Baroota Prescribed Water Resources Area 2018-19 water resources assessment

Department for Environment and Water
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Government of South Australia
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1 Summary

Rainfall

- Rainfall typically ranges from 350 to 450 mm, with the higher rainfall in the ranges upstream of Baroota Reservoir.
- Rainfall at Port Germein was much lower than average in 2018–19. Long-term data trends indicate a decline in rainfall.
- Rainfall in winter and early spring of 2018 was below average and very dry conditions occurred in summer 2018–19 and into early autumn 2019.

Groundwater

- Water levels in the Quaternary and Tertiary aquifers range from lowest-on-record to very-much-above-average in 2019 when compared to their historic range.
- Average water levels were observed in 38% of the wells and the median well compared to their historic range.
- Five-year trends in water level show rising trends in the majority of wells (69%), with the median five-year trend being a rise of 0.13 m/y.
- Groundwater salinity varies widely across the PWRA, with salinities increasing from east to west. No salinity data is available for 2019.

Water use

- Water use for irrigation and stock and domestic purposes comes from groundwater, supplemented by imported River Murray water via the Morgan to Whyalla pipeline.
- The volume of groundwater extracted from metered irrigation wells has declined from 1916 ML in 2002–03 to less than 1000 ML since 2009–10. The most recent measurement of extraction was 685 ML in 2015–16.

1.1 Purpose

The Department for Environment and Water (DEW) has a key responsibility to monitor and report annually on the status of prescribed and other groundwater and surface water resources. To fulfil this, data on water resources are collected regularly, analysed and reported in a series of annual reports. Three reports are provided to suit a range of audiences and their needs for differing levels of information:

- **Technical Notes**: (this document) build on the fact sheets to provide more comprehensive information for each resource area, helping to identify the resource condition in further detail;
- **Fact sheets**: provide summary information for each resource area with an Annual Resource Status Overview;
- **State-wide summary**: this summarises information for all resources across all regions in a quick-reference format.

This document is the Technical Note for the Baroota Prescribed Water Resources Area (PWRA) for 2018-19 and addresses groundwater data collected up until December 2019.

1.2 Regional context

The Baroota PWRA lies on the western side of the Flinders Ranges in the Northern and Yorke Landscape Region, approximately 25 km north of Port Pirie. It is a local scale resource for which surface water and groundwater have been prescribed under South Australia's Landscape SA Act. A water allocation plan has not yet been prepared for this area.

The main groundwater resource in the Baroota PWRA is composed of a number of aquifers located in Quaternary alluvial sediments adjacent to the Flinders Ranges. An area of low-salinity groundwater surrounds Baroota Creek, which has a large catchment to the east and north-east. Baroota Reservoir lies in the headwaters of Baroota Creek, but is no longer used for water supply.

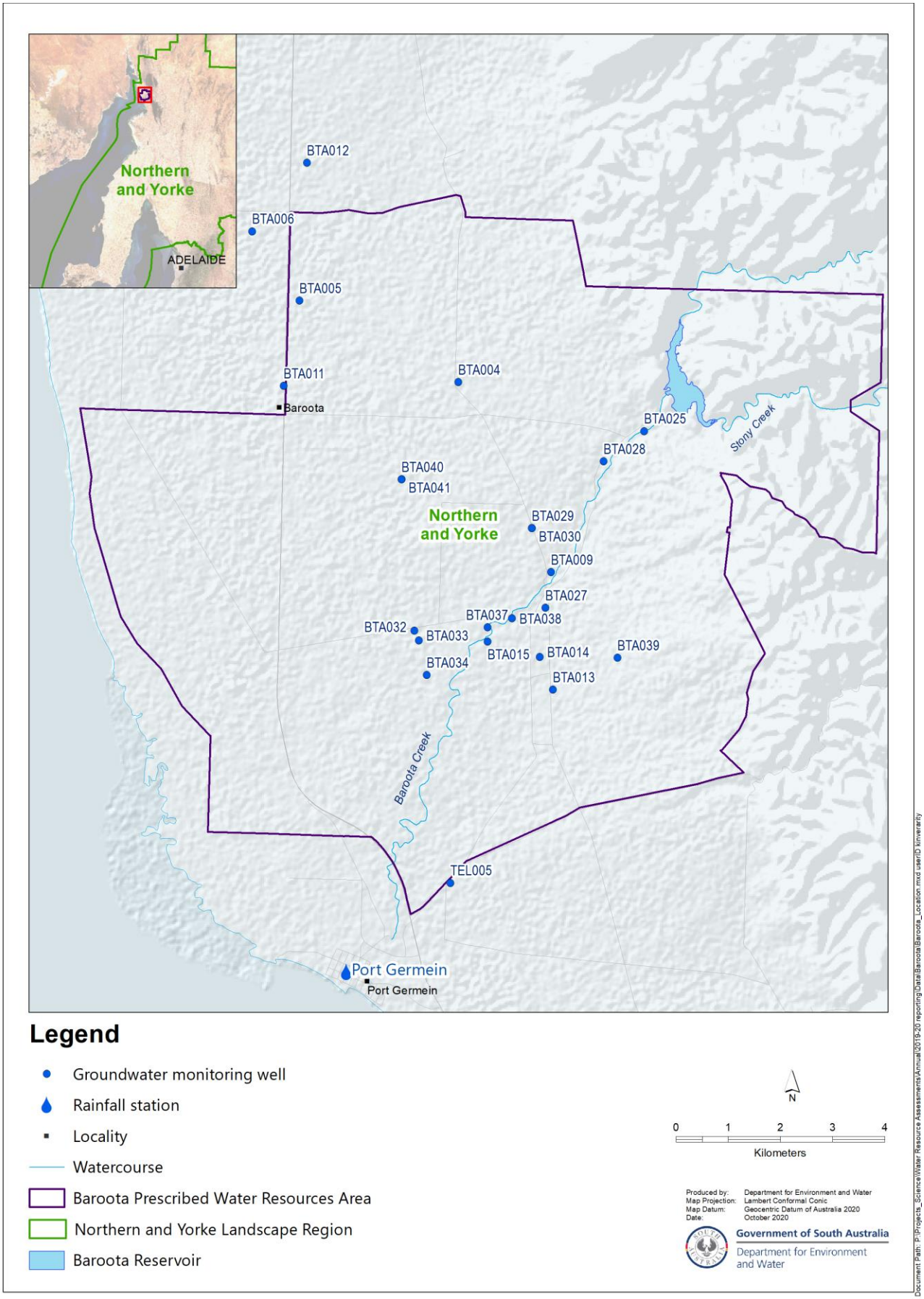

Figure 1.1. Location of Baroota PWRA

2 Methods and data

This section describes the source of rainfall, surface water, groundwater and water use data presented in this report and the methods used to analyse and present this data.

2.1 Rainfall

Daily rainfall observations were used from selected Bureau of Meteorology (BoM) stations in order to calculate monthly and annual totals. The data were obtained from the SILO Patched Point Dataset service provided by the Queensland Government, which provides interpolated values to fill gaps in observations (Figure 3.2 and Figure 3.3).

Rainfall maps were compiled using gridded datasets obtained from the BoM (Figure 3.1). The long-term average annual rainfall map (1986-2015) was obtained from Climate Data Online. The map of total rainfall in 2018–19 was compiled from monthly rainfall grids obtained for the months between July 2018 and June 2019 from the Australian Landscape Water Balance website.

2.2 Groundwater

2.2.1 Water level

Water level[1] data were obtained from wells in the Baroota PWRA monitoring network from both manual and continuous logger observations. All available water level data were verified and the maximum annual water level for each well was identified for further analysis. The maximum annual water level represents the unstressed or recovered water level following seasonal irrigation pumping. The amount of pumping can vary from year to year and the proximity of pumping wells to observation wells may affect the reliability of trends and historical comparisons. Therefore, the recovered water level provides a reliable indicator of the status of the groundwater resource. The period of recovery each year was reviewed for each well. In general, the aquifers in the Baroota PWRA return to a maximum recovered level at a variety of times throughout the year, and the maximum level from each calendar year is used for the annual recovered level.

For wells with suitable long-term records, the annual recovered water level was ranked and described according to their decile range[2] from lowest to highest on record (Table 2.1). The definition of a suitable long-term record varies depending on the history of monitoring activities in different areas; for the Baroota PWRA, any well with 10 years or more of recovered water level data is included. For the most recent year, the number of wells in each decile range was then summarized for each aquifer (for example see Figure 4.1). Hydrographs are shown for a selection of wells to illustrate common or important trends (for example see Figure 4.3).

Five-year trends were calculated using annual recovered water levels for those wells which have at least five measurements (i.e. at least one measurement a year). The trend line was calculated by linear regression and the well is given a status of 'declining', 'rising', or 'stable', depending on whether the slope of this trend line is below, above or within a given tolerance threshold. This threshold allows for the demarcation of wells where water levels

[1] "Water level" in this report refers to both the watertable elevation, as measured in wells completed in unconfined aquifers, and the potentiometric water level elevation, as measured in wells completed in confined aquifers where the water level or pressure in the monitoring well rises above the top of the aquifer. These are collectively referred to as the "reduced standing water level" (RSWL).

[2]. Decile: a division of a ranked set of data into ten groups with an equal number of values. In this case e.g. the first decile contains those values below the 10th percentile.

are changing at very low rates and the water level can therefore be considered stable. The threshold also accommodates for very small measurement errors. The number of rising, declining and stable wells are then summarized for each aquifer (for example see Figure 4.2).

Moderately-sized sedimentary confined and unconfined aquifers such as the Quaternary and Tertiary aquifers of the Baroota PWRA are given tolerance thresholds of 2 cm/y.

Table 2.1. Percentile/decile descriptions*

Decile	Percentile	Description	Colour used
N/A	0	Lowest on record	
1	0 to 10	Very much below average	
2 and 3	10 to 30	Below average	
4, 5, 6, and 7	30 to 70	Average	
8 and 9	70 to 90	Above average	
10	90 to 100	Very much above average	
N/A	100	Highest on record	

* Deciles and descriptions as defined by the Bureau of Meteorology[3]

2.3 Water use

Meter readings are used to estimate extraction volumes for groundwater irrigation wells. The most recent financial year for which metered extraction volumes are available is 2015-16.

2.4 Further information

Groundwater data can be viewed and downloaded using the *Groundwater Data* page under the Data Systems tab on WaterConnect. For additional information related to groundwater monitoring well nomenclature, please refer to the Well Details page on WaterConnect.

Other important sources of information on water resources in the Baroota PWRA are:

- A summary report on the groundwater resources (DFW, 2010) of the Baroota PWRA.
- Annual groundwater level and salinity status reports such as DEW (2019b).
- Barnett (2009) provides a groundwater resource assessment of the Baroota PWRA.

[3] Bureau of Meteorology Annual climate statement 2019

3 Rainfall

The Baroota PWRA has a temperate climate, with mild and wet winters and hot summers with reduced rainfall. The average annual rainfall is between 350 mm and 400 mm for the plains within the central Baroota PWRA, with slightly higher totals of up to 450 mm found in the elevated areas to the east.

In 2018–19 the annual rainfall was well below average for the entire PWRA, which was mostly below 300 mm (Figure 3.1).[4]

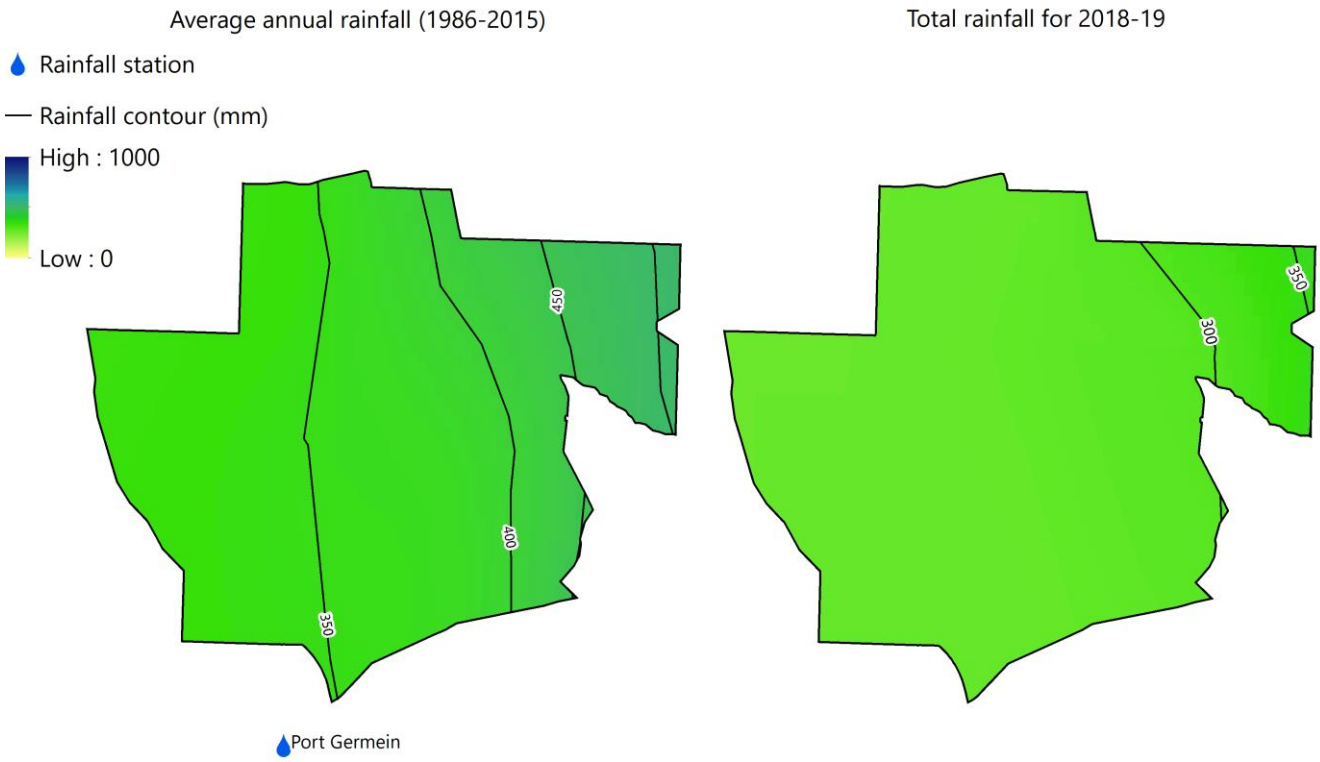

Figure 3.1 Rainfall in the Baroota PWRA for 2018–19 compared to the 30-year average (1986-2015)

The Port Germein rainfall station (BoM station 19037) is located at the southern edge of the PWRA. The annual total recorded for 2018–19 was 234 mm (Figure 3.2). This was 96 mm lower than the annual average rainfall of 331 mm (1970-71 to 2018–19). Annual rainfall was similarly below average in the previous year (2017–18).

Conditions in winter 2018 and early spring 2018 were drier than average (Figure 3.3). In particular, the summer of 2018–19 and early autumn 2019 were very dry compared to average conditions (Figure 3.3).

[4] Some differences may be noticeable between the spatial rainfall maps and the annual rainfall from individual stations. This is due to the use of different data sources and time periods and further detail is provided in Section 2.1.

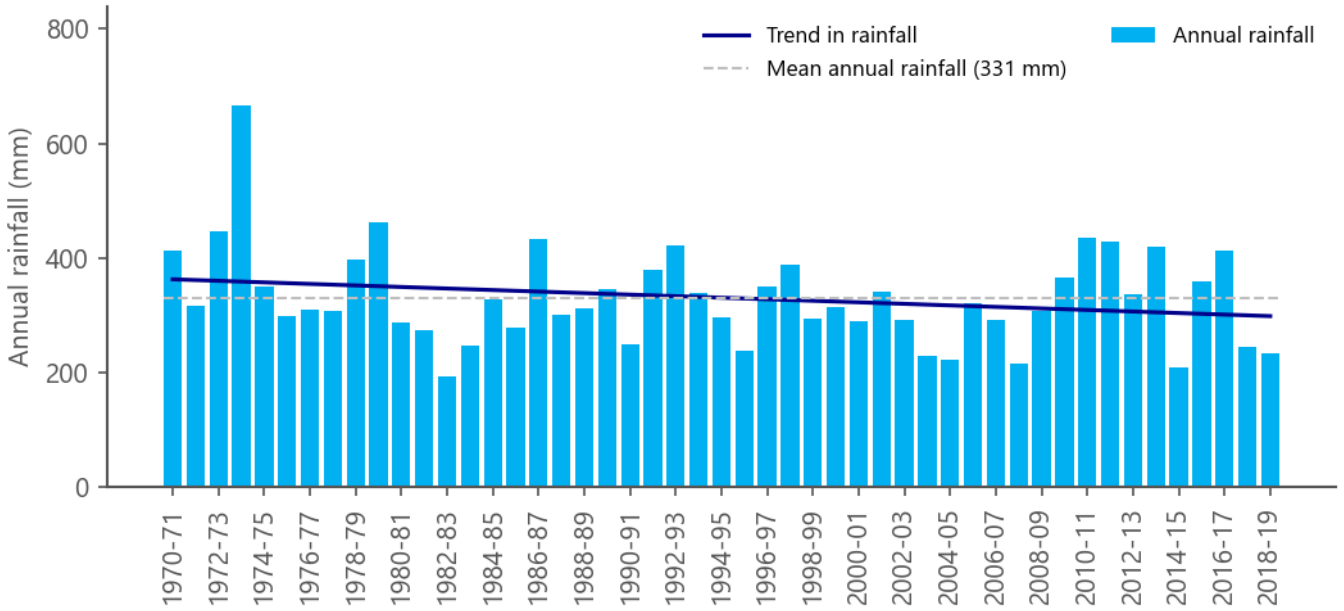

Figure 3.2 Annual rainfall for 1970–71 to 2018–19 at the Port Germein rainfall station (19037)

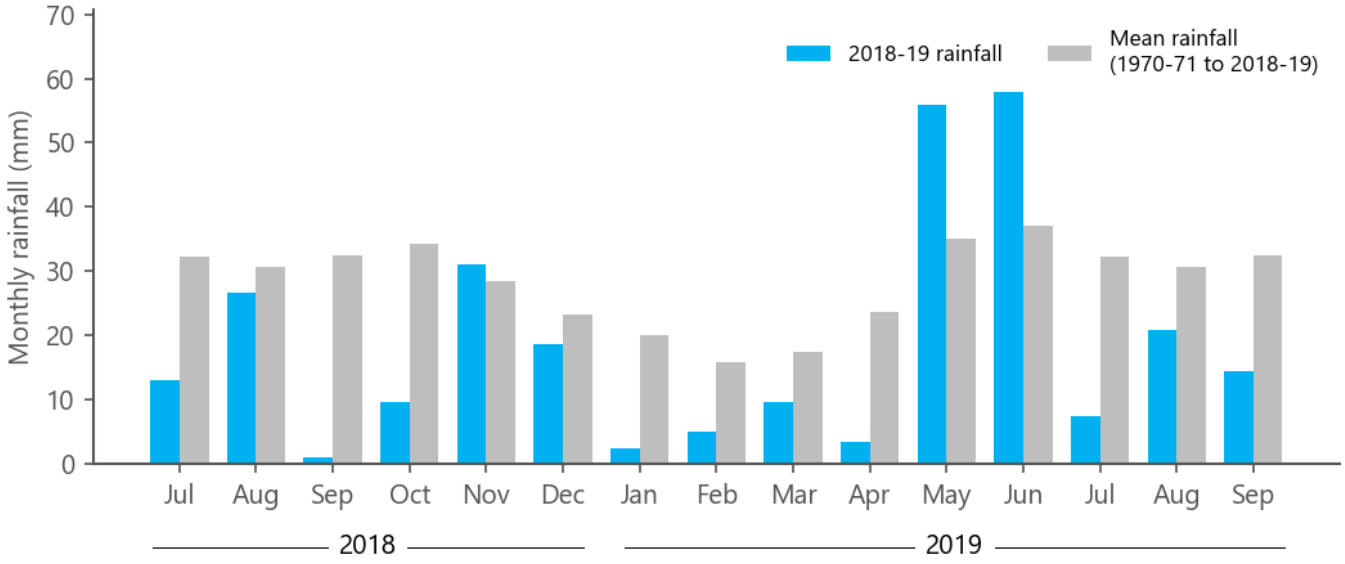

Figure 3.3 Monthly rainfall between July 2018 and September 2019 at the Port Germein rainfall station (19037)

4 Groundwater

4.1 Hydrogeology

The main groundwater system in the Baroota PWRA lies within the Pirie Basin, which abuts the Flinders Ranges to the east. The Pirie Basin within the PWRA is composed of fluvial and alluvial Quaternary clays and gravels, deposited as part of outwash fans from the ranges to the east. Underlying these sediments are fine sandstones and clays deposited during the Tertiary, which directly overlie Neoproterozoic basement.

Recharge to Quaternary sediments occurs both from lateral through-flow from fractured rock aquifers in the Flinders Ranges and from recharge from surface water flows in Baroota Creek, downstream of Baroota Reservoir. Recharge is likely to occur both from leakage through the reservoir dam wall and through rare events when the reservoir overflows into Baroota Creek (Barnett 2007). Prior to 1997, reservoir levels were generally maintained at higher levels through use of River Murray water from the Morgan to Whyalla pipeline, but since then there have been longer periods where the reservoir is at lower levels.

The Quaternary sedimentary sequence is generally up to 100 m thick, with numerous thin and laterally discontinuous gravel beds which are the main source of water for irrigation wells. Some irrigation wells have multiple screens targeting several gravel beds. The direction of groundwater flow is from the ranges in the east towards Spencer Gulf to the west. Due to the generally low permeability of the Quaternary sediments and therefore slow movement of groundwater, salinities increase significantly from east to west, with the freshest groundwater found near the sources of recharge (Baroota Creek and the Flinders Ranges).

Groundwater levels are affected by the amount of rainfall recharge to both the Quaternary sediments and fractured rock aquifers in the ranges, as well as reservoir levels and flow conditions in Baroota Creek. Periods of above-average rainfall are likely to result in rising groundwater levels and decreasing groundwater salinity, while years of below-average rainfall are likely to result in declining groundwater levels and increasing groundwater salinity.

4.2 Water level

In 2019, monitoring wells showed recovered water levels ranging from lowest-on-record to very-much-above-average when compared to long-term records. The median level was average, with 38% of wells recovering to average levels (Figure 4.1). The majority of these wells are located around Baroota Creek, about 5 km downstream of Baroota Reservoir, where the majority of irrigation occurrs. Lowest-on-record water levels were observed further downstream and at the northern and southern extremities of the PWRA.

Changes in water level over the last 10 years ranged from a decline of 1.05 m to a rise of 6.85 m, with the median change being a rise of 0.32 m. The median change over the last 30 years was a decline of 1.60 m.

Five-year trends in water level are generally rising (69% of wells), with the overall rates ranging from a decline of 0.61 m/y to a rise of 0.90 m/y, and the median rate being a rise of 0.13 m/y; Figure 4.2).

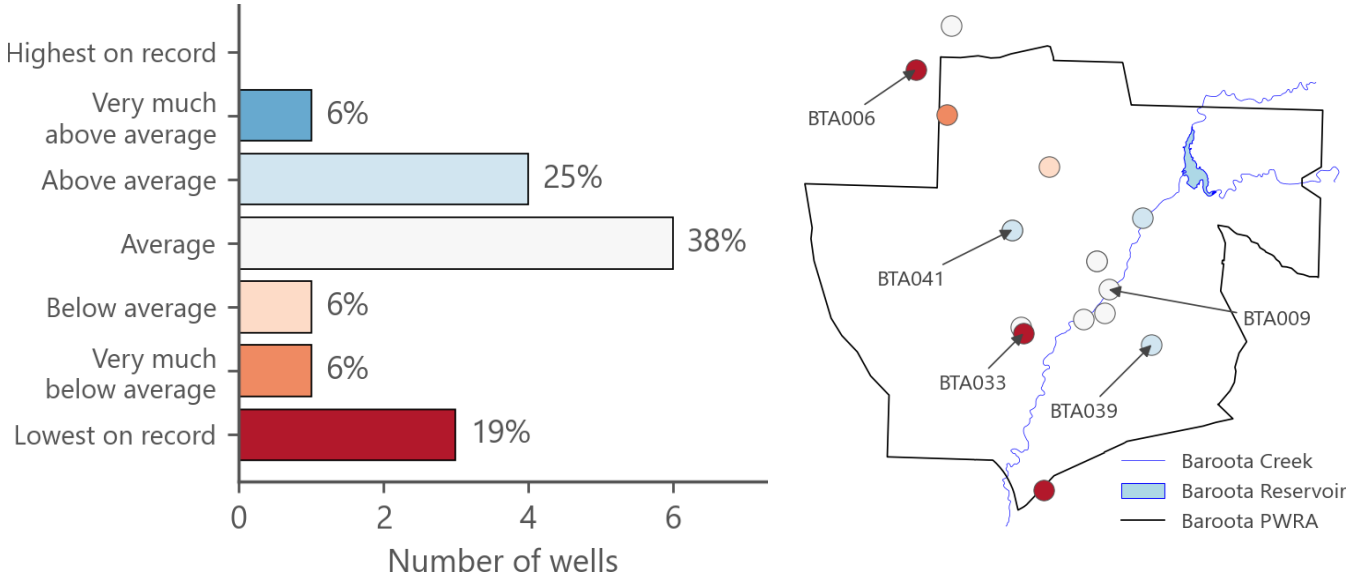

Figure 4.1 2019 recovered water levels for wells in Quaternary and Tertiary aquifers in the Baroota PWRA

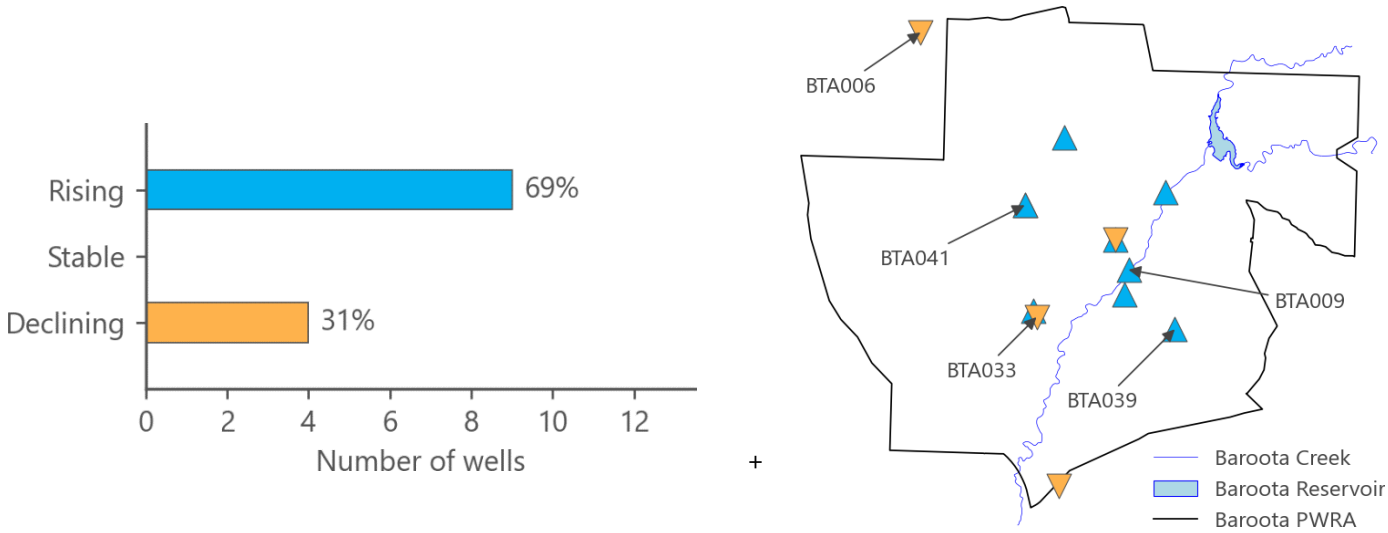

Figure 4.2 2015-2019 trend in recovered water levels for wells in Quaternary and Tertiary aquifers in the Baroota PWRA

Groundwater levels have been slowly declining in the northern and western parts of the Baroota PWRA over the long-term. For example at BTA006 where monitoring has been regularly undertaken since 1978, water levels have declined in the shallowest unconfined Quaternary aquifer by around 3 m over 40 years (Figure 4.3). It should be noted that saturated Quaternary sediments are up to 100 m thick across the PWRA.

BTA009 is located close to Baroota Creek about 4 km downstream of the reservoir. The hydrograph in Figure 4.3 shows a number of large transient increases in water level of 5 to 10 m related to flow events down Baroota Creek, for example in 1989, 1993 and 2002. Following each of these events, a steady decline in water level was observed. The increase between 2011 and 2018 may be related to above-average rainfall in six of the seven years between 2010 and 2016, and reduced extraction over that period. BTA039 is completed closer to the ranges, in the south-eastern part of the PWRA, and monitoring began in 2011. It also shows a gradual rise in water levels over the same period (2010 to 2016).

The majority of irrigation wells are located in the area between BTA009, BTA033, and BTA041. BTA033 is also located near Baroota Creek and shows a long-term decline in water level, with generally stable water levels between 2012 and 2018. BTA041 is farther to the north and shows generally stable levels since 2002, with seasonal drawdowns due to irrigation. The natural flow gradient from east to west remains present, with much higher water elevations at BTA009 (25 m AHD) and BTA039 (29 m AHD) compared to wells farther west such as BTA041 (6 m AHD) and BTA033 (3 m AHD).

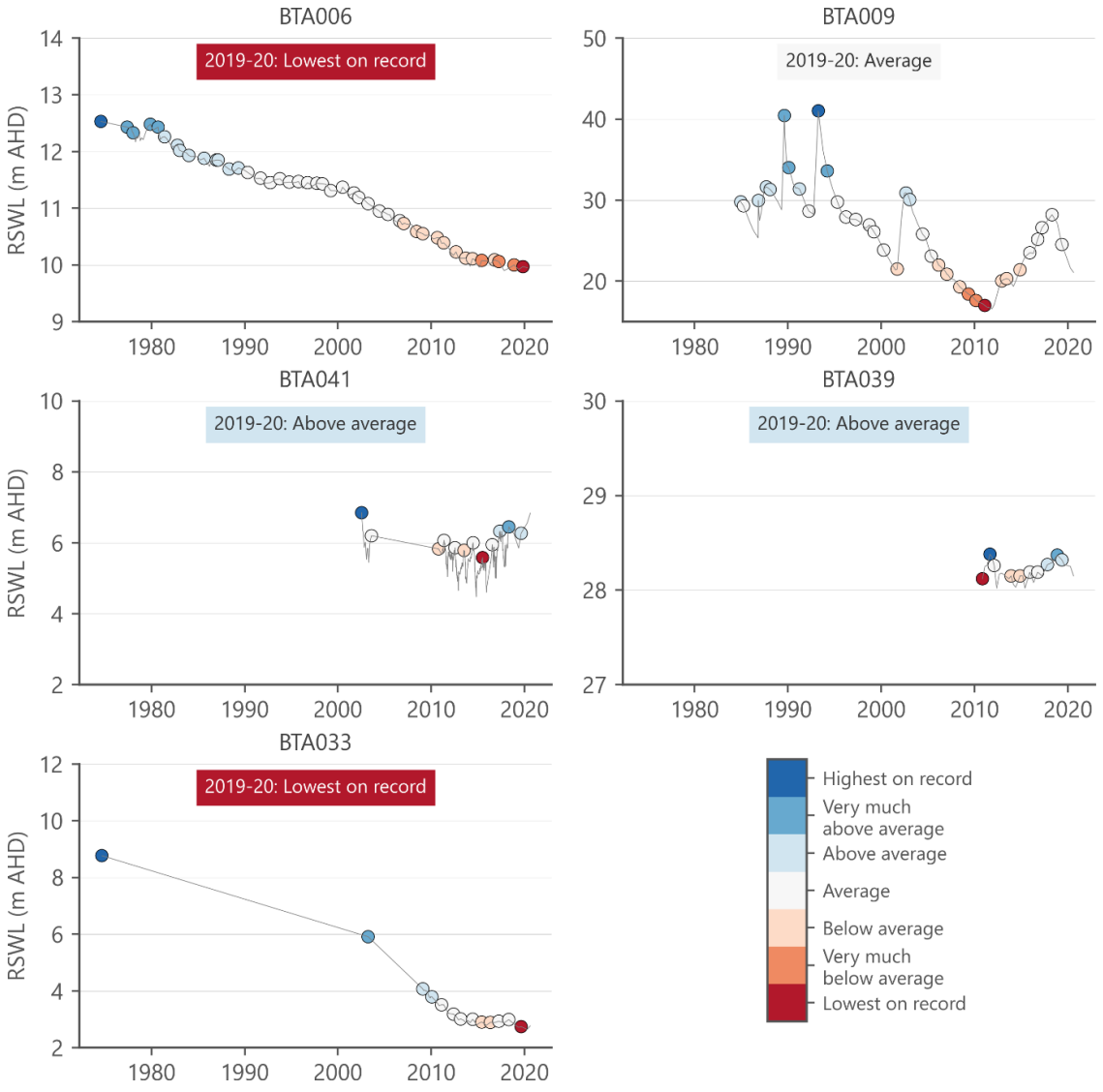

Figure 4.3 Selected hydrographs from wells in the Quaternary aquifer in the Baroota PWRA

5 Water use

Groundwater is extracted from the aquifers of the Baroota PWRA primarily for irrigation and stock and domestic use. River Murray water is also available for use via the Morgan to Whyalla pipeline.

Meters have been installed on all wells used for irrigation. The most recent year for which metered extraction data is available is the 2015-16 financial year. The volume of groundwater extracted for irrigation reduced from a peak in 2002–03 of 1916 ML to levels below 1000 ML since 2009–10.

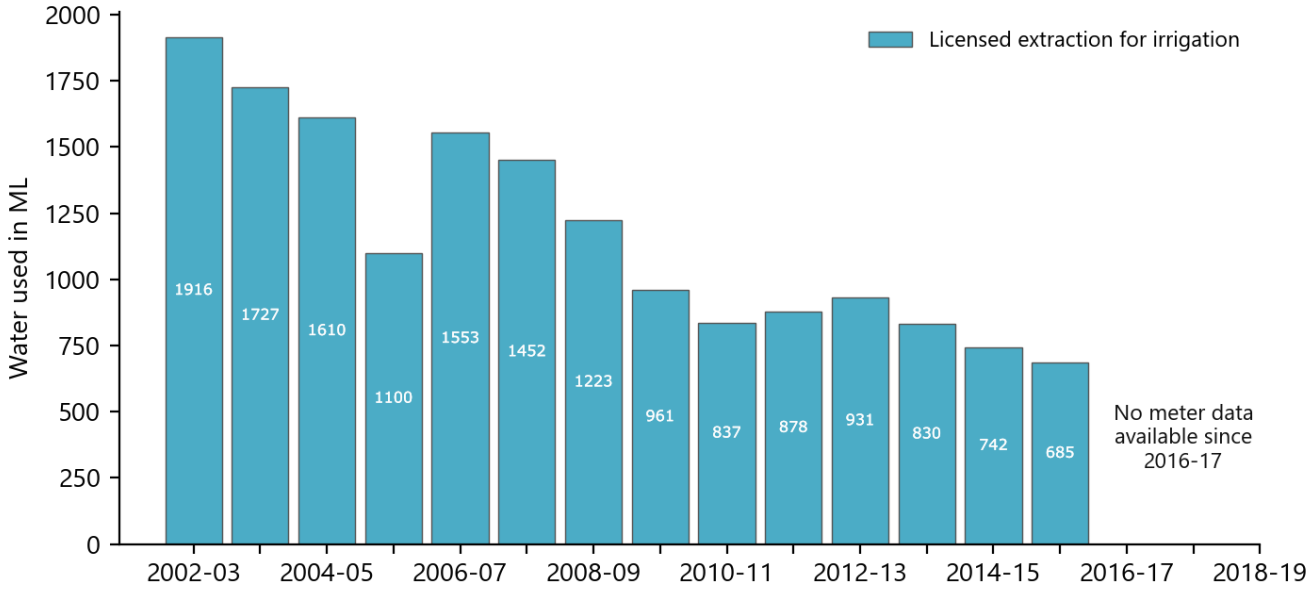

Figure 5.1 Metered groundwater extraction for irrigation wells in the Baroota PWRA from 2002–03 to 2015–16

6 References

Barnett S (2007), Groundwater resource assessment of the Baroota Prescribed Water Resources Area, Technical Note 2009/27, Government of South Australia, through Department of Water, Land and Biodiversity Conversation, Adelaide.

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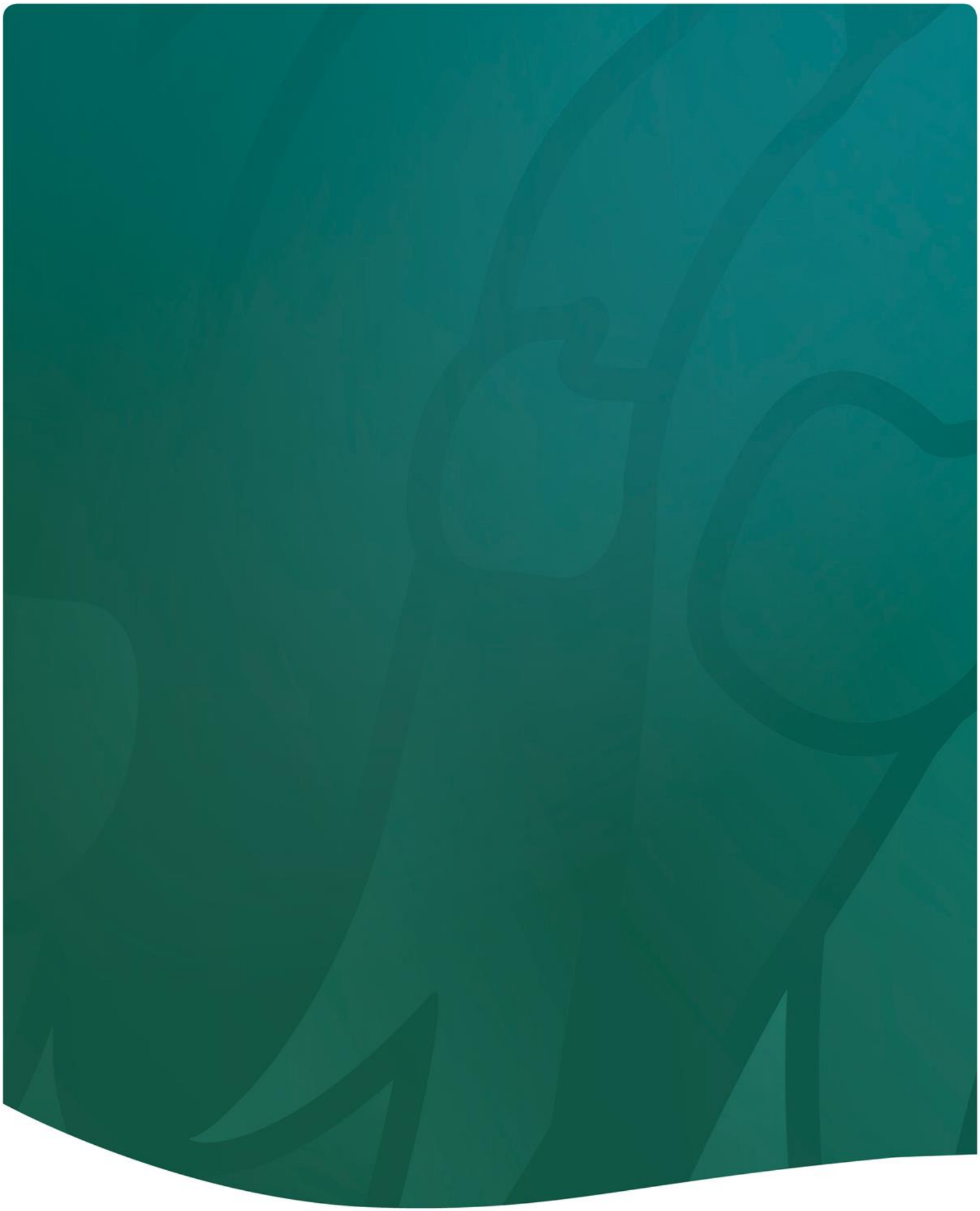
DFW (2010), Baroota PWRA Groundwater Status Report 2009–10, Government of South Australia, through Department for Water, Adelaide.



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