2021 review of groundwater levels in alluvial groundwater sources of inland NSW

Introduction

At the end of 2020, NSW had seen up to four years of drought across large parts of the state. In 2019 conditions were drier and hotter than in any other NSW drought for the last 120 years. From January 2017 to December 2019, rainfall was the lowest on record. During these extreme dry conditions, there was increased demand for groundwater resources as access to surface water became very limited.

The greatest demand on groundwater during this recent drought was in the inland alluvial groundwater systems. These systems account for around 70% of all groundwater entitlement in NSW. These systems contain large volumes of low salinity groundwater which is used for town water supplies, irrigated agriculture and industries. The graph below shows that there were larger volumes of groundwater pumped across the entire inland during 2017-18, 2018-19 and 2019-20 compared to the wetter years of 2016-17 and 2020-21. Water take in the groundwater systems in the southern NSW was consistently higher than in the northern inland.

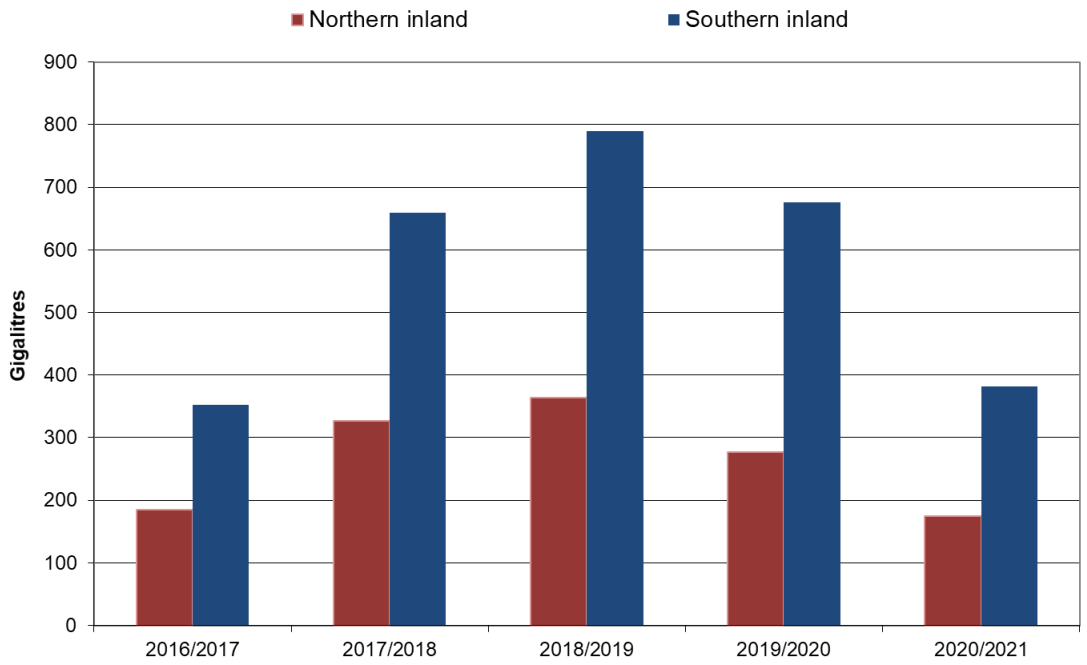

Figure 1: Groundwater extraction from the inland alluvial groundwater sources since 2016-17 to 2020-21.

The Department of Planning and Environment – Water (the department) has progressively reviewed how the groundwater systems responded to the increased pumping during the drought. This work focused on the inland alluvial systems where groundwater was heavily relied on for

water supplies during this time. This report summarises the results of these assessments, which looked at both the effects of pumping and how groundwater levels have recovered.

Separate reports for the groundwater sources within the Upper and Lower Namoi, the Upper Lachlan and the Lower Gwydir will be published to provide more detailed data and maps of measured changes to groundwater levels. In parts of these groundwater sources, the groundwater level data shows there are areas where groundwater levels have exceeded or are close to exceeding acceptable levels set by the department.

Assessing pumping impacts on groundwater levels

Pumping groundwater causes the water level in the aquifer to draw down in the area near the pumping bore. When the pumping stops, the water level typically recovers, or rises.

If there are multiple bores pumping, the area of drawdown around the individual bores can combine to form large areas where groundwater levels are lower during the pumping season. The size and shape of the area affected by the drawdown depends on the volume being pumped, how transmissive the aquifer is and the level of confinement of the aquifer. Confinement is a measure of how connected the aquifer is to the water table, where a highly confined aquifer is less connected to the water table.

If groundwater levels do not fully recover before the start of the next pumping season and this continues for multiple seasons, there is an ongoing decline in the recovered groundwater levels (i.e. a long term decline in water levels) from one season to the next. The pumping drawdowns will then drop deeper each successive irrigation season.

In large groundwater systems reliant on episodic recharge events to replenish the groundwater store, a decline in the seasonally recovered groundwater levels is an expected management outcome. The large volume of groundwater in storage in these systems enables groundwater pumping to continue during droughts to provide much needed water supplies when surface water is scarce. However, if the seasonally recovered groundwater levels continue to decline after successive recharge events it is an indicator that the levels of pumping in that area of the water source may not be viable in the long term.

The department aims to manage the cumulative pumping drawdowns so that there is minimal effect on the environment and the yield of water supply bores, including those for domestic and stock supplies. This is managed in part by placing conditions on new water supply bore approvals to limit pumping impacts to acceptable levels, as detailed in the Assessing groundwater applications information sheet.

2021 assessment

Firstly, to assess whether the monitored groundwater levels are fluctuating within these acceptable limits, we set a baseline for each area to compare the observed changes against. Depending on the period of available data, this baseline is generally set to a date prior to widespread groundwater pumping in an area, typically before 1990.

The observed change in groundwater levels is expressed as a percentage of the total available drawdown (TAD) during this baseline period. For most groundwater sources this is the height of the groundwater head above the base of the groundwater source as shown in Figure 2. For most inland alluvial groundwater sources, the acceptable level of drawdown is set at 40% of the pre-development total available drawdown (Figure 2).

As well as assessing the magnitude of the pumping drawdowns during the drought, the review also looked at the level to which the groundwater levels recovered after the 2019-20 pumping season. For this review, the long-term change in the seasonally recovered groundwater levels was compared against a fall of 25% of the total available drawdown from the baseline water level.

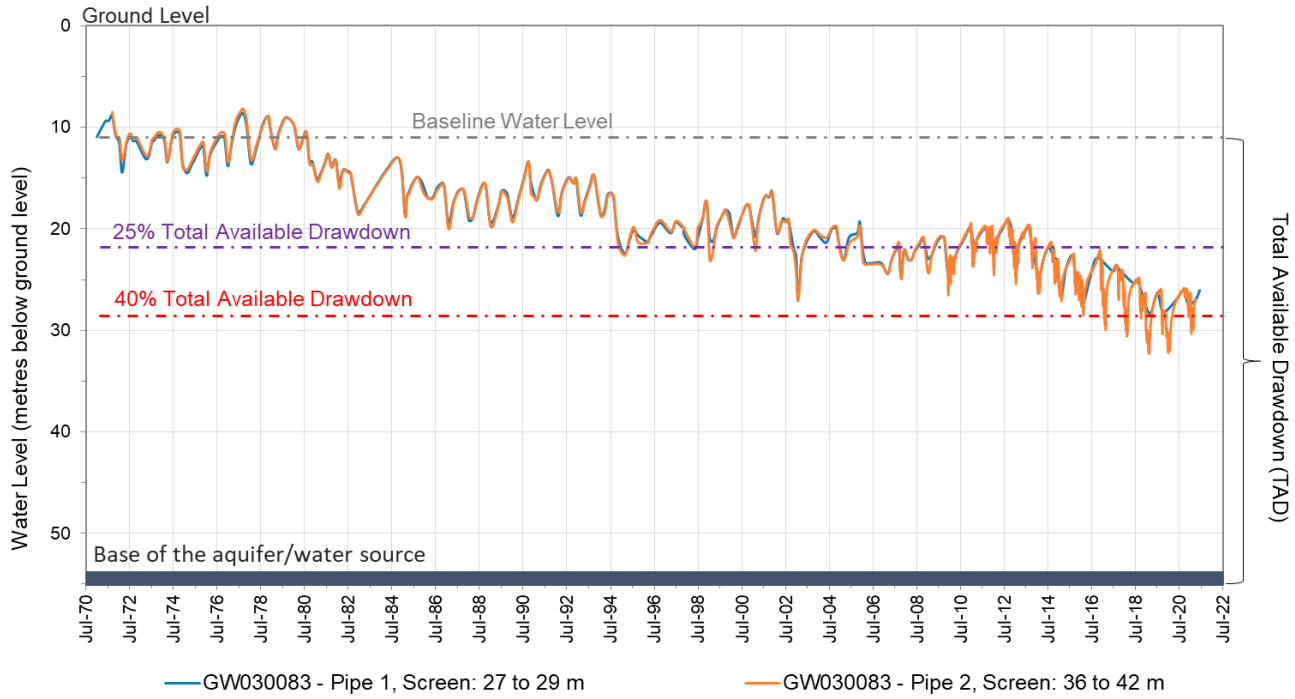

Figure 2: A hydrograph from a monitoring site in the Upper Namoi Zone 8 groundwater source. It shows the total available drawdown above the base of the water source, the depths equivalent to the 40% and 25% total available drawdown, the seasonal drawdowns during pumping cycles and the change in the recovered groundwater levels.

For the Lower Murray and Lower Murrumbidgee Deep groundwater sources, the criteria are different. The total available drawdown is set based on the groundwater head above the top of the confined aquifer which the high yielding water supply bores are pumping from. The criteria for the acceptable level of drawdown is set at 70% of the pre-development groundwater head above the top of the productive aquifer as shown in Figure 3. The review compared the long-term change in the seasonally recovered groundwater levels against a fall of 50% of the baseline total available drawdown.

The monitoring sites where the measured groundwater levels exceed or are close to exceeding the criteria for acceptable levels of pumping drawdown or recovery decline are summarised in **Error! Reference source not found.**. A map of NSW showing the location of these groundwater sources is at Figure 4.

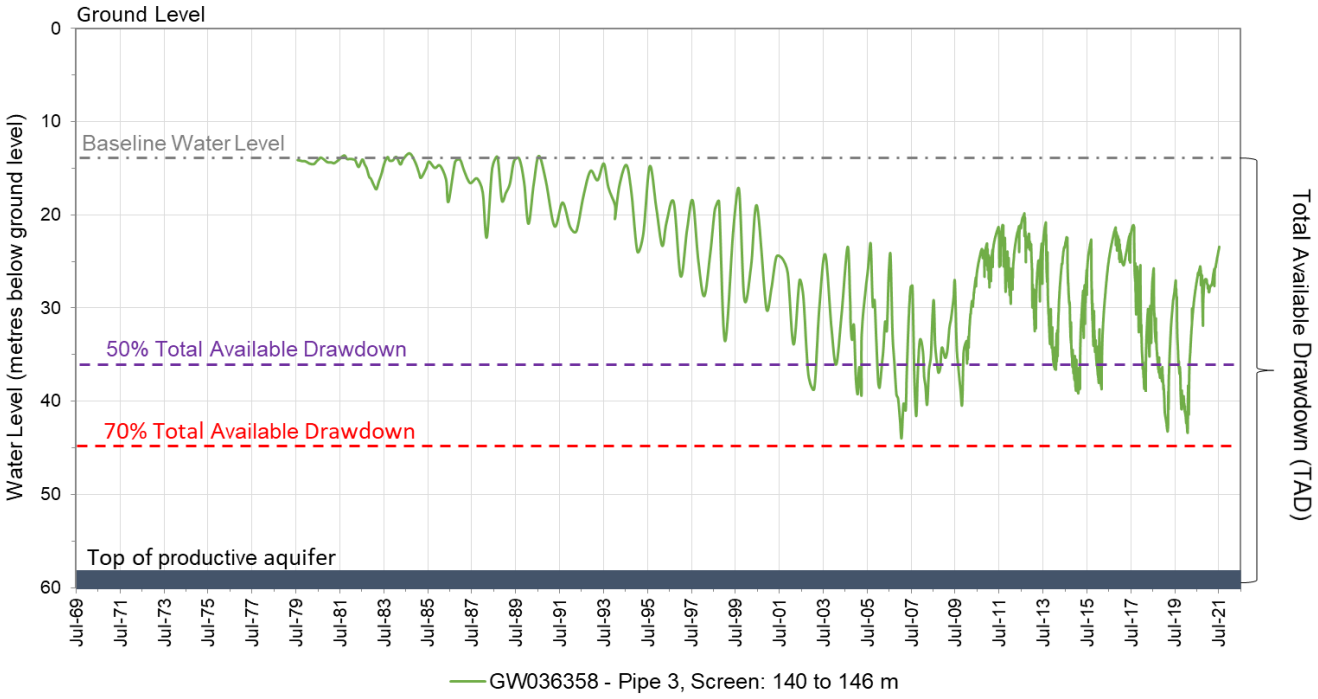

Figure 3: Example hydrograph from the Lower Murrumbidgee Deep groundwater source. It shows the total available drawdown measured from the top of the aquifer, the depths equivalent to the 70% and 50% total available drawdown, the seasonal drawdowns during pumping and the change in the recovered groundwater levels.

Further information

Information and data on groundwater monitoring from the NSW government monitoring program is available via the Real-time data - WaterNSW website. WaterNSW measures the groundwater levels at 4,630 monitoring pipes at 2,830 sites across NSW.

Just under 400 of these pipes have telemetered data loggers installed enabling the groundwater level to be accessed in real time. Another 550 pipes have data loggers installed taking a continuous record of groundwater levels although this data is not available in real time on the website. The logger data and the manually measured data for the other 3,680 monitoring pipes is uploaded periodically to the real-time data website.

In 2020, the department published 29 reports on groundwater sources providing information on the licensing, levels of metered extraction, trading and groundwater level data. These can be viewed or downloaded from the department's website (https://www.industry.nsw.gov.au/water/science-archive/groundwater/document-library. These reports collate and report the data that is publicly available from several state-based websites into a summary format for a groundwater source. These will be updated regularly.

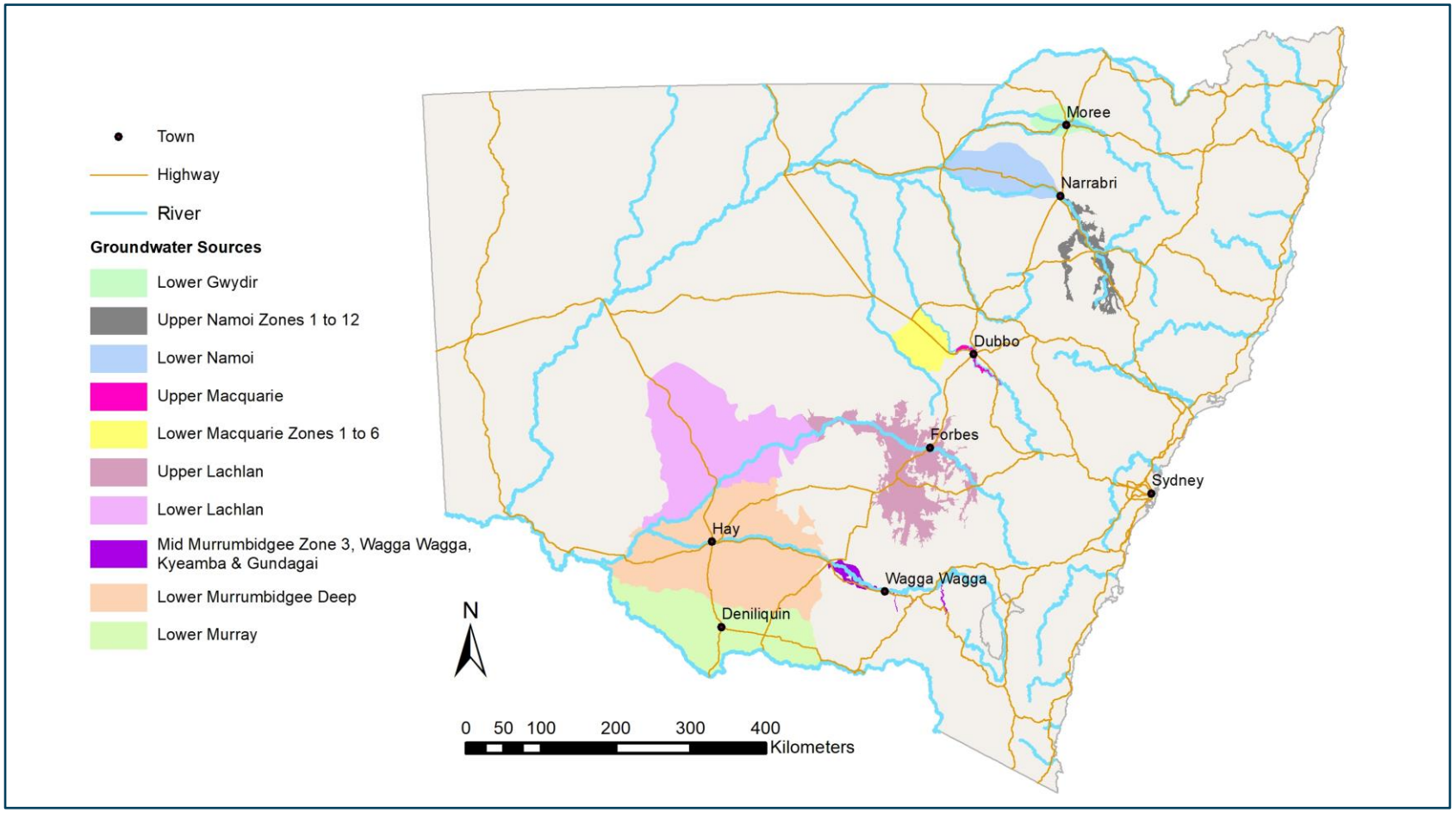

Figure 4: Map of NSW showing the location of the groundwater sources in which groundwater level data was assessed against pumping and non-pumping groundwater level criteria.

Table 1: Summary of the monitoring bore data review for 29 alluvial groundwater sources in inland NSW. This table lists the number of monitoring sites in each groundwater source that has measured groundwater levels exceeding or are close to exceeding the criteria for acceptable levels of pumping drawdown or long-term decline in recovered (i.e. non-pumping) groundwater levels. Groundwater sources are listed from north to south.

Groundwater Sources	Number of monitoring sites reviewed	Drawdown Assessment (short-term)	Recovery Assessment (long-term)	Comments
Lower Gwydir	56	Over the last 5 years (July 2016 to June 2021) the depth of the pumping drawdown was equal to or exceeded 40% of the TAD below the baseline at 6 sites. At 8 sites it was in the range of 30 - 40% of the TAD.	In 2021, the recovered water level at 4 sites was more than 25% of the TAD below the baseline	A separate report on the water level trends in the Lower Gwydir groundwater source will be published.
Upper Namoi groundwater sources - Zones 1, 2, 6, 7,9,11	94 across the 6 groundwater sources	The depth of the pumping drawdowns at all monitoring sites did not exceed 30% of the TAD below the baseline.	The recovered water level at all monitoring sites were within acceptable levels.	A separate report on the water level trends in the Upper and Lower Namoi groundwater sources will be published.
Upper Namoi Zone 3	58	Over the last 5 years the depth of the pumping drawdown exceeded 40% of the TAD below the baseline at 2 sites. At 8 sites it was in the range of 30 - 40% of the TAD.	The recovered water level at all monitoring sites were within acceptable levels.	
Upper Namoi Zone 4	65	Over the last 5 years the depth of the pumping drawdown exceeded 40% of the TAD below the baseline at 2 sites. At 1 site it was in the range of 30 - 40% of the TAD.	In 2021, the recovered water level at 2 sites was more than 25% of the TAD below the baseline.	

Groundwater Sources	Number of monitoring sites reviewed	Drawdown Assessment (short-term)	Recovery Assessment (long-term)	Comments
Upper Namoi Zone 5	39	Over the last 5 years the depth of the pumping drawdown at 3 sites was in the range of 30 - 40% of the TAD below the baseline.	In 2021, the recovered water level at 1 site was more than 25% of the TAD below the baseline.	A separate report on the water level trends in the Upper and Lower Namoi groundwater sources will be published.
Upper Namoi Zone 8	52	Over the last 5 years the depth of the pumping drawdown exceeded 40% of the TAD below the baseline at 3 sites. At 11 sites they were in the range of 30 - 40% of the TAD.	In 2021 the recovered groundwater levels at 11 sites was more than 25% of the TAD below the baseline	
Upper Namoi Zone 10	1	Over the last 5 years the depth of the pumping drawdown at 1 site was in the range of 30 - 40% of the TAD below the baseline Zone 10.	The recovered water level at all monitoring sites were within acceptable levels.	
Upper Namoi Zone 12	8	Over the last 5 years, the depth of the pumping drawdown did not exceed 30% of the TAD below the baseline at any of the monitoring sites.	In 2021 the recovered groundwater levels at 1 site was more than 25% of the TAD below the baseline, the rest of the monitoring sites had recovered groundwater levels that were between 20-25% of the TAD.	

Groundwater Sources	Number of monitoring sites reviewed	Drawdown Assessment (short-term)	Recovery Assessment (long-term)	Comments
Lower Namoi	243	Over the last 5 years the depth of the pumping drawdown exceeded 40% of the TAD below the baseline at 55 sites. At 59 sites they were in the range of 30 - 40% of the TAD.	In 2021 the recovered groundwater levels at 32 sites was more than 25% of the TAD below the baseline	A separate report on the water level trends in the Upper and Lower Namoi groundwater sources will be published.
Upper Macquarie	47	During 2019-20 the depth of the pumping drawdown at 2 sites exceeded 40% of TAD below the baseline and another 4 sites were within 30-40% of the TAD.	In 2020 2 sites had a recovered groundwater levels that was more than 25% of the TAD below the baseline.	The areas with declining water levels will continue to be monitored.
Lower Macquarie Zone 1	8	During 2019-20 the depth of the pumping drawdowns at 1 site exceeded 40% of TAD below the baseline and 3 sites were within 30-40% of TAD.	In 2020 3 sites had a recovered groundwater level that was more than 25% of the TAD below the baseline.	The areas with declining water levels will continue to be monitored.
Lower Macquarie Zone 3	9	During 2019-20 the depth of the pumping drawdowns at 1 site was within 30-40% of TAD.	The recovered water level at all monitoring sites were within acceptable levels.	The areas with declining water levels will continue to be monitored.
Lower Macquarie groundwater sources - Zones 2, 4 and 5	26	The depth of the pumping drawdowns at all monitoring sites did not exceed 30% of the TAD below the baseline.	The recovered water level at all monitoring sites were within acceptable levels.	Within Zone 4, there are approval conditions on production bores requiring them to cease pumping if groundwater levels reach specified depths in monitoring bores.

Groundwater Sources	Number of monitoring sites reviewed	Drawdown Assessment (short-term)	Recovery Assessment (long-term)	Comments
Lower Macquarie Zone 6	12	During 2019-20 the depth of the pumping drawdowns at 1 site was within 30-40% of TAD below the baseline.	The recovered groundwater level at all monitoring sites were within acceptable levels.	The areas with declining water levels will continue to be monitored.
Upper Lachlan	160	During 2019-20 the depth of the pumping drawdowns exceeded 40% of the TAD below the baseline at 10 sites. At 6 sites they were within 30-40% of the TAD.	The 2019 recovered groundwater levels at 11 sites was more than 25% of the TAD below the baseline and 16 sites had recovered groundwater levels that were between 15-25% of the TAD.	A section 324 Order limiting extraction and trade in Zone 1 is in place until 30 June 2024. A separate report on the water level trends in the Upper Lachlan Alluvial groundwater source will be published.
Lower Lachlan	93	During 2019-20 the depth of the pumping drawdown at 1 site was within 30-40% of the TAD below the baseline.	The 2019 recovered groundwater levels at 3 sites was more than 25% of TAD below the baseline and at 6 sites the recovered groundwater level was between 15-25% of the TAD.	The areas with declining water levels will continue to be monitored.
Lower Murrumbidgee Deep	152	During 2019-20 the depth of the pumping drawdowns at exceeded 70% of the TAD below the baseline at 2 sites and at 13 sites was within 50-70% of TAD.	The 2019 recovered groundwater levels at 9 sites were within 30-50% of the TAD below the baseline. All other sites had recovered groundwater levels of less than 30% of the TAD below the baseline.	There are two local management areas that restricts trade to limit declines in the groundwater levels. The areas with declining water levels will continue to be monitored.

Groundwater Sources	Number of monitoring sites reviewed	Drawdown Assessment (short-term)	Recovery Assessment (long-term)	Comments
Gundagai Alluvial	9	During 2019-20 pumping drawdowns did not exceed 30% of the TAD below the baseline at any site.	The 2019 recovered groundwater levels at 1 site was within 15-25% of the TAD below the baseline.	
Kyeamba Alluvial	4	During 2019-20 the depth of the pumping drawdown at 2 sites was within 30-40% of the TAD below the baseline.	The 2019 recovered levels was more than 25% of TAD below the baseline at 2 sites.	The areas with declining water levels will continue to be monitored.
Mid Murrumbidgee Zone 3	47	During 2019-20 pumping drawdowns did not exceed 30% of the TAD below the baseline at any site.	The 2019 recovered levels at 1 site was within 15-25% of the TAD below the baseline	
Wagga Wagga Alluvial	34	During 2019-20 pumping drawdowns did not exceed 30% of the TAD below the baseline at any site.	The 2019 recovered levels at 5 sites were within 15-25% of TAD.	The areas with declining water levels will continue to be monitored.
Lower Murray	77	During 2019-20 the depth of the pumping drawdowns at all sites was less than 50% of TAD below the baseline.	The 2019 recovered levels at all sites were less than 30% of TAD.	