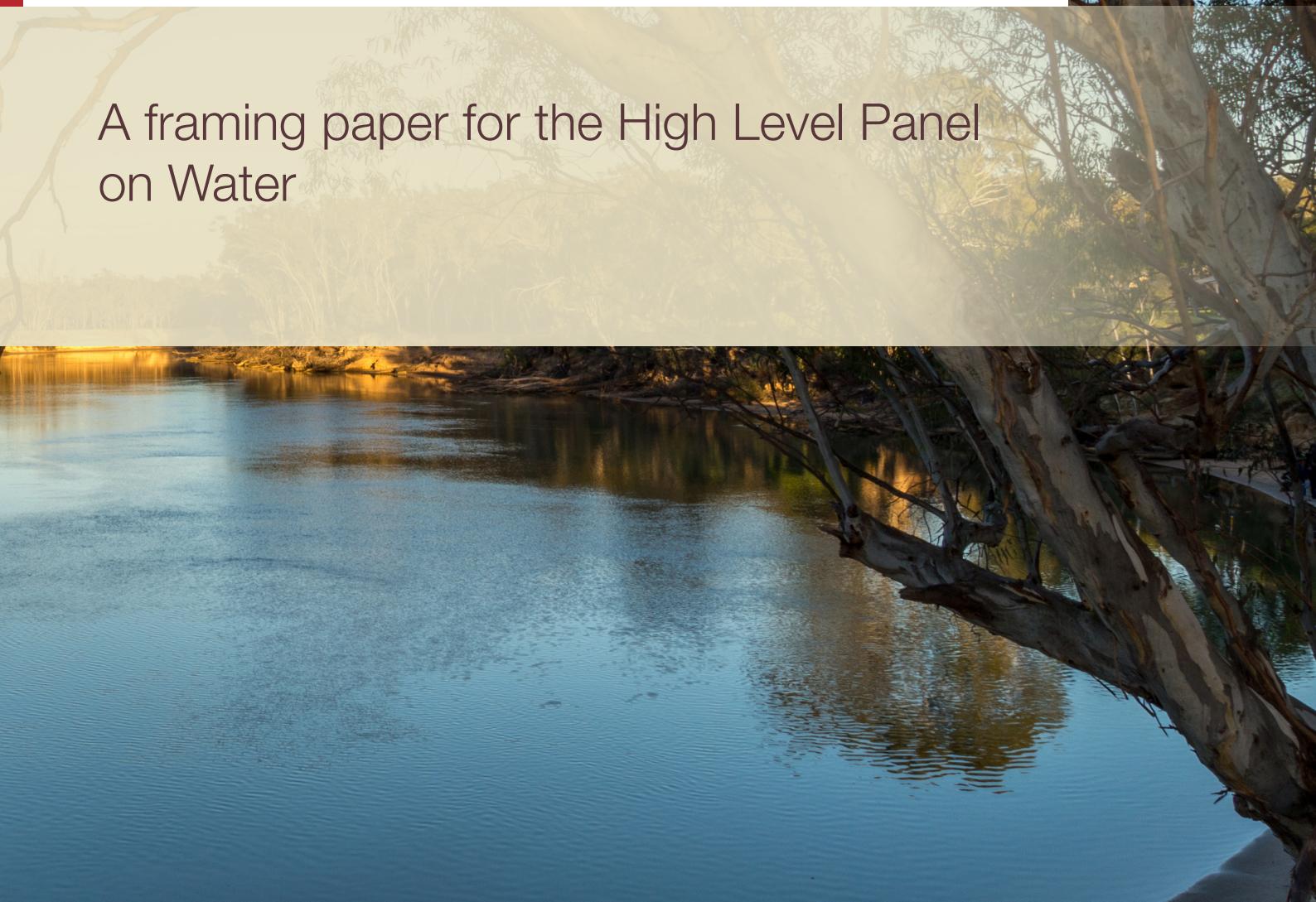




# A Guide to Managing Water for the Environment



A framing paper for the High Level Panel  
on Water

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**A I T H E R**



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March 2018

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## Abbreviations

CEWH	Commonwealth Environmental Water Holder
CEWO	Commonwealth Environmental Water Office
HLPW	High Level Panel on Water
IWRM	Integrated water resource management
MDB	Murray-Darling Basin
MDBA	Murray-Darling Basin Authority
SDG	Sustainable Development Goal(s)
VEWH	Victorian Environmental Water Holder

## Glossary

Water for the environment	The portion of total water resources in a given system that sustains the water dependent ecosystem assets and the ecological processes that define the health of that system.
System health	The health of the environment at the catchment or aquifer scale, which contributes to the health of society and the economy.
WaterGuide	A framework designed to help decision makers optimise outcomes from the management of scarce water resources, including by understanding and communicating the value of water to users.

## Key messages

1. In contexts of competing demands for water, widespread pollution, and over-extraction for agricultural and industrial uses, current water allocation and use practices are increasingly unsustainable and threaten system health.
2. Individuals, communities and governments seeking to improve management of water for the environment need to collectively define what ‘system health’ means, at the scale of the catchment or aquifer.
3. Environmental, social, economic and cultural benefits that can be achieved from managing the health of surface and groundwater systems — more resilient economies and societies; sustainable cities; improved access to clean water; and increased investment — should be clearly articulated.
4. Unsustainable water use threatens ongoing access to a wide range of benefits and values, well beyond those directly related to the river, lake, estuary, aquifer or wetland. Managing water for the environment is ultimately about much more than protecting ecosystems.
5. To the extent surface and groundwater systems continue to decline as a result of decision makers opting not to allocate, manage or enforce water for the environment, the consequences of these actions will include forgoing the range of benefits that could otherwise be realised now and in the future. These trade-offs should be made transparent and should be understood by all stakeholders.
6. This guide presents six elements that can be helpful when establishing or reforming a policy framework for managing water for the environment in any jurisdiction, based on learnings from the experience of Australia and other countries:
  1. Confirm a vision for water management and the value of water
  2. Understand changing water availability and demand over time
  3. Determine allocation of water between uses
  4. Ensure effective water policies and institutions
  5. Plan, monitor and deliver water for the environment
  6. Assess and improve system effectiveness and efficiency
7. Globally, provision and management of water for the environment needs to be urgently improved. This guide provides examples that demonstrate how practical action — recognising water dependent values, better managing infrastructure, and reforming allocative and other management systems, for example — can deliver progress in both the near and long term.
8. Importantly, this guide demonstrates that managing water for the environment can deliver not only environmental benefits, but economic, social and cultural ones too.

# 1 Background

## 1.1 Australia's contribution to the High Level Panel on Water

This practical guide is an Australian contribution to the work of the High Level Panel on Water (HLPW), of which Australia is a member. The HLPW was established in 2016 to ‘mobilize effective action to accelerate the implementation of Sustainable Development Goal (SDG) 6 and its related targets’. SDG 6 seeks to ‘ensure availability and sustainable management of water and sanitation for all’. The effective management of water for the environment is relevant to many of the HLPW’s thematic areas of interest and activity: ‘Water and the Environment’; ‘Resilient Economies and Societies’; ‘Water Infrastructure and Investment’; ‘Sustainable Cities and Human Settlements’; and ‘Universal Access to Safe Water and Sanitation’.

This guide offers practical advice for countries seeking to improve management of water for the environment within an SDG timeframe (i.e. by 2030). It describes common challenges and draws on Australian and international experiences in designing and implementing solutions. The guide focuses on improving management of water for the environment where there are competing demands for water, rather than in settings where there is an abundance of water. In many countries, the water demands of agriculture, industry, towns and cities are increasing year on year. As pressure on existing resources and the natural environment increases, water allocation and use decisions must acknowledge the fundamental importance of water for the environment as the basis for system health. Without system health being maintained, water dependent values are unable to be sustained. Water policy and management settings should be designed, implemented and monitored to sustain surface and groundwater system health into the future.

This guide has been developed as a companion piece to two of Australia’s previous contributions to the work of the HLPW: *Valuing Water* (Aither 2016) and *WaterGuide: Setting a path to improved water management and use under scarcity* (Aither 2018). The WaterGuide framework is designed to help decision makers improve outcomes from the management of scarce water resources, including by understanding and communicating the value of water. This guide reflects the six-element structure of WaterGuide, transforming and applying it in the context of determining and sustaining the health of surface and groundwater systems. Australia anticipates that the practical guidance offered in the pages of this document may assist decision makers grappling with the inherent complexity of managing water for the environment.

### Box 1: The High Level Panel’s view on water and the environment

The HLPW published its Action Plan in September 2016 (United Nations and World Bank Group 2016). In the Action Plan, the Panel notes the importance of both water quantity and quality to the maintenance of a healthy environment. According to the Panel, ‘protecting or restoring the environment — or maintaining or expanding ‘natural infrastructure’ — may be the most cost-effective approach to avoiding water stress’. The Panel advocates that built (grey) and natural (green) infrastructure should be considered together, with investments in natural infrastructure potentially offsetting the need for some built infrastructure investments. The Panel cites the example of watershed restoration in the catchment upstream of a dam as contributing to reduced sedimentation and hence reducing the storage volume required in the reservoir.

Source: United Nations and World Bank Group 2016.

## **1.2 The SDGs and other international commitments**

Existing international commitments reflect the importance of effectively managing water for the environment to sustain the benefits provided by surface and groundwater systems to individuals and communities everywhere.

The SDGs motivate the actions of the HLPW. In 2015, the United Nations adopted the SDGs and called for countries to take action to eradicate poverty, protect the planet and ensure prosperity for all by achieving 17 specific goals (United Nations 2015). Sustaining natural systems is key to the SDGs and achieving many of the goals depends on effective water management:

- SDG 6 includes a target, and associated indicator, for the protection and restoration of water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes (6.6).
- SDG 6 aims to improve water quality by reducing pollution (6.3); this is critical to protecting and restoring water-related ecosystems and will also increase the total volume of water available that is appropriate for human use.
- SDG 6 seeks a substantial increase in water-use efficiency across all sectors, including to combat water scarcity (6.4); achievement of this goal could free up additional water resources to sustain system health where water use is unsustainable at present.
- SDG 15 includes a target to ‘ensure conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services’ by 2020 (15.1).
- SDG 15 relates to the integration of ‘ecosystem and biodiversity values into national and local planning, development processes, poverty reduction strategies and accounts’ (15.9); recognition of the value of water for the environment directly facilitates achievement of this goal.
- Progress toward many goals will be indirectly supported by the effective management of water for the environment, including goals concerned with hunger (2), health and wellbeing (3), affordable and clean energy (7), sustainable cities and communities (11), and climate action (13).

The SDGs are the latest step in a long journey toward improved global management of water for the environment. Box 2 describes some of the international commitments that preceded and informed the development of the SDGs.

### **Box 2: Selected international commitments to providing water for the environment**

The International Convention on Wetlands, initiated in 1971, was the first international commitment to protecting and restoring freshwater ecosystems and environmental health. Now known as the Ramsar Convention on Wetlands of International Importance, the Convention has been ratified by 169 nations (Ramsar 2014). Since the Ramsar Convention came into force, there have been several other important international commitments to improved management of water for the environment, including:

- adoption of the Ecosystem Approach by the Convention on Biological Diversity in 1992;
- recognition and inclusion of environmental flows in the Convention on the Protection and Uses of Transboundary Watercourses and International Lakes in 1992;
- adoption of the United Nations Convention on the Law of Non-Navigational Uses of International Watercourses in 1997;

- acknowledgement of ecosystem needs and associated social impacts both upstream and downstream by the Report of the World Commission on Dams in 2000;
- recognition of the need to provide environmental flows to maintain downstream ecosystem functions by the International Hydropower Association in 2004 (IHA 2004); and
- establishment of ecological and social principles of environmental flows, and declaration of the need to embed water for rivers into science, assessment, strategic planning and policies, at the 2007 International Riversymposium, resulting in the Brisbane Declaration.

### **1.3 *Objectives***

This guide has been developed to meet the following objectives:

1. To define ‘water for the environment’ and improve understanding of the importance of managing water for the environment as fundamental to system health (Chapter 2).
2. To offer practical guidance to inform efficient and effective management of water for the environment, by sharing Australia’s approach and experience, and by offering examples from other countries where relevant (Chapter 3).

The guide presents six elements of improved management of water for the environment. It is not intended that these should be regarded as prescriptive ‘steps’ in a defined process. Instead, each element is an area for action. There are many high-quality reports, articles and handbooks that exist for the benefit of environmental water managers and other technical specialists (Horne et al 2017; Harwood et al 2017). The intention of this guide is that it serves as a source of practical insight for decision makers wishing to improve the management of system health within their jurisdiction, and a source of inspiration for those who wish to make the case for adequate resourcing for these improvements.

## 2 Importance of water for the environment

Most of the world's surface and groundwater systems have been modified from their natural state. Water abstractions of any volume have an impact on the health of a system and so have the potential to compromise natural assets and ecosystem processes. Acknowledging that human influence is so pervasive and has had such significant impacts on rivers, lakes, wetlands, estuaries and aquifers on every continent, what then do we mean by 'water for the environment' and why is it important?

### 2.1 What is 'water for the environment'?

Water for the environment is the portion of total water resources in a given system that sustains the water dependent ecosystem assets and the ecological processes that define the health of that system.

For surface water systems, water for the environment is not simply a matter of quantity; it is a regime defined by 'the quantity, timing and quality of water required to sustain freshwater and estuarine ecosystems and the human livelihoods and well-being that depend on these ecosystems' (Brisbane Declaration 2007). In groundwater systems, water for the environment is generally less well understood. However, it is similarly recognised that the health of groundwater systems depends not just on water quantity but also on the timing, quality and location of water (Murray et al 2003). Consideration should also be given to surface water-groundwater relationships in hydraulically connected systems.

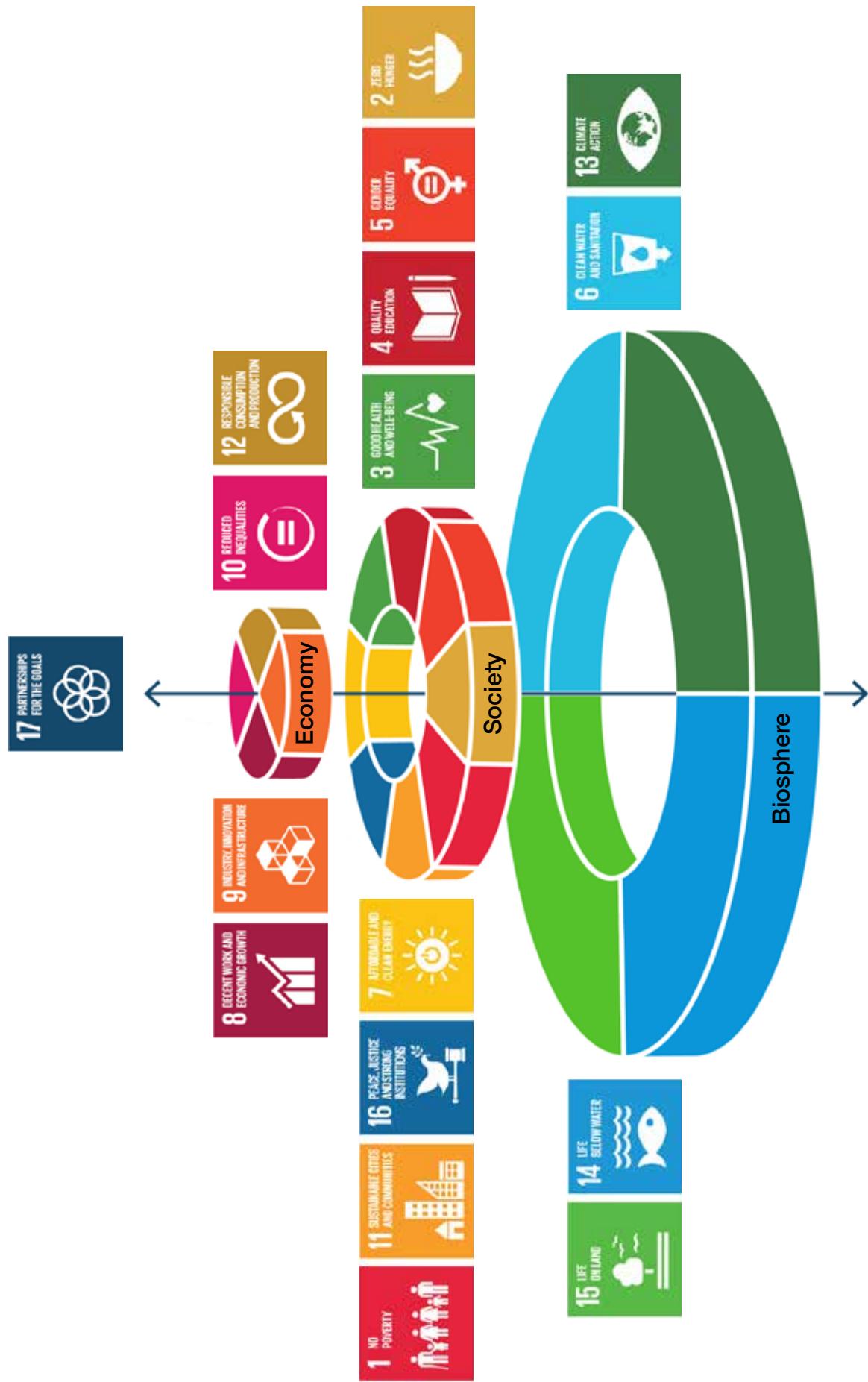
### 2.2 Why is water for the environment important?

When surface and groundwater systems experience alterations to natural water movement, distribution, temperature, or quality, assets and ecosystems are impacted. Sometimes, those assets and ecosystems are pushed beyond their ability to rebound, resulting in the degradation of the system as a whole. Changes to river flow regimes, for example, are likely the single biggest factor in the 81 per cent decline in global freshwater species populations observed since 1970 (Harwood et al 2017).

Water abstractions of any volume change natural systems, often in significant ways. Large or poorly timed abstractions from a single system can reduce groundwater infiltration, lower water tables, lead to the closure of river mouths, isolate river pools, destroy mangroves and wetland habitats, prevent fish spawning and migration, reduce carbon cycling and increase pollution loads, and lead to salt water intrusion (Hirji and Davis 2009). Even relatively small abstractions, or reversals of the flow regime, can be highly disruptive to ecosystems and ecosystem functioning.

While water for the environment does not explicitly include uses beyond ecological ones, it is recognised that the water that sustains ecosystem assets and associated ecological processes underpin the health of surface and groundwater systems. The health of those systems, in turn, sustains a wide range of social and economic benefits and values. By protecting or restoring water for the environment, various water dependent social, cultural and economic values can be sustained. Conversely, unchecked use of water will impact on system health and all of the values that depend on a healthy system. The relationship between biosphere health (including as promoted by the achievement of selected SDGs, such as SDG6) and accelerating social and economic progress (including as evidenced by the achievement of all SDGs) is illustrated in Figure 1. This clearly demonstrates how water for the environment, along with other biosphere-related SDGs, supports the achievement of all other economic and social objectives.

**Figure 1** Water for the environment supports the SDGs



Source: Stockholm Resilience Center 2017

## **2.3 How does managing water for the environment deliver benefit?**

When water for the environment is effectively and adaptively planned and delivered, it can contribute to realisation of the wide range of environmental, social and economic benefits described above.

*It's increasingly clear that,  
in the mid to long term,  
failure to meet environmental  
flow requirements has  
disastrous consequences  
for many river users.*

Dyson et al 2003

When water for the environment is not managed or is poorly managed, the impacts on system health can impose additional consequences on all other users of the affected water bodies. In Asia, research reveals that almost 80 per cent of rivers, with a total economic value of USD 1 trillion, are in poor health (ADB 2013). Not taking action to restore the health of these rivers puts at risk the livelihoods of the tens of millions of people who reap the range of social, cultural and economic benefits provided by them. While the costs of

inaction can be significant, the consequences of poorly planned action can be just as high. For example, destructive blue-green algal blooms have occurred on multiple occasions in the River Murray in Australia as a result of changes in flow patterns caused by the construction of weirs and the manipulation of flows, largely for agricultural needs. In 2010, costs associated with these algal blooms were estimated at USD 94 million per year (NSW Office of Water 2010).

Effective management of water for the environment can be pro-poor. Since the poor often rely on healthy environments more directly than other people for their livelihoods, managing water for the environment can have a disproportionately positive influence on their lives (Silvius et al 2000; Mainka et al 2005; MEA 2005).

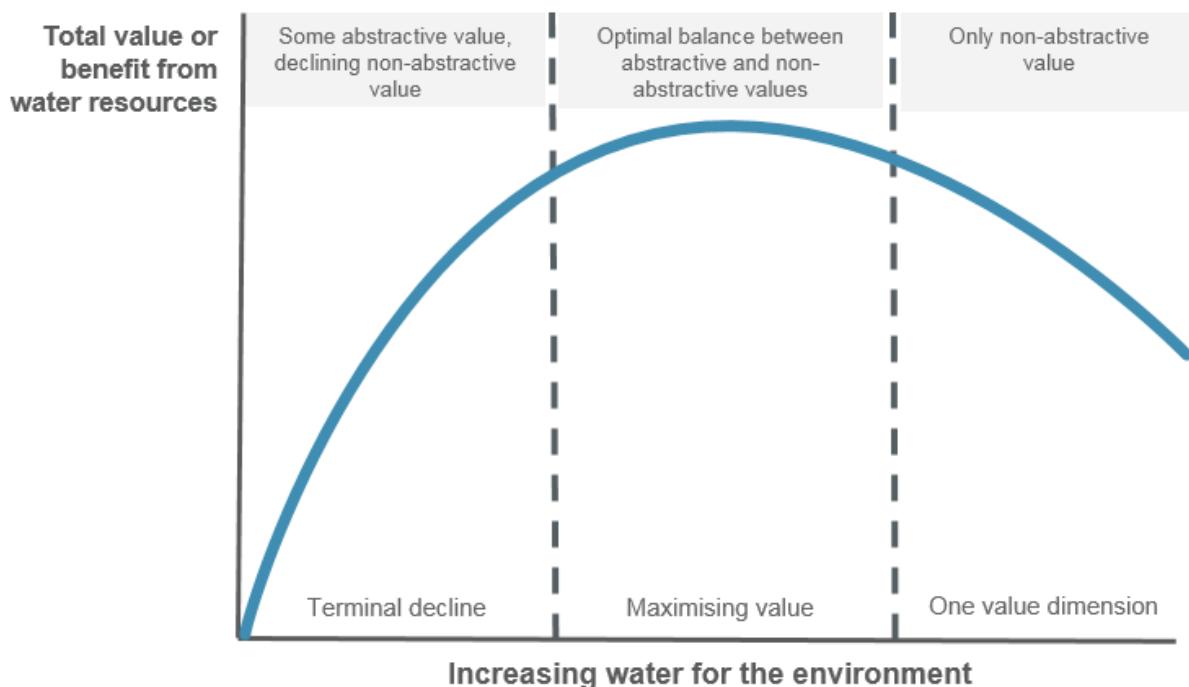
## **2.4 What needs to be considered when managing water for the environment?**

Active and adaptive management of water for the environment offers the best long-term prospect of sustaining water dependent ecosystem assets and ecological processes, and the broader economic, social and cultural values that rely on system health. As soon as there is some level of abstractive water use in a system, there are trade-off decisions that must be made. Managing water for the environment is about actively managing these trade-offs, fully understanding the consequences of the available courses of action, and achieving outcomes that are as close to optimal as possible.

'Value' offers a useful conceptual lens for thinking about trade-offs. The value of water is the benefit that people receive from water. This includes all people and all alternative uses and is not limited to commercial benefits. Individuals, communities and governments make implicit judgments about the value of water all the time, in the way they source, share and use available resources. Often, however, the range of benefits that water for the environment provides (as described above) is not adequately included in these judgments. This tends to result in trade-off decisions that excessively favour abstractive use of water, providing tangible short-term — often, financial — benefits. Abstractive uses are uses where water is removed from a water source and consumed to generate value, often for social and commercial benefit. In many surface and groundwater systems, these benefits include domestic, stock, agricultural and industrial uses.

Acknowledging and accounting for the benefits of managing water for the environment in the context of system health (and the implications of not managing it) enables more informed and transparent decision making by all stakeholders. The contribution of water for the environment to provision of the wide range of benefits described above is shown conceptually in Figure 2.

**Figure 2 Managing water for the environment to maximise benefit**



Effectively managing water for the environment requires identification of the specific water requirements for maintenance of system health. Allocating water to the environment seeks to maintain system health by limiting water abstractions. As a larger proportion of a system's water resources are abstracted and consumed in agriculture, industry and domestic settings, less water is available for the environment. In most systems, this will lead to a decline in system health. The challenge is to ensure that water abstractions do not breach ecosystem limits, irrevocably damaging system health and placing all water dependent values at risk.



Photo: Chris Arnott 2018.

## **2.5 A framework for effective management of water for the environment**

Management of water for the environment must occur within a water resource planning framework that accounts for all water uses in a given basin, catchment or aquifer. The best approach to managing water for the environment will vary based upon the setting. This guide sets out the fundamentals of effective management of water for the environment in a way that allows for difference, providing guidance that is applicable at multiple scales and recognises the financial, political and human resource constraints within which all decision makers must operate.

The body of this guide sets out the elements of effective management of water for the environment. These elements provide practical options for countries and water managers seeking to improve management of water for the environment and realise the associated benefits.

While every context is different, the elements show that any approach to managing water for the environment requires:

- a vision for water management, informed by an understanding of system health needs and associated water dependent values in the local context (element 1);
- an accurate understanding of current water availability and demand, and realistic estimations of future availability and demand under multiple scenarios (element 2);
- an agreed approach for allocating water to the environment, determined through an assessment of the trade-offs involved in relation to all water dependent values, while recognising that long-term system health is fundamental to the maintenance of all other values (element 3);
- the development of effective policies and institutions for implementing allocation decisions and establishing and protecting the rights of the environment (element 4);
- a plan for achieving agreed system health outcomes, and for managing and operating associated works and measures in accordance with the plan, followed by monitoring of outputs and outcomes (element 5); and
- ongoing evaluation of outcomes, which should be communicated to stakeholders, as the basis of ongoing adaptive management (element 6).

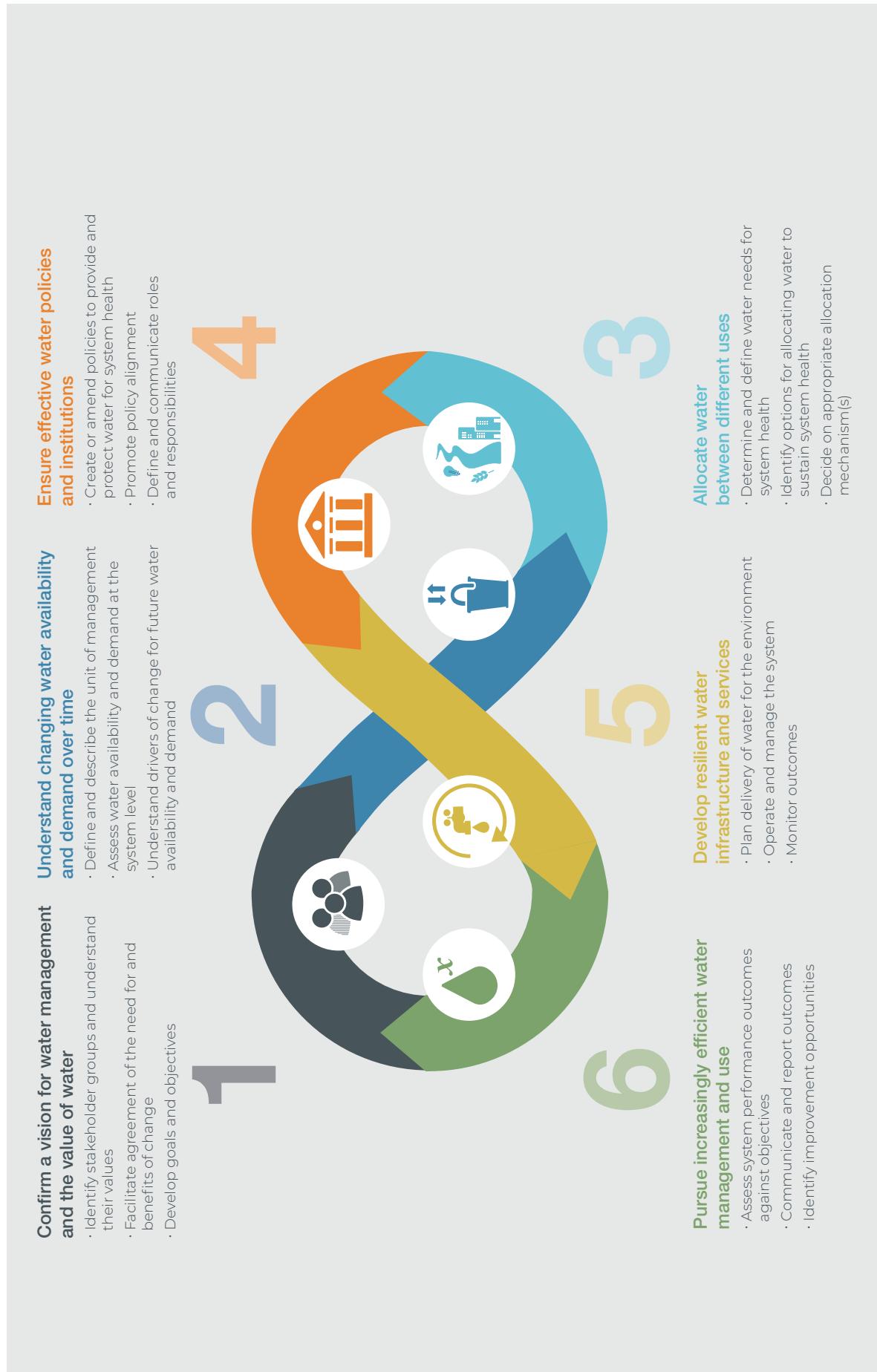
While the elements are numbered, it is important to consider them both collectively and discretely. They are not intended to be applied as sequential ‘steps’ in a linear process. Rather, the major consideration should be whether or not they are present and where the most value might be derived through focus on one or more elements. In addition, just as the elements are shown mapped against an ‘endless loop’, there is recognition that:

- engagement with the elements may commence at any point around the loop; and
- value will continue to be derived by returning to each element over time, reviewing and refining efforts based upon an adaptive management approach informed through monitoring and evaluation of system performance.

The six elements, and associated recommendations for action, are summarised in Figure 3.

**Figure 3**

**Fundamentals of effective management of water for the environment**



### 3 Fundamentals of effective management of water for the environment

#### 3.1 Confirm a vision for water management and the value of water

Maintaining system health is a sustained effort that demands a similarly long-term vision for outcomes from water management. This vision should relate to outcomes from both abstractive and non-abstractive water use, recognising and communicating the benefits of sustaining system health. The vision will be strengthened to the extent that it is shared by stakeholders in government (including across ministries and departments), various water-using sectors, civil society, and the general population. A vision for what is desired from water management should consider how different stakeholders value water differently in different uses and at different times. Many international frameworks have identified the establishment of a shared vision as a critical initial step for bringing about positive change (United Nations 2015, IAP2 2014).

##### **Benefits:**

- Reveals the benefits that water provides to different stakeholders, including through abstractive and non-abstractive use
- Provides a clear basis on which to debate trade-offs and make the consequences of these decisions transparent to all stakeholders
- Provides clarity for determining objectives and targets, and system monitoring and improvement over time

##### **Inputs:**

- Active facilitation and support to ensure diverse and representative stakeholder engagement
- Good information on the benefits provided across water uses at different levels of consumption and system health
- Political commitment to managing water on the basis of its value to different stakeholders

##### **Activities:**

- Engage stakeholder groups and determine the value they attach to different water related outcomes
- Facilitate improved understanding of the need for and benefits of change
- Develop objectives for the management of water for the environment
- Identify ‘champions’ to argue the merits of the proposed vision, in particular the fundamental value of system health

### **3.1.1 Identify stakeholder groups and understand their values**

Stakeholders are individuals, groups or organisations that have an interest in or are affected by a particular issue (Freeman 1984). In order to identify stakeholders in a given context, one needs to understand where, when and how the impacts of water management are felt by different individuals and groups (Steyaert and Jiggins 2007). For example, policies and mechanisms for managing water in a particular water source are likely to be of interest to the individuals who live near that source and are dependent on the use of the water source, but could also have impacts on the lives of others who attach value to, or have aspirations for, the water source (Conallin et al 2017). This wider grouping could include individuals who occasionally travel to the water source for recreational purposes, or international non-government organisations with an interest in protecting plants or animals associated with the water source. In waterways, downstream water users are another important stakeholder group, with a large proportion of the world's population living in estuaries or on coastlines (Harris et al 2014). Failure to consult all interested stakeholders on matters of water management can increase the likelihood of opposition to policy decisions that affect, or are perceived to affect, their interests.

Once stakeholder groups have been identified, there is a need to establish one or more representative groups to facilitate consultation with, and between, those stakeholders. These groups should include system operators, environmental water managers, scientists, and a wide range of water users, from farmers to fishers and factory owners. Local people, vulnerable groups, minorities, women, and indigenous people should be included; effective and enduring management has been directly linked to participation by local people (Schultz 2011). A balanced consultative group will provide the basis for all perspectives to have an appropriate weighting. In Australia's Murray-Darling Basin, various consultative groups have been established. Some are designed to facilitate discussion between national and subnational governments, while others seek to gather the views of local environmental advisory groups, such as the Macquarie Cudgegong Environmental Water Advisory Group in New South Wales (NSW Office of Environment and Heritage 2017).



Photo: Amy Syrrud 2013.

These groups can also allow for the identification of stakeholder values. Different values will drive recognition of the importance of water for the environment in different contexts and among different stakeholders. In each case, there will be a number of values influencing change, although some may act as stronger drivers than others. In Australia, while there were social and economic drivers of change, ecological values were the strongest driver in improving management of water for the environment. Specifically, the loss of floodplain forests and birds encouraged the government to adjust the way water resources were managed (Acreman et al 2017). In India, cultural values have often been an important motivator for the restoration of environmental flows, as most rivers are linked to customs, festivals and social rituals such as marriage, worshipping and cremation (Acreman et al 2017). In the United Kingdom, recreational and aesthetic values have driven public support for improved management of water for the environment.

By mapping stakeholder values, policy makers can

understand and leverage overlaps between the interests of diverse groups. These commonalities hold the greatest potential for reconciling conflict among seemingly divergent values. Through this process, it is important to clearly define what it is that people value, as certain terms are often interpreted differently.

For example, an abundance of fish could signify a ‘healthy environment’ to one person, while another person in the same context may define a ‘healthy environment’ as one in which those same fish are not only in abundance, but are also safe to eat. It is important to connect vague concepts, such as a ‘healthy environment’, to clear and specific outcomes.

### **3.1.2 Facilitate agreement on the need for and benefits of change**

Members of the public are often unaware that they live in a modified natural world. In Victoria, Australia, a survey exploring Victorians’ knowledge of, and attitudes towards, water for the environment found that only 16 per cent of respondents were fully aware that Victoria’s waterways had been modified for human use (ORIMA Research 2017). This demonstrates the importance of education as the basis for advocating the benefits of managing system health, and the consequences of inaction.

*Any arguments for environmental water protection or restoration will need to resonate with business continuity and government priorities, and perhaps with higher degrees of community participation.*

Richter and Orr 2017

Advocates for protecting or restoring water for the environment must determine how to align and integrate those values that are most strongly influencing water allocation and use with planned restoration and protection initiatives (Richter and Orr 2017). It is often the broad social, economic and cultural benefits of effectively managing water for the environment that are most effective in

promoting action from diverse stakeholder groups. A clear narrative should be established, linking the future of societies and economies with sustainable water management and the health of the ecosystems that allow them to thrive.

In order to support new initiatives, opinion makers and group leaders (perhaps already convened in a consultative group) must recognise the benefits that will be realised by managing water for the environment. At the same time, not everyone will be totally satisfied by the process of, or outcomes from, water management — those with authority over management decisions should be transparent about this fact. While some trade-offs will be necessary, there are likely to be benefits and connections between the interests of different groups that will not be immediately apparent; these should be explored and highlighted.

### **3.1.3 Develop goals and objectives**

Once stakeholders agree that there is a need for change in the way water is managed, a consensus needs to be reached on what that change should look like and how it should be achieved. A vision for the system alone is not enough; specific goals and objectives that define the measurable components of that vision need to be developed as the first step toward a plan for action. Ensuring that objectives for all water dependent values are defined in a clear and measurable way will provide the basis for any necessary trade-off decisions that are referred to in Element 3 of this guide.

*Establishing a shared and defined vision is a critical initial step in managing river resources and implementing environmental water regimes.*

Horne et al 2017b

These goals and objectives must be determined collaboratively and should reflect water dependent aspirations of stakeholders for system health. They should be determined at the appropriate scale, ideally in a way that aligns the agendas of national, subnational and local management authorities. In the Columbia River Basin in the USA, for example, the Bonneville Power Administration, a federal agency, worked in partnership with state regulatory agencies, nongovernmental water trusts, conservation organisations and watershed groups to successfully recover water to enhance fish habitat in tributaries across all four states in the Basin (Garrick 2009).

Finally, it is important to clearly define indicators for measuring progress against goals and objectives. Qualitative indicators may be useful in describing benefits and progress for general audiences, but quantitative indicators will usually be necessary to improve the validity of findings and to hold to account those responsible for specific outcomes. As this is an ongoing adaptive and iterative process, goals and objectives developed at this stage will need to be regularly revisited and revised at later stages. Specific and measurable outcomes are also fundamental to effective system monitoring, detailed in Elements 5 and 6.

### **Case Study 1: Establishing a vision for a shared surface water system**



The Nile River holds significant potential to foster regional social and economic development through advances in food production, transportation, power production, industrial development, and other related activities. In an attempt to achieve these benefits, nine riparian countries that share the Nile River Basin's water resources have joined together to create the Nile Basin Initiative (NBI, the Initiative) through the Council of Ministers of Water Affairs of the Nile Basin states. The nine countries are Burundi, Democratic Republic of Congo, Egypt, Ethiopia, Kenya, Rwanda, Sudan, Tanzania and Uganda. These countries decided to collaborate after recognising that cooperative, sustainable management of the Nile River holds the greatest potential to address current challenges and realise identified values and desired benefits.

The first step of the Initiative was to come up with a shared vision for the water source: 'to achieve sustainable socio-economic development through the equitable utilisation of, and benefit from, the common Nile Basin water resources'.

The establishment of this vision led to the creation of

The Shared Vision Program and the Subsidiary Action Program, which provided guidance to states in determining concrete actions, projects and activities that they could pursue in order to fulfill their vision. The NBI also identified specific objectives and long-term goals to work towards in order to realise the vision — one such objective is to 'build trust, capacity, and an enabling environment for investment in the Nile Basin countries'.

While there have been multiple efforts like this to establish basin-wide cooperative institutions and programs in the Nile River Basin, it has become increasingly difficult to realise the shared vision due to changes in water availability and demand, and regional geo-politics. Given these challenges, it is even more important to re-confirm a vision for the management of the Nile River and the value of its resources in order to foster environmental conservation, peace, socio-economic growth, and many other related benefits.

Photo: World Wildlife Fund for Nature 2017.

## **3.2 Understand changing water availability and demand over time**

Without an understanding of water availability at the catchment or groundwater system scale, and the way this can change over time, it is impossible to establish the water balances needed to sustainably manage water resources for the full range of current and future needs. The consequences of changing water availability and demand for environmental assets should be carefully assessed. Reliable data and models are essential, though this can be particularly challenging in surface and groundwater systems where hydraulic connection is difficult to determine. Data collection, analysis and sharing is central to improved management of water for the environment, ensuring that all stakeholders have a similar level of understanding of the state of water resources and the system as a whole, and of the factors that can impact that system. Current and future uncertainty and risk should be minimised, recognising that uncertainty can never be fully eliminated. Recognising these challenges and the importance of higher quality information, the High Level Panel on Water has undertaken work in water data as a key part of its program, through its ‘World Water Data Initiative’.

### **Benefits:**

- Understanding the dynamic characteristics of the water resource provides the foundation for informed stakeholders and decisions, and ongoing assessment of system performance
- The largest areas of uncertainty and potential risk can be identified and progressively improved
- By developing future scenarios, potential crisis points and shocks can be identified and avoided or mitigated in a more structured and proactive manner
- Stakeholders who understand the criticality of reform are more likely to be engaged in supporting and delivering that reform

### **Inputs:**

- Water information systems, including relevant software and instrumentation
- Local capacity for data collection and analysis

### **Activities:**

- Clearly define the unit of management
- Clarify the supply-demand situation for the unit of management, including risks and trends over time
- Ensure that good water information underpins supply-demand estimates and future projections
- Employ hydrologic models capable of representing complex ecosystems, when necessary, including surface and groundwater interactions where applicable

### **3.2.1 Define and describe the unit of management**

Determining the scale and characteristics of the water resource will inform the types of activities that can be undertaken to manage system health. An important part of this is whether the system is regulated (i.e.: river flows can be controlled by a dam or other regulating structures) or unregulated. By understanding where water comes from, where it moves to and the values it supports, decision makers and other stakeholders can improve their understanding of the benefits of effectively managing the resource. Even the simplest of system schematics can aid understanding of linkages and impact pathways, communicate the boundaries of the resource, and serve as an invaluable tool in discussions and negotiations. The value of these schematics for groundwater resources is often even greater due to the ‘hidden’ nature of the resource and the impossibility of being able to physically see

aquifer boundaries and connections with other groundwater and surface water sources. In Australia, a precautionary approach has been recommended, whereby connection between surface and groundwater systems is assumed to exist until proven otherwise (NWC 2009).

In Australia, the Murray-Darling Basin Authority (MDBA) has created conceptual diagrams illustrating the natural characteristics of the Basin, including flow components such as base flow, river channel flow, flood extent and flood depth, flow variability within the channel, and indications of the floodplain, wetland spatial scale, and connections along rivers (MDBA 2011b).

### 3.2.2 Assess water availability and demand at the system level

In order to effectively manage a system for long-term health, an accurate understanding of water availability and demand in that system is required.

For all systems, water availability should be determined through appropriate data collection and/or system modelling. In surface water systems, water availability tends to vary considerably within and across years. Data that may be collected can include information on the five components of a flow regime: volume, frequency, duration, seasonality, and rate of change of flow. The goal is to understand

*Water budgets can serve as the basis for stakeholder dialogue, providing a means for formulating proactive agreements around desired levels of environmental water protection and appropriate allocations to consumptive use.*

Richter and Orr 2017

how water flows through the system, how flows change over time (within and between seasons), and what these changes cause (Poff et al 1997). Information on water temperature and quality (including sediment and salinity) is also useful, as these factors can affect the suitability of available water resources for some purposes. In groundwater systems, it is important to gather information on the scale of the total resource, recharge rates including interaction with surface water systems, and water quality.

Wherever possible, historical water availability should be compared with current availability to build an understanding of trends and to assist in communicating the case for change (Element 1) and determining allocations (Element 3). A basic view of water use by sector (e.g. industry, cities, agriculture, and the environment) can inform strategies to improve efficiencies and reallocate water to maintain or improve system health. Finally, water demand encompasses all quantities of water needed to fulfil all desired uses for water in the system, including all abstractive and nonabstractive uses. While water use is a proxy for demand, demand for water may be higher than current use in some circumstances, especially where water scarcity and drought are prevalent. Determining the water demands of the environment is discussed in the next section of this guide.

For more information on how water data is collected, and the different types of data that exist, refer to *WaterGuide* (Aither 2018) and the *Good Practice Guidelines for Water Data Management Policy* (Bureau of Meteorology 2017).

### 3.2.3 Understand drivers of change for future water availability and demand

Water availability in any system fluctuates over time. Drivers that can alter the availability of water of a sufficient quality include climate change impacts and water quality impacts. Climate change is expected to contribute to further drying in many arid regions, and more heavy and frequent rainfall in wet regions (IPCC 2014). It will also affect seasonality and overall patterns of rainfall, such as advancing monsoons in South Asia (Loo et al 2015). Another factor that is impacting the availability of water for beneficial

uses is declining water quality. Pollution from industrial discharges, urban stormwater, domestic sewage and agricultural runoff is causing a dramatic decline in the quality of water in many systems, to the point where water can no longer be used for many purposes without undergoing extensive treatment (UNDESA 2014).

Just like water availability, water demand also fluctuates over time. Drivers that can influence water demand include population changes, lifestyle changes, urbanisation, human migration, land use change and technological innovation leading to enhanced water-use efficiency. The overall trend from these drivers at the global scale has been an increase in demand for water (WWAP 2012).

It is important to estimate future supply and demand to inform resilient long-term allocation decisions. As data quality reduces, additional allowances should be made on a ‘precautionary principle’ basis. In Australia, CEWO’s publicly available Fact Sheet ‘Managing the Commonwealth Environmental Water Portfolio’ provides information about how CEWO makes decisions to account for drivers of changes in water availability and demand (CEWO).

### **Case Study 2: Understanding the water budget in a data-scarce environment**

Water data in the north-central region of the Middle East is often not transparent or accessible and tends to be unreliable, as it is not collected regularly. Multiple studies have confirmed the lack of publicly available surface water and groundwater data — observations of streamflow, precipitation, evaporation, water table height, and annual groundwater extraction are largely non-existent (Chenoweth et al 2011; Kayvas et al 2011). Different countries within the region have collected various water datasets, but access to this information is restricted and the countries often do not share data with each other. This results in an incomplete and inaccurate understanding of water use and availability in this region.

In an attempt to fill some of the water data gaps, a study used observations from the Gravity Recovery and Climate Experiment (GRACE) satellite mission to evaluate freshwater storage trends in the north-central Middle East, including areas within the Tigris and Euphrates River Basins and western Iran, from January 2003 to December 2009. The GRACE mission deployed satellite water sensors to provide a record of variations in total terrestrial water storage. This information was then analysed to estimate rates of groundwater depletion and reservoir storage changes. Other available datasets were also analysed in an attempt to identify the causes of identified variations and trends and to better understand the water balance. The study found that in 2007, the Euphrates River stream flow had decreased to approximately 70 per cent of its average flow by the time it reached the border of Iraq. It also found that Iraq responded to this decline in surface water resources by abstracting 80 per cent of its groundwater resources between 2007 and 2009.

The GRACE mission, and other recent advances in hydrologic remote sensing, have demonstrated the valuable insight to hydrologic trends that these new kinds of tools can provide in data-inaccessible contexts. However, the study also stressed the importance of ground-based observational research, as some degree of this data was necessary for ensuring that accurate conclusions were drawn. Further, the results highlighted the need for improved monitoring and analysis of core components of the water budget in the area, as well as the need for improved sharing and communication of data — as there have been few basin-wide hydrological studies using observational data for the region in recent years. An accurate and holistic understanding of the water budget, communicated to water managers and decision makers, is critical for determining, developing and implementing effective water allocation and environmental policy decisions for any water source.

Source: Voss et al 2013.

### **3.3 Determine allocation of water between uses**

As discussed in Chapter 2, any abstractive use of water creates a level of environmental impact. Informed trade-offs are therefore necessary to allocate water between uses based on an assessment of current and future availability and demand. In order to be effective, allocation decisions must be made at the appropriate scale and be supported by a rationale that is transparent to all stakeholders and provides certainty for investment and planning by governments, businesses, communities and individuals. Recognising the environment as a user of water entitled to a portion of the available resource is an important first step, and a critical hurdle in many contexts.

#### **Benefits:**

- Determines sharing of water between uses, in support of vision and values, with consideration for necessary trade-offs, and with clear communication of the reasons for the decisions made
- Transparency and clarity around allocations motivates system performance — everyone plays a part in seeing the plan implemented as defined
- Accounts for current and future limitations to availability and demand

#### **Inputs:**

- Legal authority for governments (or other resource governing bodies) to make allocation decisions
- A clear understanding of water availability and demand

#### **Activities:**

- Determine and define water needs for system health
- Identify and assess options for allocating water to sustain system health
- Clarify the allocation process, the temporal and spatial scales that apply, and how changes to supply and demand parameters are dealt with

#### **3.3.1 Determine and define water needs for system health**

While knowledge of water requirements for environmental values has improved greatly in recent decades, there is still considerable uncertainty about what the environment actually needs and requires for the maintenance of system health (Lowe et al 2017). This is particularly true in settings where system data is poor and the complex relationships between ecological values and water have not been established. There is no single best method, approach or framework to determine an environmental flow or sustainable level of extraction, but there are multiple models that have been used around the world that have proven capable of approximating water requirements for system health (Dyson et al 2003). What is critical is that system managers leverage these approaches to establish a basis for determining the water needs that underpin system health. By establishing this basis, system understanding can be strengthened over time as part of a monitoring (Element 5) and improvement (Element 6) regime.

In South Africa, the Habitat Flow Stressor-Response has evolved over recent years to determine environmental water requirements for rivers (Hughes et al 2014). This process is now widely applied through rapid desktop environmental flow assessments. In England and Wales, the Environmental Flow Indicator (EFI) model is used to indicate where abstraction pressures may start to cause an undesirable effect on the environment (Environment Agency 2013). In Australia, a framework for assessing environmental water requirements for groundwater dependent ecosystems was created along with

management tools to help incorporate these requirements into water allocation planning (Land & Water Australia 2009). These are internationally recognised frameworks, though a wide variety of methods are used around the world and the most appropriate framework for a particular setting will depend upon a range of factors.

### **3.3.2 Identify and assess options for allocating water to sustain system health**

Once water needs to sustain system health have been estimated across spatial and temporal scales, decisions about how to secure that water and maximise benefits to society through appropriate allocation can be made. When discussing allocation mechanisms, there is a need to inform all stakeholders of the options, allow open discussion, and educate and engage over an appropriate timeframe.

There are many ways to allocate water for the environment. Options include conditions on water users, such as the introduction or strengthening of a cap on extractions, imposing or altering licence conditions for water abstractors, or imposing or altering conditions on storage operators (Horne et al 2017a). Additional options include the creation of specific legal rights to water for the environment, such as through the establishment of an ecological or environmental reserve or by granting legal personhood to a river, lake or aquifer (O'Donnell and Talbot-Jones 2017). The best option depends on a range of factors, including whether the system is regulated or unregulated. The natural characteristics of the resource will also dictate the effectiveness of each option in achieving desired ends. Further, they can also be used in isolation or in combination within the same water system. For instance, multiple allocation mechanisms were introduced in Australia's Murray-Darling Basin to provide water for the environment, including a cap on extractions in 1995, and 'sustainable diversion limits' and the establishment of the Commonwealth Environmental Water Holder (CEWH) in 2007 (Horne et al 2017a).

*Distinguishing among each of the allocation mechanisms is important, as they afford the environment different levels of protection relative to human water uses, they have varying levels of flexibility, and they have different operational challenges.*

Horne et al 2017a

### **3.3.3 Decide on appropriate allocation mechanism(s)**

In determining which allocation mechanisms should be implemented, decision makers should be guided by their understanding of the way in which natural systems function and the benefits they are seeking from abstractive and non-abstractive water use.

One-third of global freshwater sources are overallocated and are being heavily depleted (Brauman et al 2016). Overallocation is where the total sum of allocations exceeds the level at which system health can be sustained. As a result, overallocation, especially to irrigated agriculture, is a major contributor to the degradation of surface and groundwater systems. In order to restore and sustain these systems, abstractive water use will need to be reduced. For instance, South Africa's Ecological Reserve and environmental water rights held by CEWH in Australia are two means for securing water for system health (Horne et al 2017a). This does not necessarily mean that abstractive uses need to be curtailed or eliminated, as it may be possible to reduce abstractive use through improved water-use efficiency (and reduced losses) (Richter et al 2017). In the two thirds of global freshwater sources that are not overallocated or over-exploited, it is important to monitor future changes in supply and demand and prevent overallocation before it occurs. The Whanganui River in New Zealand and the Ganges and Yamuna Rivers in India were granted legal status to protect water for the environment in each case and prevent overallocation and overuse (O'Donnell and Talbot-Jones 2017).

### **Case Study 3: Determining water allocations for the environment**



Under the Northern Territory Water Allocation Planning Framework, all available scientific research directly related to environmental and other public benefit requirements for the water resource are applied in setting water allocations for non-abstractive use as the first priority, with allocations for abstractive use made subsequently within the remaining available water resource.

In the absence of directly related research, contingent allocations are made for environmental and other public benefit water provisions and abstractive use.

In the Top End (northern one third) of the Northern Territory, at least 80 per cent of flow or annual recharge in any part of a river or aquifer, at any time, is allocated as water provisions for the environment and public benefit, and abstractive use cannot exceed the threshold level equivalent to 20 per cent of flow or annual recharge at any time. In the event that current and/or projected abstractive use exceeds the 20 per cent threshold level, new surface water or groundwater licenses will not be granted unless supported by either directly related scientific research into environmental or other public benefit requirements (for rivers) or into groundwater dependent ecosystem or cultural requirements (for aquifers).

This illustrates an approach to preventing overallocation of water by accounting for potential development effects on flow or level patterns when determining allocations rather than simply ensuring a minimum instream flow or groundwater level.

Source: Supplied by CEWO. Photo: Stephen Michael Barnett 2009. <https://creativecommons.org/licenses/by/2.0/>

### **3.4 Ensure effective water policies and institutions**

Legislative and administrative tools are required to enable and enforce management of water for the environment at all scales. An appropriate governance framework for managing water for the environment is one that supports the agreed vision and objectives of water management and is understood and implemented by stakeholders at all levels.

#### **Benefits:**

- Good governance is a prerequisite for sustainable system management
- Provides clarity for, and enables coordination of, roles and responsibilities
- Promotes improved stakeholder understanding of how policies, regulations and other institutions govern water management and contribute to improved system health outcomes

#### **Inputs:**

- Strong institutional and political leadership to support reform
- Legal authority for governments to design and implement policies, or create institutions, to realise vision and objectives for water management

#### **Activities:**

- Create or amend policies to provide and protect water for system health
- Align legal frameworks and incentives and avoid overlapping institutional responsibilities, including by ensuring coherence between government departments and between different levels of government
- Develop and champion a compelling reform narrative that engenders stakeholder buy-in and can be widely understood
- Invest in capacity, leadership and effective coordination

#### **3.4.1 Create or amend policies to provide and protect water for system health**

First and foremost, the histories, cultures and customs of the societies in which water allocation and management decisions are implemented must be acknowledged and their implications for policy decisions must be identified. Even where there are limited formal institutions for managing water for the environment, there will typically be an informal system or structure in place. For instance, in some developing country settings, the traditional view on groundwater ownership is that the water is owned by the overlying land owner, while in other customary regimes, groundwater belongs to the community and the concept of individual rights to water is rejected (Mechlem 2016). Water management policies will become more difficult to implement as stakeholders become used to existing systems, as the system grows in complexity over time, and as competition increases (Harwood et al 2017). Thus, where competition for water resources is an emerging but not ingrained issue, there is advantage in moving decisively to protect water for system health.

In some settings, it will be possible to use existing laws and regulations to meet new water management goals that have not previously been pursued through the use of that institution. For example, in the United States, the federal government was able to secure water for the environment in multiple water systems where at-risk or threatened species were located with reference to the provisions of the existing Endangered Species Act (U.S. Fish and Wildlife Service 1973). The Act requires the restoration of critical

habitat for these species. In other contexts, it may be possible to use existing political commitments or policies as a basis or motivation for creating new policies or regulations. In Australia, the Commonwealth Government was motivated to create policies to better support its international commitment to both the Convention on Biological Diversity and the Ramsar Convention. In most cases, the creation of new policies will be required to formalise protections for system health, and for any legal instrument, there will be a trade-off between legal power and ease of implementation. For instance, rules and customary operations may be easy to implement, but hold low legal power; regulations and legislation are more difficult to change or implement but hold greater legal power; and a constitution is the most difficult to change but holds the highest legal power (Horne et al 2017a).

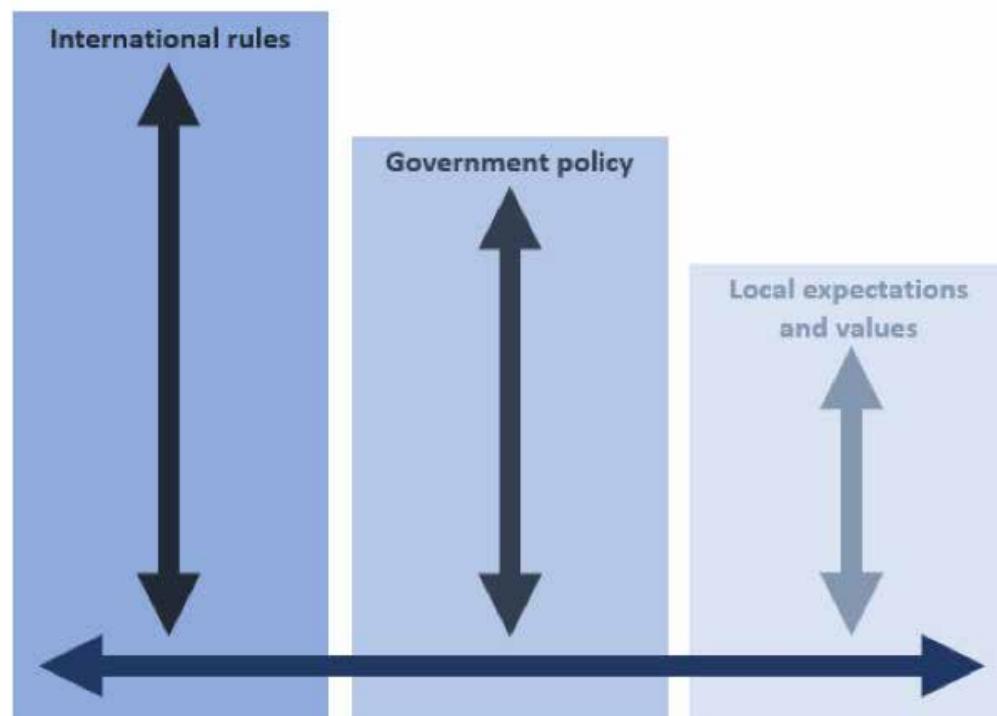
### 3.4.2 Promote policy alignment

Policy alignment should be promoted at both the interstate and domestic level, to reduce duplication and gaps and to make the most of available funds and other resources.

In contexts where the water resource spans national or subnational boundaries, all parties must coordinate their actions and manage water for the environment collaboratively. In the first instance, there is an obligation to comply with international laws and requirements, such as those established by the Ramsar Convention (UNESCO 1994) and the UN Convention on the Law of the Non-navigational Uses of International Watercourses (United Nations 2014). The legal framework governing transboundary aquifers continues to evolve (United Nations 2016).

At the domestic level, government ministries should also promote policy alignment. In many countries, different ministries manage different aspects of water management, often in relative isolation. This typically results in ineffective and inefficient policy creation and implementation, creating duplication and gaps. Decision makers should foster nested governance arrangements and promote linkages across spatial scales and policy areas, and between the public and private sectors. The vertical and horizontal scales of alignment are illustrated in Figure 4 below.

**Figure 4 Policy alignment between and across scale and sectors**



### 3.4.3 Define and communicate roles and responsibilities

Policy alignment is promoted by, and should be reflected in, clearly defined roles and responsibilities for all stakeholders. Often, governments create agencies specifically responsible for fostering this alignment and clarity, though with varying success. In order to negotiate and coordinate efforts in

*It is unlikely that a single organisation will be solely responsible for the entire set of actions required for environmental water implementation. Partnerships can operate in parallel, across different policy areas...and across jurisdictional boundaries.*

O'Donnell and Garrick 2017

Mexico and the US, for example, the two countries created their own respective organisations responsible for settling and implementing water treaties: the U.S. International Boundary and Water Commission and Mexico's counterpart, the International Commission of Limits and Waters between Mexico and the USA. Additionally, a partnership of six American and Mexican NGOs called Raise the River participated in these negotiations and was involved in the implementation of

the policies. Importantly, specific roles and responsibilities were delegated to each country, to specific government departments within each country, and to local stakeholders within the specific catchment.

Organisations with responsibilities for managing water for the environment can include government organisations, such as statutory corporations (Victorian Environmental Water Holder (VEWH) or MDBA in Australia), statutory entities (CEWH in Australia or the Colorado Water Conservation Board in the US), functions within a government department (Washington State Department of Ecology in the US), or non-government organisations, such as not-for-profit groups (Murray-Darling Wetlands Working Group in Australia) or trusts (Environmental Water Trust of New South Wales in Australia) (O'Donnell 2017). Within these organisations, departments, agencies or individuals should be designated as specifically responsible for different aspects of managing water for the environment, including regulation and monitoring and evaluation. In addition to being clearly defined and delineated, roles and responsibilities for managing water for the environment should also be communicated to, and understood by, all stakeholders.

#### Case Study 4: Transboundary environmental policy cooperation

An example of international collaboration to establish coherent policies to manage water for the environment within a transboundary resource is the co-management of the Colorado River Basin and Delta between the United States and Mexico. From the 1930s to the 1980s, no regular base or pulse flows reached the Delta in Mexico, resulting in the decline of many species and the collapse of fisheries, with a subsequent decline in indigenous populations and further social and economic costs (Richter 2014).

Over the last two decades, the two countries have engaged in several cooperative policy efforts to restore water for the environment in the Delta. The first was a managed pulse flow in 2014 from a large-volume water release from a US dam (Minute 319) (IBWC 2012), returning water to areas of Mexico that had been without it for 17 years (TNC 2014). Then in 2017, the two countries reached an agreement on how they would make voluntary cutbacks during drought, committing the US to financially supporting water efficiency projects in Mexico in return for a one-time water exchange, and requiring both countries to provide water and funding for habitat restoration and scientific work

in the Delta for the next decade (Minute 323) (IBWC 2017). While Mexico and the United States have gradually aligned policies for managing the Colorado River, and moved from conflict to cooperation, this was only after decades of disagreement, compromise and negotiation.



Photo: Stuart Rankin 2015. <https://creativecommons.org/licenses/by-nc/2.0/>

### **3.5 Plan, deliver and monitor water for the environment**

Ensuring the proper quantity, quality, timing and location of water supports system health and a range of associated values. It is for this reason that effective planning, delivery and monitoring of water for the environment provides the basis for the achievement of system health outcomes, as well as the ability to support associated values. Achievement of desired outcomes requires coordination within planning and operation, necessitating the creation of a clear plan for water delivery. Other critical factors include political coordination between actors to implement the plan, enforcement of related legislation and regulations to support the plan, and sustainable financing for planning, operation and management, and monitoring.

#### **Benefits:**

- Improved clarity around the planning and delivery of water for system health contributes to better coordination
- Complementary measures are identified and implemented, resulting in better outcomes from the allocation of water for system health
- Effective system monitoring provides the basis for performance insights and ongoing revision and improvement in time

#### **Inputs:**

- Political and policy coordination across relevant levels of government
- Adequate and sustainable financing for planning, delivery and monitoring
- Strong enforcement mechanisms and appropriate authority

### **Activities:**

- Plan delivery of water for the environment, giving consideration to efficiency of water use and costs of implementation
- Coordinate with appropriate stakeholders to harmonise complementary works and measures, ensure compliance and enforcement of regulations, and mobilise funds for system operation and management
- Monitor outputs and outcomes to demonstrate progress towards realisation of the vision and allocations defined for the system

#### **3.5.1 Plan delivery of water for the environment**

Plans for delivering water for the environment range from the simple to the complex. In their simplest form, they may dictate a maximum level of extraction per day from a groundwater resource. At their most complex in some regulated systems, they may involve detailed release arrangements based on seasonal trigger flows to achieve ‘freshes or pulses’ through a surface water system that encourages fish migration. In determining how to most efficiently deliver and manage water for the environment, consideration should be given to: volumes of water likely to be available; the water needs of the environment; expected outcomes and risks associated with each option; multiple water use scenarios; trigger points and cut-off dates associated with natural events; system-wide strategies for particular species or ecological communities; and constraints to water delivery (CEWO 2013a). An approach that considers seasonal climatic conditions, such as VEWH’s seasonally adaptive approach, can further increase benefits, as water delivery is prioritised based on current conditions and the ability to achieve target flows while adequately managing any risks (VEWH 2004).



Photo: Tracey Koper, Victorian Catchment Management Council.

In the operation of regulated surface water systems, improved understandings of how ecosystems respond to releasing more or less water at different times can improve the efficiency with which that water is managed, and increase the total benefit obtained from the same volume of water. Greater efficiencies of water use can also be gained by considering how a single volume of water can serve multiple purposes along a river or within a groundwater system. In developed surface and groundwater systems, the way that infrastructure is used often contributes to

problems of environmental degradation, through a loss of connectivity or build-up of sediment and through the reversal of flow regimes. However, works and measures can also be an important part of the response, facilitating effective and targeted management of water for the environment. They can take the form of pumps and regulators that move water into riparian wetlands and sustain flood peaks for a range of ecological outcomes such as bird breeding events, or fish ladders that provide migration routes past instream obstructions such as weirs. Strategic siting, design and operation of infrastructure can realise benefits for biodiversity conservation, climate change adaptation, food security and human livelihoods (Thomas 2017). In systems where there is no or limited ability to intervene in system operations, emphasis should be placed on protecting the existing resource rather than managing works and measures in a specific way.

Different delivery and management options can vary substantially in cost of implementation. A cost-benefit analysis of available options can be helpful in determining the most cost-effective manner for achieving a specific outcome. In many cases, there is a challenge in determining who should pay and how costs will be met; once a plan has been agreed upon, a framework for meeting the costs associated with that plan needs to be developed.

### **3.5.2 Operate and manage the system**

Effective management of surface and groundwater systems requires clarity and coordination between a range of stakeholders. Implementation of the agreed plan will require all water users and other stakeholders with a vested interest to know what needs to be done where, when and by whom. Critically, this will include rules in relation to the timing and volume of water abstractions and the regulatory approaches paired with these arrangements. Regulatory approaches that invest effort in education and awareness raising, standard-setting, and supporting system users to achieve compliance will typically be most effective, provided that there are consequences for breaches. All stakeholders must be clear on the value of regulation and recognise that it is fundamental to the achievement of the system health outcomes sought.

Also fundamental to the effective management of any finite and allocated resource is the need for an effective system of compliance and enforcement as part of system regulation. The financial and other resources expended establishing policies, institutions and works and measures necessary to deliver water of appropriate quantity and quality for the environment will only be worthwhile if water users, water managers and infrastructure operators comply with relevant policies and decisions. Compliance and water accounting is one of the most pressing challenges in water management, encompassing how water is made available to different users, when and where it can be taken or stored, and the approvals required (Docker and Johnson 2017). System health depends on all water users and stakeholders trusting that the management system works and that nobody is getting a ‘free ride’. There is a need to establish appropriate avenues for water users and members of the public to report breaches of rules and regulations, and to ensure that the consequences of being found to be non-compliant with those rules and regulations are serious enough to dissuade wrongdoing. These can be tiered based upon a combination of the risk or harm to system health and the culpability of the offender.

Implementation and operation of complimentary works and measures identified in the planning stage will typically deliver additional benefits than water management in isolation. This may include changes to operational arrangements such as the way in which abstractive water volumes are released through a surface water system to benefit native flora and fauna, to major infrastructure works such as changing dam release structures to reduce cold water pollution and regulators and pumps to manipulate water on the floodplain (Macquarie River Food & Fibre 2017). In general, there will often be a range of significant benefits that can be achieved in most systems through the implementation of a number of these complimentary works and measures.

Finally, effectively operating and managing the system for delivery of water to the environment will often require the mobilisation of both public and private funds. Australia has leveraged public funds, as well as private funds through partnerships with private actors to finance works and measures for delivery of water for the environment. For instance, the CEWH entered into a five-year partnership agreement with the Renmark Irrigation Trust to allow the delivery of Commonwealth environmental water to floodplains in the Renmark area using the Trust’s extensive irrigation infrastructure during the off-peak irrigation season (CEWO and Renmark Irrigation Trust 2016).

### 3.5.3 Monitor outcomes

Monitoring is critical for demonstrating progress toward realisation of the vision established at the beginning of the process (Element 1) and the allocations defined for the system (Element 3). To be effective, monitoring needs to occur at three levels: monitoring of outputs, monitoring of outcomes, and monitoring of the connection between outputs and outcomes.



Photo: Chris Arnott 2018.

Monitoring of outputs consists of determining whether or not certain actions occurred, such as specific watering events, complementary works, or illegal well closures, for example. Monitoring of outcomes is the basis of system performance reporting and should be defined as a component of the vision for water management (Element 1), as well as within the goals of chosen allocation mechanisms (Element 3). While outcomes are often difficult to monitor and measure, they are critical for informing the level of success achieved. Lastly, monitoring of the connection between outputs and outcomes is

necessary to improve conceptual models over time. All three levels require appropriate data collection.

The complexity of the monitoring required will depend on the complexity of the system and available resources to undertake monitoring. In smaller and less complex systems, it can be sufficient for a single individual to record stream or groundwater levels and water quality over time. In catchments throughout the state of Victoria in Australia, public citizens monitor waterway health through the WaterWatch program, voluntarily collecting data on their local waterways as one component of data collection (Victoria State Government 2018). Alternatively, in highly developed and regulated systems, it is recommended to adopt an explicit strategy or framework that sets out an approach for monitoring. In the Murray-Darling Basin, the CEWO maintains such a strategy (the Monitoring, Evaluation, Reporting and Improvement Framework), which describes a method for monitoring Commonwealth environmental water use, meeting reporting requirements and supporting adaptive management and improvement (CEWO 2013b).

#### Case Study 5: Monitoring a waterbird breeding event

Australian Commonwealth environmental water was used in 2016-17 to, among other things, complete a waterbird breeding event in the Macquarie Marshes in New South Wales, Australia. Monitoring of this event included observations of bird nests to analyse breeding success, analysis using imagery from a drone, and satellite tracking of straw-necked ibis.

A partnership with a university allowed breeding success to be monitored across multiple sites that were targeted for environmental watering. This revealed that, for some species, success rates were considerably lower in one of the two targeted sites. This information can be used in the future to improve the effectiveness of environmental watering efforts in this region.

The use of drones enabled improved accuracy in the counting of waterbird nests, with individual nest locations able to be recorded more quickly and efficiently than other methods.

In addition, five satellite GPS transmitters were deployed on adult straw-necked ibis, allowing researchers to better understand how and when the birds engage with different bodies of water over a period of time. While waterbird movements varied considerably, all travelled significant distances and spent time in one or more key wetland regions.

This data may be used in the future to assist environmental water managers and river operators to better tailor management of water for the environment to the specific needs of target waterbird species.



Source: Supplied by CEWO. Photo: CEWO 2015.

### **3.6 Assess and improve system efficiency and effectiveness**

The specific goals of water management are likely to change over time, as environmental conditions and community expectations change, and as new knowledge and experience is brought to bear. As water supply and demand conditions change, the scientific knowledge base on which management of water for the environment rests is also continuously expanding and developing. To respond to this dynamic environment, management of water for the environment must be adaptive and flexible. Continual communication, adaptive management and improvement is required to ensure that system performance is maintained and improved over time.

#### **Benefits:**

- Ensuring progress towards improved water management requires ongoing commitment to optimising the value of scarce water resources
- Continuous assessment and revision of plans and approaches drives system improvement and underpins system health, in turn benefiting all stakeholders

#### **Inputs:**

- Professional capacity in water science, economics and strategy
- Adequate and sustainable financing for monitoring, reporting and adaptive management

#### **Activities:**

- Assess outputs and outcomes against the vision and associated targets, including by measuring the extent of targets or benefits that have been achieved
- Regularly and truthfully communicate system performance outcomes through appropriate communication channels
- Reflect on, and adaptively respond to, the lessons of the past and changing norms and attitudes
- Introduce settings to facilitate an improved water management system, such as adaptive management and planning arrangements

### **3.6.1 Assess system performance outcomes against objectives**

*The information gained from monitoring can be used to demonstrate the return-on-investment of environmental water in terms of environmental, economic, and social outcomes.*

Webb et al 2017

After identifying outputs and outcomes through monitoring, data must then be interpreted, evaluated and assessed against system health objectives. Evaluation is important for promoting progress toward realisation of the vision and associated targets for water management. This includes measuring the extent of targets or benefits that have been achieved, including both direct ecological benefits from managing water for the environment, as well as any additional social, economic and cultural benefits that have been achieved as a result of improved or sustained system health.

While outcomes are more difficult to observe in the short term, they are essential for maintaining support in defining a proportion of water allocations for system health. In degraded systems where water recovery is occurring as a critical part of establishing water for the environment and restoring system health, long time delays often exist between the return of water to the environment and the improvement of system health. System health in surface water systems, particularly in highly variable settings such as Australia, will be supported by water for the environment over multiple seasons, years, and, for some species and processes such as trees, decades. In these settings, consideration should be given to effective 'system health proxies' that bridge the temporal gap between outputs and ecological outcomes. Given the ease and speed with which stakeholder surveys can be completed, increasing stakeholder confidence in the management of the system is one such proxy which also has the associated benefit of deeper stakeholder engagement.

The CEWO has developed such a strategy for assessing environmental outcomes in the Murray-Darling Basin against objectives set out in the Basin Plan (The Environmental Water Outcomes Framework) (CEWO 2013c).

It is critical to recognise that stakeholder views and values may change over time, which will, in turn, impact targets. Twenty-five years ago, for example, ecological values were not a major driver for change in water management in Australia. However, community views have shifted and developed over time, reflected in decisions like the enactment of The Living Murray program in 2002 (MDBA 2011a). A flexible, dynamic system is therefore required for measuring and describing benefits and objectives. This should account for population growth, climate change, and other factors that could impact the system and the benefits it delivers. Evaluation and analysis of system performance is important for identifying where efforts are working properly and achieving desired outcomes, and where improvement is feasible and necessary.

### **3.6.2 Communicate and report outcomes**

Communicating outcomes is essential to building trust and maintaining stakeholder support for water management initiatives for system health. Outcomes communications should be the subject of a committed and strategic approach in the same way that significant efforts were expended to achieve the outcomes in the first place. One crucial element is identification of the appropriate channels through which to communicate outcomes, be they traditional media outlets or social media platforms or even public forums. Ensuring that information is accessible to all stakeholders is critical. Investment in science communication is fundamental too, especially at a time when scientific knowledge and expertise is often politicised. While scientific data should be appropriately interpreted for the general public, it is

*Communities with high levels of 'water literacy' tend to value water, conserve water and support government policies and programs to improve water management.*

Bureau of Meteorology 2017

also important to actively build water management literacy among stakeholder groups. This will not only improve understandings of the reported outcomes but will help to generate support for management of system health, particularly in settings where that continues to degrade after commencement of restoration efforts. An additional component of an effective communications strategy is timing and regularity. At a minimum, system performance should be transparently communicated on an annual basis, although a range of formats and time-steps should be considered to build awareness and support for the changes being implemented. In general, more information provided more often will be better than the alternative.

The benefits that water for the environment has provided, and the extent of those benefits, should be accurately and honestly described in communications and reports, even if those benefits are smaller than was hoped for, or if costs were larger than expected. If expectations of some stakeholders have not been met, then communications materials must explain why that is the case. If it became apparent that all objectives could not be achieved due to financial or political constraints, then this should be explained, and objectives should be revisited in light of what is realistically achievable.

Regardless, communications should focus on celebrating successes and acknowledging achievements that reflect outcomes beyond the environmental and ecological. These achievements could be related to relationships and partnerships that have been formed, financial contributions, or the efforts of specific individuals who have helped improve management of water for the environment. It is imperative that environmental outcomes are tied back to people, to jobs and economies, and to the wide range of benefits that are underpinned by system health.

### **3.6.3 Identify improvement opportunities**

Based on system performance evaluation and reporting, efforts should be dedicated to the areas identified as needing improvement.

There are multiple tools and approaches available for those wishing to further improve the overall efficiency and effectiveness of water management for system health. If not already adopted, these options should be explored and considered in future planning, and selected based on their potential contribution to, and feasibility of being implemented in, the local context.

Many decision support tools have proven to be useful in helping decision makers navigate uncertainty and complexity in managing water for the environment, in a way that is consistent, based on a clear methodology, and transparent to stakeholders — cost-benefit analysis, multi-criteria analysis and other tools are now widely used. These can help to manage low-likelihood but high-impact risks, such as the risk that all users will want to draw on their water allocations at the same time of the year. In South Africa, the IUCMA uses decision-support and forecasting tools to manage water allocations for the environment in the Crocodile River (Harwood et al 2017).

Water trading is another approach that can support improved environmental outcomes and water-use efficiency by allowing water to move to its highest value use, and by providing governments with a tool for purchasing water rights for environmental purposes (as has occurred in Australia). However, water trading requires the existence of various preconditions so is not appropriate in many circumstances.

Trading of environmental water rights in the Murray-Darling Basin must comply with CEWO's Trading Framework, which ensures that trading activities support enhanced environmental outcomes, have regard to social, economic and cultural outcomes, consider impacts on the market, meet legislative requirements, and are financially responsible, equitable and transparent (CEWO 2016). In the western USA, senior water rights have been purchased through established water banks in order to mitigate the negative impacts of water extraction by ensuring adequate quantities of water to sustain system health (Harwood et al 2014).

## **Case Study 6: Improving outcomes through adaptive management**

Restoring Golden Perch populations has been a priority for environmental water managers in the Goulburn River in Australia following the breaking of the millennium drought in 2012. At first, water management events targeting Golden Perch outcomes were small and discrete with limited fish or ecological response, but over subsequent years, outcomes were enhanced through focus on the flow regime.

The timing of watering actions has been modified multiple times to address specific ecological priorities and community concerns. For example, efforts were made to ensure the completion of environmental watering prior to the opening of the Murray cod fishing season to minimise any disruption to angling activities in the area. Operational releases were also adapted to complete environmental water flow events while also meeting irrigation and critical human water needs. The changes to the management of flows in the Goulburn River to achieve social, economic and environmental outcomes resulted from an increasing involvement of all water resources managers, contemporary science and a range of community feedback.

This case study highlights the need to consider the overall vision for the water resource and all values to water when adapting the management of the resource to achieve improved outcomes.



Supplied by CEWO. Photo: Goulburn Broken CMA 2017.

## 4 Conclusion

Too often, the environment is an afterthought, the user of last recourse — this approach neglects the critical role of a healthy surface or groundwater system in providing a range of benefits. While water for the environment does not explicitly include uses beyond ecological ones, ecological water uses underpin system health and, by extension, social, cultural and economic benefits. By effectively protecting or restoring water for the environment, these values can be sustained. Conversely, unchecked use of water will impact on system health and all of the values that depend on a healthy system.

Effective management of water for the environment is increasingly seen as a fundamental component of good water management. The decision of the High Level Panel on Water to focus on ‘water and the environment’ as one of the core themes of its work evidences this. Achievement of the SDGs will not be possible without consideration of system health and improved water management for environmental outcomes.

The framework developed in this guide can be used to help build the case for, and implement, effective management practices with the cooperation and support of stakeholders. By sharing global practice in managing water for the environment, there is an opportunity for different countries to accelerate achievement of desired outcomes and avoid costly pitfalls that have affected different countries at different stages of their journey. It is hoped that this guide can assist in settings where systems are being unsustainably managed, placing at risk not just environmental values, but critical social, cultural and economic values too.

The six fundamental elements of improved management of water for the environment, as expressed in the framework developed for this report, are:

1. Confirm a vision for water management and the value of water
2. Understand changing water availability and demand over time
3. Determine allocations of water between uses
4. Ensure effective water policies and institutions
5. Plan, deliver and monitor water for the environment
6. Assess and improve system efficiency and effectiveness

The challenge for the international water management community is to recognise the centrality of system health to the future of the water dependent ecosystems that provide social, economic and cultural benefits for a wide range of stakeholders. This is the first step toward protecting these benefits in the long term. The urgency of the challenge — many systems are in serious decline or have already surpassed thresholds for survival — demands immediate action.

Australian water management experts and practitioners welcome engagement with counterparts around the world, including through the Australian Water Partnership, to collaborate for the future of water dependent ecosystems globally.

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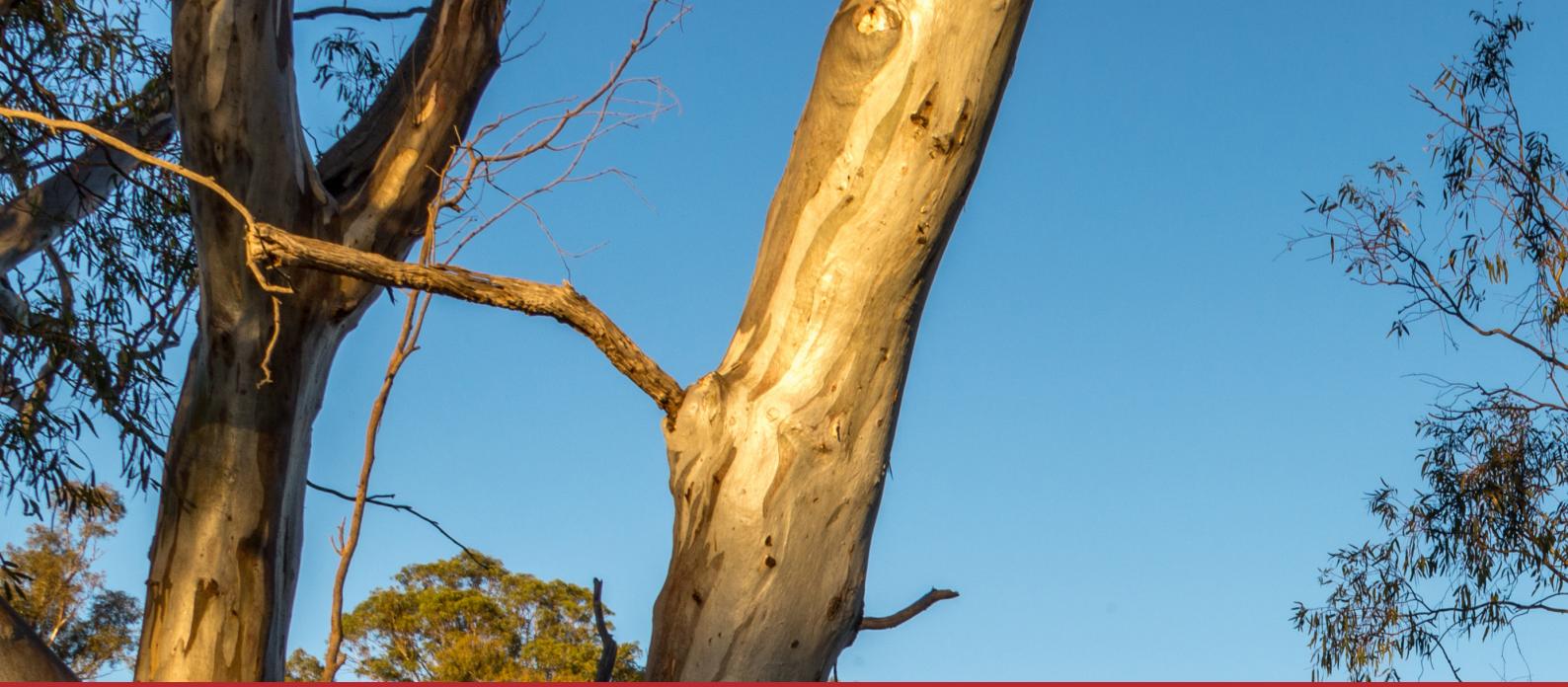
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*The Australian Water Partnership is an Australian Government aid initiative bringing together public and private organisations from the Australian water sector with international development partners.*