Statement of expectations for managing groundwater

Groundwater management in the Murray–Darling Basin

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Executive Summary

Groundwater is used across the Murray–Darling Basin for a variety of purposes including town water, irrigation, industry and stock and domestic supply. The use of groundwater varies from supplementing surface water supplies to communities and industry who are entirely reliant on groundwater. During drier periods, the relative importance of groundwater increases and is especially important for regional communities during these times. This dependence can be expected to increase in frequency and severity under climate change. In particular, increases are likely to occur for communities in north-western New South Wales and south-western Queensland where there is a high reliance on groundwater.

Groundwater management in the Basin is not a new concept. However, like all aspects of water management it is constantly evolving as new information becomes available. Each of the Basin states (New South Wales, Queensland, South Australia, Victoria and the Australian Capital Territory) has a groundwater licensing and management framework in place. In developing the Basin Plan, the Murray–Darling Basin Authority (MDBA) considered these state frameworks and drew on the expertise and knowledge held by the states.

Significantly, the implementation of water resource plans under the Basin Plan will be the first time that limits on groundwater use will be in place across the entire Basin (in contrast to surface water, where the Cap on surface water diversions has been in force since the late 1990s). It is also the first time a consistent set of management arrangements will be applied across all the Basin’s groundwater resources.

The MDBA has been working with states to ensure the management arrangements detailed in water resource plans consider relevant risks to ensure sustainable management of groundwater resources across the Basin. It should be noted, however, that water resource plans provide for water resource management at relatively large spatial scales. These plans set out management arrangements to address specific requirements which are relevant for an entire local water system. Therefore there may be instances where localized risks are not managed or mitigated under the plans and instead require a more localised response. There are a number of risks that may not be mitigated by prescribed management in a specific local area under a water resource plan, even though the Basin Plan requires consideration of risks and management of impacts from groundwater use.

Where the MDBA does not have the legal mandate through water resource plan requirements for a specific groundwater risk to be managed in a certain way, it will ensure that significant threats to groundwater resources are carefully monitored and mitigated through other mechanisms, such as policy agreements. The MDBA will also be considering risks associated with any potential growth in groundwater use in the future. The MDBA intends to manage these risks through incorporating new research into decision-making to ensure groundwater is managed sustainably.

This statement provides an overview of the Basin Plan requirements relating to groundwater management, notes potential issues which may not be fully mitigated by water resource plans and sets out the MDBA’s expectations for a strategic way forward to manage these issues. It also discusses the need for groundwater management to remain adaptive and potential opportunities for new knowledge to be incorporated into water resource plans and the Basin Plan.
Background

Groundwater in the Basin is used for drinking water, agriculture, industries and for the environment.

Groundwater supports the environment in many ways. Some plants are completely dependent on groundwater for their needs. River red gums are an iconic species with deep roots that access groundwater.

Groundwater is important for ecosystems in caves. It is the water source and pressure for springs and supports rivers and wetlands. Many groundwater dependent ecosystems are also significant cultural places for Aboriginal nations.

In the past, the complexity and importance of groundwater has not been well recognised in water management. The connection between groundwater and surface water has not been well understood. This led to inadequate management of this precious and finite resource, resulting in issues associated with access and water quality.

The sustainable use of groundwater is vital to the health of the Murray–Darling Basin.

Groundwater and surface water, like rivers and wetlands, can be highly connected and need coordinated management. When groundwater is very connected to surface water, it can provide permanent pools for fish and other aquatic animals. This is very important when there are shortages in surface water.

Recharging groundwater takes time. In some systems groundwater may flow quickly over days or weeks, in other systems flow may be very slow, taking decades or longer to move through (Figure 1). Basin states consider individual aquifer properties and manage areas differently to suit. Under the Basin Plan, Basin state and territory governments will manage both surface water and groundwater resources through water resource plans.

Key facts about groundwater

- Groundwater and surface water are connected and must be jointly managed for river health and the health of the Basin.
- Sustainable diversion limits set the limit of groundwater that can be used.
- There will be 19 water resource plans to manage groundwater resources in the Basin.
- Some rivers and river ecosystems in the Murray–Darling Basin fully or partly rely on groundwater to survive.
- Some communities in the Basin rely on groundwater reserves for drinking water.
- Groundwater is often used to maintain water supply and keep fish and aquatic animals alive in times of drought.
Maintaining groundwater health

The MDBA works with Basin state governments to monitor and manage the Basin’s groundwater resources to make sure they are healthy and productive. Groundwater resource monitoring looks at changes in the water level or pressure in a groundwater resource. This tells water managers the amount of water that:

- can be sustainably taken from groundwater systems
- is flowing into (recharging) groundwater systems.

The MDBA also monitors salinity levels in some groundwater systems because saline groundwater flow is a health risk for the environment, including our trees, grasslands, rivers and wetlands. Unlike surface water, groundwater resources can take longer to recharge—or refill with water—when water is taken. This may be weeks, months, years or even hundreds of years in some systems. This means the long-term management of groundwater resources is needed, to ensure the amount of water taken is sustainable.

**Recharge:** the process of addition of water to a groundwater system by infiltration, flow or injection from sources such as rainfall, overland flow, adjacent surface or groundwater systems or irrigation.

**Discharge:** the process of natural removal or extraction of groundwater from a groundwater system.
Monitoring and management of impacts

The Basin Plan sets a limit on the amount of groundwater that can be taken across the Murray–Darling Basin and requires Basin states to monitor and report against these limits. In addition to limits, rules and monitoring arrangements are required to manage the impacts of groundwater use, such as those impacts on environmental features, surface water baseflows, structural integrity and water quality. These arrangements will be documented in water resource plans. In some areas it is possible that monitoring of groundwater levels may reveal ongoing risks, including localised groundwater level declines.

Sustainable diversion limits

The Basin Plan sets baseline diversion limits and sustainable diversion limits for each groundwater system in the Basin. The baseline diversion limit is an estimate of how much groundwater could have been taken on average under management and infrastructure arrangements prior to the Basin Plan. Sustainable diversion limits are how much water, on average, can be used in the Basin by towns, communities, industry and farmers, while leaving enough water in the system to sustain natural ecosystems. The groundwater resources in the Basin have been split into 19 groundwater water resource plan areas (Figure 2). These have been further divided into 80 SDL resource units (Figure 3). The boundaries of these units were determined to accommodate the level of connectivity of various groundwater resources and state planning boundaries. A number of the SDL resource units have also been vertically or horizontally separated, to reflect that water is or can be extracted from different groundwater systems within the same area. Sustainable diversion limits for groundwater are listed in Schedule 4 of the Basin Plan.

Critical to implementing and enforcing the limits is a system of accounts that keep track of how much water is taken each year from the groundwater systems of the Basin. The Commonwealth Water Act 2007 and the Basin Plan 2012 put in place the requirements for such a system of accounts. Compliance with the limits commenced in all groundwater SDL resource units on 1 July 2019. Water resource plans are the main mechanism for giving effect to the limits and the Basin Plan more generally.

Water resource plans: set out the rules for how water is used at a local or catchment level, including new limits on how much water can be taken from the system for both surface water and groundwater, how much water will be made available to the environment, and how water quality standards can be met.

Water resource plans outline how each region aims to achieve community, environmental, economic and cultural outcomes and ensure that state water management rules meet the Basin Plan objectives. The plans reflect current arrangements that are working and include new arrangements that strengthen water management at a local level.
Figure 2: Murray–Darling Basin water resource plan areas - groundwater
Figure 3: Murray–Darling Basin SDL resource units – groundwater
Groundwater use within sustainable diversion limits

Groundwater use across the Basin is currently significantly lower than the sustainable diversion limit with more than two-thirds of the SDL resource units having use levels 50% below the limit. There is little evidence of increased groundwater use at the Basin scale over the past six years (Figure 4), and it is unlikely that use in the Basin will reach the limits in the coming decades. This is due to many aquifers in the Basin being highly saline and/or having low transmissivity and a lack of economic drivers (i.e. groundwater infrastructure is more costly than surface water infrastructure).

![Graph](image)

Figure 4: Groundwater Basin-wide sustainable diversion limit, baseline diversion limit and annual actual take for 2012–13 to 2017–18

Transmissivity: the rate at which groundwater moves through a groundwater system.

There is some concern that groundwater use has the potential to increase significantly up to the sustainable diversion limit. This is because the Basin-wide limit allows for an increase in groundwater development in areas where groundwater take has been low and the MDBA’s assessment indicates that such an increase is sustainable.

Monitoring has indicated that while groundwater use at a Basin-scale has not significantly increased over time, some areas have experienced a growth in groundwater use. Growth can be driven by changes in land use, climatic conditions or surface water availability and policy, for example implementation of the Cap on surface water diversions. The MDBA will continue to monitor take and apply new knowledge to ensure any risks associated with increasing groundwater use are mitigated early.
Figure 5 shows an example of growth in groundwater use in a particular monitoring bore in the Lower Murrumbidgee Deep Alluvium. It shows a water level response in a productive system in an area of high levels of use. It should be noted that this is not necessarily indicative of the entire system, and further investigations are required to fully understand these impacts.

![Groundwater extraction and level decline in the Lower Murrumbidgee Deep Alluvium](image)

**Water resource plan requirements**

Basin state governments are currently developing water resource plans and the MDBA is working with Basin state governments to ensure these plans meet the requirements of the Basin Plan. Water resource plans outline the mechanisms for achieving community, environmental, economic and cultural outcomes in accordance with the Basin Plan requirements. The plans must reflect current arrangements that operate in each state and new arrangements that strengthen water management, including at a local level, where these are deemed necessary.

To ensure the risks associated with groundwater use are minimised, there are a number of requirements in the Basin Plan which must be addressed through water resource plans. These include consideration of whether it’s necessary to include rules to ensure the plan doesn’t compromise:

- environmental watering requirements of priority environmental assets and functions that are partially or fully dependent on groundwater (s10.18)
- environmental watering requirements where there is high surface water and groundwater connectivity, e.g. baseflows (s10.19)
- overall structural integrity and hydraulic relationships and properties of the aquifer (s10.20) and
- maintenance of water quality within groundwater SDL resource units (s10.35C).
Although water resource plans must consider these risks, they provide for water resource management at relatively large spatial scales and set out management arrangements which are relevant across the water resource plan area. There are some allowances for localised responses, such as environmental watering requirements for priority environmental assets and priority ecosystem functions. However, largely the Basin Plan does not prescribe detailed management actions to address specific issues at smaller scales and for specific circumstances. The nature of groundwater resources means that intense use in a localised area, while still within the limit, can have unacceptable impacts, for example localised groundwater level decline, which is explained below.

The MDBA acknowledges that Basin state governments have monitoring, legislative and policy arrangements in place to manage groundwater which pre-date the Basin Plan. Issues which are not fully managed by the Basin Plan and water resource plans may be managed through these state frameworks. If the MDBA receives information that indicates new or identified future risks are materialising, the MDBA will inform the relevant Basin state government and will support it to identify and implement an appropriate response.

Groundwater management statement 1: Monitoring impacts to ensure sustainable groundwater management. Basin state governments should monitor the quality and quantity of groundwater and take timely action considering evidence based triggers to prevent impacts on groundwater systems, the environment and groundwater users from groundwater use. If the MDBA becomes aware of any risks or impacts the relevant state government will be notified and the MDBA will seek a timely response on the management actions that are being implemented.

Localised groundwater level decline

Groundwater level decline: Groundwater level decline is the drop in the water table or pressure level after seasonal fluctuations. It occurs in response to:

1. pumping from the bore
2. interference from a neighbouring pumping bore
3. in response to local, intensive groundwater pumping
4. regional seasonal decline due to discharge in excess of recharge.
Localised groundwater level decline is a sustained decline in groundwater levels or pressures across an area. Figure 6 shows a hypothetical example of an aquifer with localised groundwater level decline near Town 2, including a corresponding hypothetical hydrograph. Localised groundwater level decline can have serious long-term impacts on a water resource depending on its severity (rate and magnitude of water level or pressure decline), the characteristics of the resource (recharge rate) and connectivity of neighboring groundwater resources. Localised groundwater level decline can be associated with the following impacts (Figure 7):

- degradation of structural integrity
- reduced reliability for groundwater users
- reduced availability for groundwater dependent ecosystems
- reversal of hydraulic gradients, that can lead to water quality changes from induced leakage from adjacent systems
- reduced surface water flows, where there is high surface water-groundwater connectivity.

Figure 6: Hypothetical example of localised groundwater level decline near Town 2.
Figure 7: Schematic of groundwater local drawdown impacts

There have been consistent localised water level declines in some groundwater SDL resource units over the past 20–30 years. Some of these declines commenced or increased following the introduction of the Cap on surface water diversions in 1996 (the Cap), which is a restriction on surface water take under the Murray–Darling Basin Agreement.

Basin state governments have or are in the process of providing mechanisms to manage localised groundwater level decline risks through the development of water resource plans. Although requirements through the plans include monitoring, they may not always be sufficient to address emerging groundwater risks. Local groundwater level decline and increased growth in groundwater take may pose a threat to groundwater (and potentially surface water resources) and dependent environmental assets and ecosystem functions.

The MDBA may seek to improve understanding of groundwater level decline issues and their implications through commissioning further work into the location and impacts of groundwater level decline. This work could consider:

- the change in volume of surface water recharging groundwater systems due to changes in groundwater level decline spatial and temporal patterns
- the change in volume of groundwater storage due to seasonal fluctuations and recharge
- the source of groundwater recharge
- the risk of irreversible damage to groundwater systems
- the economic implications for users should water quality and/or quantity decline in high-use areas.

**Groundwater management statement 2: Reporting use.** The MDBA will analyse and report on groundwater use across the Basin in response to Basin state governments annual reporting. The analysis will include considering state monitoring data against localised groundwater level decline risks. As required, the MDBA will notify and seek a response from states as per statement 1.
New knowledge and information

The Basin Plan is an adaptive management instrument. That is, it defines the Basin-wide water sharing arrangements based on the best available knowledge, but is also required to adapt if better information is brought forward. This adaptation is achieved through the on-ground management instruments within the Basin Plan (such as the environmental watering plan and water resource plans), but it is also achieved through regular review points at which the effectiveness of the Basin Plan settings will be re-examined. There are a number of areas where groundwater knowledge can be improved to inform future reviews of the Basin Plan, including estimates of how much water is recharged into the ground, surface water—groundwater connectivity, impacts of increased groundwater use on river flows and climate change.

Basin Plan review in 2026

The MDBA has a statutory obligation to review the Basin Plan in 2026. This provides an opportunity to review the information used to determine the limits and consider whether provisions in the Basin Plan are sufficient to sustainably manage groundwater systems. The review will examine if its settings or implementation can be improved. To assist with this examination, the MDBA publishes annual reports on the progress of the Basin Plan and will have conducted three evaluations of the effectiveness of the Plan in 2017, 2020 and 2025.

Groundwater management statement 3: Improved knowledge and adaptation. Any improvements in information available since the Basin Plan was developed will be used to inform the review of the Basin Plan in 2026. Sources of new knowledge or information may come from:

- groundwater SDL data reviews (for example improved knowledge on groundwater recharge)
- monitoring the impact of groundwater take on river flows and other groundwater systems
- analysis of annual reporting on groundwater take
- research into the impacts of climate change
- research into the relationship between river flows, groundwater, the community, agriculture and the environment.

Recharge estimates

Some stakeholders have criticised the recharge estimates and modelling used to inform sustainable diversion limits when the Basin Plan was developed. The MDBA acknowledges there is a degree of uncertainty in all modelling, but re- iterates that the best information available at the time was used to develop the limits. The MDBA will examine the information used in setting limits and incorporate new information where available, as part of the Basin Plan review in 2026.

Between 2015 and 2018, the MDBA partnered with the National Centre for Groundwater Research and Training (NCGRT) in a $2 million strategic groundwater research program. The research examined critical scientific issues with a particular focus on understanding and managing surface water and groundwater interaction. Specific attention was placed on increasing the understanding of
groundwater recharge processes in the Basin and estimation techniques. The key findings and recommendations from the partnerships project are presented in a final report and associated publications.

Surface water – groundwater connectivity

The connectivity of groundwater and surface water systems involves a complex interplay of many variables. The complex nature of connectivity is difficult to define technically, difficult to measure and therefore difficult to manage. Geology and topography are the most significant drivers of flux in a water system. Similar geologic conditions in the major rivers of the Basin lead to similar groundwater–surface water interaction processes on a broad scale, but each catchment behaves differently (Figure 8). Local knowledge is needed to fully appreciate their complexities.

The connectivity between surface water and groundwater and the risk of groundwater use on surface water resources was considered and incorporated in developing each of the 80 separate groundwater limits in the Basin Plan. The Basin Plan requires states to have regard to surface water–groundwater connectivity and to incorporate connectivity management rules where necessary in their water resource plans. The operational detail and specific approach taken to manage these connected systems remains with the states. The management approaches being used by states for connectivity are:

- applying distance conditions from surface water bodies for new and replacement bores
- creating zones within which groundwater use is limited

Figure 8: Connectivity between surface water and groundwater considering geology and topography
• managing use to trigger levels and/or reduced levels of allowable use within a season
• applying joint announced allocations (often on average annual limit) on surface water and groundwater use
• restricting the issuing of entitlements or restricting full use of entitlements by using announced allocations.

Potential impacts of increased groundwater take on river flows

Concerns have been raised that increased groundwater use and irrigation efficiency projects may lead to reductions in flows making it into the river (reduced return flows) and therefore offset the benefits of surface water recovery for the environment.

Under the Basin Plan, groundwater use has potential to increase—this could reduce groundwater discharge or induce leakage from rivers (Figure 9) in connected systems. The MDBA intends to maintain close scrutiny on any potential increase in take, noting that there is little evidence of increased groundwater use over the past ten years. It is unlikely that use in the Basin will reach the total limit for decades. The reasons for this are that groundwater is generally highly saline, has low transmissivity and there are a lack of Basin-wide economic drivers to overcome these barriers. Nevertheless, as commodity prices and technology change, opportunities and the drivers for groundwater use may increase.

To better understand this issue, the MDBA commissioned an independent review by hydrology experts to investigate the risks posed by reduced return flows. The review examined the impact on river flow under no growth in use, 2% and 4% groundwater use growth in use scenarios at 40 years. The impact was found to be in the range of 0 to 360 GL/yr, with 170GL/yr as the most likely at 40 years. The large range is due to uncertainties in the growth of groundwater use and surface water–groundwater connectivity factors. The estimated reduction in river flows may take longer than 40 years to occur as there is an additional lag time between use and river response—this
can be 20 years or longer depending on the catchment. This means understanding any impacts from reduced return flows will be a slow process because growth in groundwater use is expected to be slow. The independent review has suggested adaptive management of impacts may be appropriate, due to the slow evolution of impacts and the high uncertainties involved.

To date, increased groundwater take has only been observed in less connected systems (for example Lower Murrumbidgee Deep Alluvium in Figure 5). Should growth in use take place in highly-connected systems it will be important to consider surface water impacts. The MDBA will continue to monitor and improve our knowledge base accordingly to support the identification and management of risks to Basin water resources, including the impact of increased groundwater use on river flows.

Climate change

During times of drought and scarcity of surface water, groundwater is often relied upon as a backup supply for communities and industries. In some areas groundwater is the sole source of town drinking water, stock and domestic and irrigation supply. Reduced rainfall means less recharge to replenish groundwater supplies, especially in shallow aquifers with high connectivity to surface water, such as alluvial groundwater systems. These systems are more at risk in drought due to the relatively smaller volume of water held in groundwater storage. Impacts of climate change are difficult to predict for groundwater resources. Some climate change model projections indicate warmer temperatures across the Basin, as well as less rainfall runoff and recharge to groundwater systems. There are considerable variations across the modelling results, meaning adaptive management is important to ensure groundwater systems are managed sustainably.

Groundwater management statement 4: Climate change. In February 2019, the MDBA released the Climate Change and the Murray–Darling Basin Plan discussion paper explaining how the Basin Plan supports adaptation to better manage the impacts of climate change. A MDBA climate change research program is now being developed with the assistance of the MDBA’s Advisory Committee for Social, Economic and Environmental Science. The MDBA will partner with the CSIRO, the Bureau of Meteorology and other leading climate change researchers to implement the program and investigate adaptation opportunities to better manage climate risks.
Working with Basin state governments

Outside of water resource plans, the MDBA will work closely with Basin state governments to ensure groundwater resources are appropriately managed.

The MDBA will:

- publish information specifying the severity and location of groundwater issues across the Basin based on best available knowledge. This work may form part of the Basin Plan annual reports or the 2020 evaluation and will be regularly updated
- meet with the Groundwater Advisory Panel (GAP), which involves representatives from the Australian Government and state government agencies, to discuss groundwater issues, how states are managing risk and potential actions to support proactive management
- request monitoring information from state governments on groundwater risks, such as groundwater levels and water quality, as well as working with the state governments to fill in knowledge gaps to support evaluations
- mitigate risks through policy agreements where possible
- incorporate new research into decision-making
- potentially expand reporting obligations under Schedule 12 of the Basin Plan to include reporting on the availability of water for the environment for groundwater dependent ecosystems (Matter 9)
- form a groundwater ‘community of practice’ with subject-matter experts for the discussion of emerging groundwater issues.

Groundwater management statement 5: Shared knowledge – community of practice: The MDBA will continue to work in collaboration with Basin states and industry partners to coordinate the development and application of improvements in science and knowledge to inform policy decisions and management plans used to support the Basin Plan and its implementation.
Conclusion

While the Basin Plan aims to achieve sustainable management of groundwater resources, there are some risks that may not be fully mitigated through existing mechanisms in the Basin Plan, such as water resource plans. The MDBA is taking a proactive approach in identifying those risks and building an understanding of their implications, to support state-based mitigation. Some of these risks will require close coordination with Basin state governments and may include the development of new policies to ensure the Basin is managed as a connected system.

The MDBA will also seek to improve groundwater knowledge across the Murray–Darling Basin, leveraging existing knowledge held by Basin state governments, to better identify risks associated with an increase in groundwater use and climate change. Any improvements in knowledge will be incorporated into water resource plans and the Basin Plan, ensuring that groundwater management in the Basin is underpinned by the best available science. The MDBA is also committed to working with partner governments to achieve innovative solutions to ensure groundwater is managed effectively outside of these policy mechanism.

These actions will ensure the MDBA is prepared to respond to any potential threats to Basin water resources, protecting groundwater resources into the future for all Australians.
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