing water users may be necessary (see section **Error! Reference source not found.** of the main guidelines). A socio-economic assessment may be a useful step to aid in setting the objectives. The information gathered during the system description phase will be useful to ensure that the objectives that are set are practical and achievable. The risk management exercise will then focus on assessing the trade-offs and managing events that may jeopardise meeting these flow and volume objectives.

- **Identify risks**

Having determined the objectives for the water resource and how it will be shared, the next step is to identify potential risks by asking, 'What could hinder or prevent the achievement of the project objectives?' (for example, meeting the volumetric flow targets). This means you should:

- identify the source(s) of each risk (that is, how the risk can occur) and add these sources to your template. This step is imperative because treatments should be developed to control the sources of the risk.
- identify the impact of each risk (that is, what happens if the risk occurs).

In some cases, as you work through the 'sources' and 'impacts', you may determine that there is a more appropriate way to describe a risk. If so, revise your risks and change accordingly.

Sources of risks will include things that are known to be occurring now, as well as things that may occur some time in the future. These can include:

- climate variability (particularly in regard to rainfall and drought patterns)
- ambiguity in water-sharing and operating rules (that could result in overallocation or limit the ability of managers to deal with low flow scenarios)
- developments in upstream catchments (resulting in changes to hydrological profiles)
- changing water demands
- degradation of the environment or water transfer structures, which cause the water system to be disrupted
- actions of upstream users
- exhaustion of the resource (particularly for non-renewable groundwater systems)
- losses of water (such as through evaporation and inefficient delivery systems.)

- **Analyse risks**

For each of the risks identified in the previous step, an assessment of the *level of risk* posed by the described risk can be a useful way to prioritise the way in which the water will be managed.

The relative magnitude of a certain risk can be determined by noting that:

Risk level = f (likelihood, consequence)

A common approach to estimating and communicating risk levels involves using a risk matrix. Once a risk has been described, the level of risk can be determined by the *likelihood* of it occurring and the *consequence* associated with that threat on a scale of, say, 1 to 5, and using a matrix such as the one below to determine the risk level:

RISK LEVEL		Likelihood				
		1	2	3	4	5
Consequence	1	very low	very low	low	moderate	moderate
	2	very low	low	low	moderate	high
	3	low	low	moderate	high	high
	4	low	moderate	moderate	high	very high
	5	moderate	moderate	high	very high	very high

These guidelines do not endorse the use of this particular matrix; it is up to the water planner, through consultation with relevant stakeholders, to adopt an appropriate approach.

The *likelihood* and *consequence* categories, as well as the final make-up of the risk matrix, will need to be developed by the water planner. The scales that are adopted should be appropriate to the specific water-planning situation.

The *likelihood* and *consequence* categories can be defined in terms of a qualitative descriptor (*for example,* a scale of '1 = rare' – '5 = almost certain' for event likelihood, or '1 = insignificant' – '5 = catastrophic' for event consequences); however, some more quantitative guidance or qualifications should be provided to assist with allocating the *likelihood/consequence* scores during the risk estimation exercise (described in the next step). Some examples of how this information could be presented are provided in the following tables:

LIKELIHOOD			
Category	Example category descriptions		
	Qualitative Descriptor	*Frequency*	*Probability of occurring**
1	Rare	Event occurs 1 in every 100 years	< 1%
2	Unlikely	Event occurs 1 in every 20–50 years	1–20%
3	Possible	Event occurs 1 in every 5–10 years	21–80%
4	Likely	Event occurs annually	80–95%
5	Almost certain	Event occurs many times per year	> 95%

** within some time period, such as the duration that the water plan will be applicable*

CONSEQUENCE			
Category	Example impact descriptions		
	Qualitative Descriptor	*Ecological/water quality impacts*	*Socio-economic impacts*
1	Insignificant	No noticeable impact to ecosystem	Short period of low level water restrictions causing minor inconvenience to householders, no material impact on irrigation allocations, minimal financial impact on industry and little to no loss of amenity.
2	Minor	Some impact on marginal ecosystems (For example, edges of riparian zones or small mixed dependency ecosystems)	Extended period of low level water restrictions causing some inconvenience to householders, reduction in irrigation allocations with minimal material impact, potential financial impact for some industries and minor loss of amenity. First signs of impact on public morale.
3	Moderate	Water availability is so low such that only the highest value environmental sites receive or retain water, putting vulnerable species at risk	Medium level of water restrictions directly impacting on householders, reduction in irrigation allocations resulting in some loss of productivity, some industries severely impacted or forced to close tourism, prioritisation of watering for amenities, increased impact on morale.
4	Major	Water availability is at critically low levels and groundwater systems become depleted beyond recharge rate. Extensive damage to ecosystems occurs with potential irreparable damage in some areas	High level water restrictions directly limiting household water use, limited irrigation allocations resulting in low levels of productivity, some industries forced to close which may impact on national economy, severe loss of amenity and morale, some people leave.
5	Catastrophic	Irreparable damage to ecosystem; severe adverse impacts to environment	Water supply to major town becomes insufficient to ever again sustain community or nationally significant activity; no irrigation allocations, collapse of industry, total loss of amenity, dislocation of people, significant impact to the national economy

Particular care is required when developing the *consequence* categories. The consequence descriptions need to consider what the impacts could be if the water delivery *objectives* are not met: that is, if water cannot or is not delivered to a certain location for some set of activities, what could happen?[1] The consequences could relate to a variety of areas. For example, there may be adverse impacts to the environment, public health, the local economy, or the reputation and business of the water providers. Because the nature of the consequences differs, it might be necessary to split the consequence descriptions at least under these headings or others. It is important to note that, where consequences are listed in a table such as the one above and where impacts are discussed under a variety of different types, there is an inference of equivalence in the severity of the consequence along each row. Consideration will be needed to ensure that these inferences of equivalence are defendable, and where appropriate, agreed with stakeholders.

During the development of the risk matrix and event likelihood/consequence categories, the water planner will need to consider two things:

- What level of action may be appropriate for risks of different levels?
- What may constitute an 'acceptable' level of risk?

In regard to the first point, if a risk is rated as 'very high', it will probably require a greater or more rapid response than one rated 'low'. Outlining the type of response that may be required for risks of different levels will provide guidance for the risk estimation/evaluation stage of the process, for example:

Risk Level	Action	Timing
Very low – low	Continue routine approach to management – no specific actions required	Ongoing
Moderate – high	Manage by specific monitoring or response procedures	Within water plan period
Very high	Develop management or investigation plan, cease activities for which high risks may arise	Immediate

The description of actions required for different risks at this stage can be quite generic and will be developed further as part of the risk evaluation.

At some point, a risk can be considered as insignificant enough, or well-enough managed, that it may require no further specific treatment beyond what is already in place. In this case, a decision has been made that such a risk level is 'acceptable'. For example, this approach could be adopted when a risk is estimated as 'very low' or 'low' on the scale presented in the risk matrix above.

Hence, when setting the type of action that would be appropriate for a certain risk level, the 'acceptable' level of risk also needs to be considered. If a water planner adopts a risk matrix such as the one above, on the premise that anything considered a 'low' risk is already well managed and that no further action is required, the planner should also check the *likelihood*

[1] When allocating the consequence score, it will depend on some further details, such as how severe the loss of water availability, and the duration of the loss. These details should form part of the event scenario, as described later.

and *consequence* categories that have been adopted and the combinations that could produce a 'low' risk and ascertain that the combination is 'acceptable'.

- **Estimate risk level / Evaluate risks (and record the process)**

The descriptions of risks (risk identification) and the risk matrices developed will be useful frameworks with which to estimate and evaluate the level of risk. The risk estimate itself should be based on a combined consideration of existing data, modelling, investigations and the experience of those involved in managing and using the water resource. All of these information sources should be considered when forming any judgments about the levels of risks posed. The reasons for any particular risk allocation need to be outlined explicitly with clear reference to the information that supports the judgment.

While a core nominated team should be responsible for collating and analysing such information, a stakeholder workshop is a useful way of conducting the risk assessment. The participants should be provided with this information prior to the workshop. A record of the discussions on the day can be kept in a risk register such as the one shown following:

EVENT SCENARIO				RISK		CONTROLS	RESIDUAL RISK		Comments, justification, management actions
ID	The risk	What can happen? (the source)	What can result? (the impact)	Likelihood	Consequ-ence	What controls are in place?	Likelihood	Consequ-ence	
001	Pollution of water supply	Tankers carrying xylene tips over and ruptures, spilling content	Lack of water for human consumption, fish kills and potential loss of plant life, water unsuitable for irrigation	Rare	Catastr-ophic	Local emergency response plan, health warning systems	Rare	Catastr-ophic	
002	Loss of access to 100% of entitlement	Increase in plantations in catchment to changes in policy	Loss of water security of existing entitlement holders	Possible	Moderate	Limited legislation, current planning controls, community outrage	Unlikely	Moderate	…
003	Land subsidence	Groundwater over-extraction	On-farm distribution systems disrupted resulting in increased losses	Possible	Moderate to major	Current legislative controls, water plans	Unlikely	Moderate	…
004	Infrastructure failure	Lack of investment leading to structural collapse	Inability to supply water	Possible	Major	Asset maintenance	Unlikely	Moderate	…
005	Mine closure	Mine becomes uneconomic	Insufficient water to supply an expansion of workers to meet changing economic conditions	Possible	Moderate	Current legislative controls, water plans	Possible	Moderate	

When assessing the consequence, the following factors need to be considered:

- the value or importance of the water-reliant activity that would be impacted by a water shortage
- the spatial extent of the impact, whether the damage or loss would be local or regional
- the capacity of the element at risk to recover from the damage, and how vulnerable it was in the first place
- the temporal extent of the damage – will it be short-term, long-term or permanently enduring?

NB: Dealing with uncertainty – during the risk evaluation there will undoubtedly be many uncertainties that arise. These may be due to, for example, inadequate data, uncertain information, or a lack of knowledge about the scientific or technological causes of certain events. These uncertainties cannot be ignored. The simplest way to deal with uncertainties, where they exist, is to be conservative in the risk evaluation so that the particular risk event is flagged for further attention. Notes in the risk register should make it clear that the risk evaluation is a conservative one, and that more information is needed. The management strategy in this situation may involve initiating a targeted research exercise that deals with the uncertainty.

- **Treat the risks**

Once the risks have been identified and evaluated, risk mitigation measures can be identified. The treatment of risk will involve assessing and implementing options for reducing the likelihood, the consequence, or both, to reduce the risk to an acceptable level.

Mitigation measures can relate to:

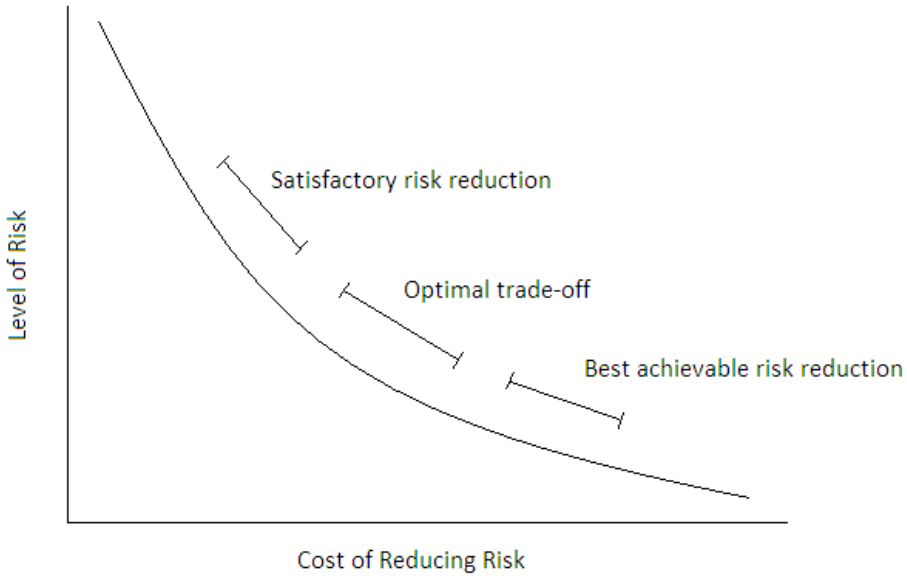
- avoiding the risk eventuating
- changing the likelihood of the risk eventuating
- changing the consequences should the risk eventuate, for example:
    - measures implemented well before the source of risk occurs, such as the provision of a redundant or a back-up supply of water so that delivery can continue even when the event happens,
    - actions for implementation at the onset or during an event, or
    - recovery after the occurrence of an event.
- sharing the risk.

For example, if there was a risk of failure of an irrigation distribution system, responses that aim to change the consequences could be either to:

- restricting landholder access to groundwater during the downtime
- monitoring the situation and having in place a plan to implement if the event occurs, for example cart water to the individual landholders for distribution on farm.

Note that the mitigation strategy adopted could impose additional risks on other water uses. These also need to be considered as part of the risk assessment.

The decision to adopt the risk treatment needs to be based on a cost–benefit consideration. There will be some trade-off between the cost of reducing a risk and the reduction in the risk level:



Those mitigation strategies adopted should be included in all water plans.

- **Monitor and review**

Monitoring should be designed and undertaken so that:

- the monitoring outcomes can be interpreted as providing evidence as to whether the water plan objectives are being met or otherwise, and
- the results can provide a warning of impending risk events.

The risk assessment and management plan process should be reviewed periodically. The period of review can be set by the planner, but it should be frequent enough to ensure that the plan continues to be relevant.

The other instances for which the risk evaluation and management plan would require some review would be:

- in response to some observed alteration to the water system
- to assess the impacts of a proposal to change the system (for example, a new interception activity) and to make a decision on whether to proceed
- when mitigation strategies are developed that pose new risks to the objectives that will require some treatment
- when monitoring results indicate that a risk may be significantly greater than was estimated during the initial evaluation.

- **Stakeholder communication and consultation**

The development of a water plan is a joint responsibility between the relevant agencies, users of the plan and the general public. Stakeholders should be consulted during all aspects of the development of the water management plan, particularly during the setting of objectives (and the trade-off assessment) and the risk identification/evaluation.

Clear communication, information availability and documentation of the consultation process should be features of the risk assessment and management plan development.