Prescribed areas of the South East 2018-19 water resources assessment

Department for Environment and Water
November, 2020

DEW Technical report 2020/26

Government of South Australia
Department for Environment and Water

Department for Environment and Water

Government of South Australia

November 2020

81-95 Waymouth St, ADELAIDE SA 5000

Telephone +61 (8) 8463 6946

Facsimile +61 (8) 8463 6999

ABN 36702093234

www.environment.sa.gov.au

ISBN 978-1-925964-77-6

Preferred way to cite this publication

DEW (2020). *Prescribed areas of the South East 2018-19 water resources assessment*, DEW Technical report 2020/26, Government of South Australia, Department for Environment and Water, Adelaide.

Download this document at https://www.waterconnect.sa.gov.au

Contents

1 Summary

Rainfall

- In the Lower Limestone Coast Prescribed Wells Area (PWA), rainfall in 2018–19 at Mount Gambier was 727 mm and rainfall at Frances, in the north-east, was 521 mm. Both are slightly above their average annual rainfall (1970-71 to present). Long-term data trends indicate rainfall is stable in the south and declining in the north-east.
- In the Padthaway, Tatiara and Tintinara-Coonalpyn PWAs, rainfall was below average. Long-term data trends indicate a decline in rainfall in these areas.
- Above-average monthly rainfall was recorded in July, August and December 2018 and May 2019 at most rainfall sites, while below-average monthly rainfall was recorded from January to April 2019 for all rainfall stations.

Surface water

- There is one streamflow gauging station in the Morambro Creek prescribed surface water area (PSWA) which recorded streamflow of 3310 ML in 2018–19, similar to long-term average annual streamflow of 3413 ML. However, long-term data trends show a decline in streamflow.
- The highest salinity on the Morambro Creek in 2018–19 was 227 mg/L, within historical variation.

Groundwater

- In the Lower Limestone Coast PWA, water levels in unconfined aquifer wells are mainly at below-average (42%) or average (44%) levels compared to their historic record. The median ranked well has below-average water levels. In the eastern highlands area, a significant minority are at their lowest levels on record (29%). In the confined aquifer, pressure levels are mainly at average levels.
- In the Padthaway PWA, water levels in unconfined aquifer wells in the Flats are mainly at below-average levels, while those in the eastern Range are mainly at average levels. Pressure levels in confined aquifer wells are mainly at below-average levels.
- In the Tatiara PWA, water levels in monitoring wells in both the unconfined and confined aquifers, in both the plains and highlands areas, are at levels below the historic average, with median ranked wells in all aquifer areas at very-much-below-average water levels compared to their historic record.
- In the Tintinara-Coonalpyn PWA, water levels in unconfined aquifer wells at generally at below-average levels in the western plains area, while the majority of wells in the eastern Mallee Highlands area are at their lowest water level on record. Pressure levels in confined aquifer wells are mainly at below-average levels.
- Five-year trends in groundwater salinity are stable for the majority of monitoring wells in all regions except for the Padthaway Flats management area, where 50% of wells have rising trends (median increase in salinity of 12% over five years).

Water use

- Groundwater is used widely in the South East for irrigation, industry, stock and domestic uses and town water supplies, with small volumes of surface water also diverted from Morambro Creek.
- Groundwater extraction in 2018–19 was 400 193 ML with 176 ML from surface water sources.
- Water use was 13% greater than 2017-18, likely to be due to higher irrigation demand caused by lower than average summer rainfall.

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 prescribed areas of the South East for 2018-19 and addresses surface water and water use data collected between July 2018 and September 2019, and groundwater data collected up until December 2019.

1.2 Regional context

The Limestone Coast Landscape Region encompasses much of the south-eastern part of South Australia, stretching southwards and eastwards from the area near Lake Albert to the Victorian border (Figure 1.1). The area incorporates coastal plains, dunes and inter-dunal flats, with highlands and ranges in the eastern areas. There is also an extensive network of drains. It includes regional water resources that are prescribed under South Australia's Landscape SA Act 2019. There are seven different prescribed areas or watercourses which are discussed in this report. The water resources managed under rules in water allocation plans, developed since 2006, are:

- The Lower Limestone Coast Prescribed Wells Area (PWA) covers an area of approximately 13 300 km^2 between Kingston SE, Naracoorte, and Mount Gambier and is managed under the Lower Limestone Coast PWA water allocation plan (SE NRM Board, 2013).
- The Padthaway PWA covers an area of approximately 750 km^2 in the area around Padthaway and is managed under the Padthaway PWA water allocation plan (SE NRM Board, 2009).
- The Tatiara PWA covers an area of approximately 3500 km^2 in the area between Keith and Bordertown and extending north to Ngarkat Conservation Park and is managed under the Tatiara PWA water allocation plan (SE NRM Board, 2010).
- The Tintinara-Coonalpyn PWA covers an area of approximately 3400 km^2 between Tintinara and Coonalpyn, extending eastward across the southern part of Ngarkat Conservation Park and is managed under the Tintinara-Coonalpyn PWA water allocation plan (SE NRM Board, 2012).
- The Morambro Creek and Nyroca Channel Prescribed Watercourses (PWC) and Morambro Creek Prescribed Surface Water Area (PSWA) cover surface water resources in an area approximately 20 km southeast of Padthaway, extending to the border with Victoria, and is managed under the Morambro Creek water allocation plan (SE NRM Board, 2006).

Groundwater is the major water resource in the Limestone Coast and is used for irrigation, industrial, stock and domestic and town water supplies. There are two aquifer systems located in the region: the upper, unconfined aquifer comprising Quaternary and Tertiary limestone and an underlying confined sand aquifer in Tertiary sediments. The confined and unconfined aquifers are generally separated by a low-permeability aquitard. The Morambro Creek is the only prescribed surface water resource in the Limestone Coast. The headwaters of Morambro Creek are located in the Wimmera region in western Victoria. The topography of the Morambro Creek area is predominantly characterised by flat plains with slight variations in elevation occurring in the westernmost section.

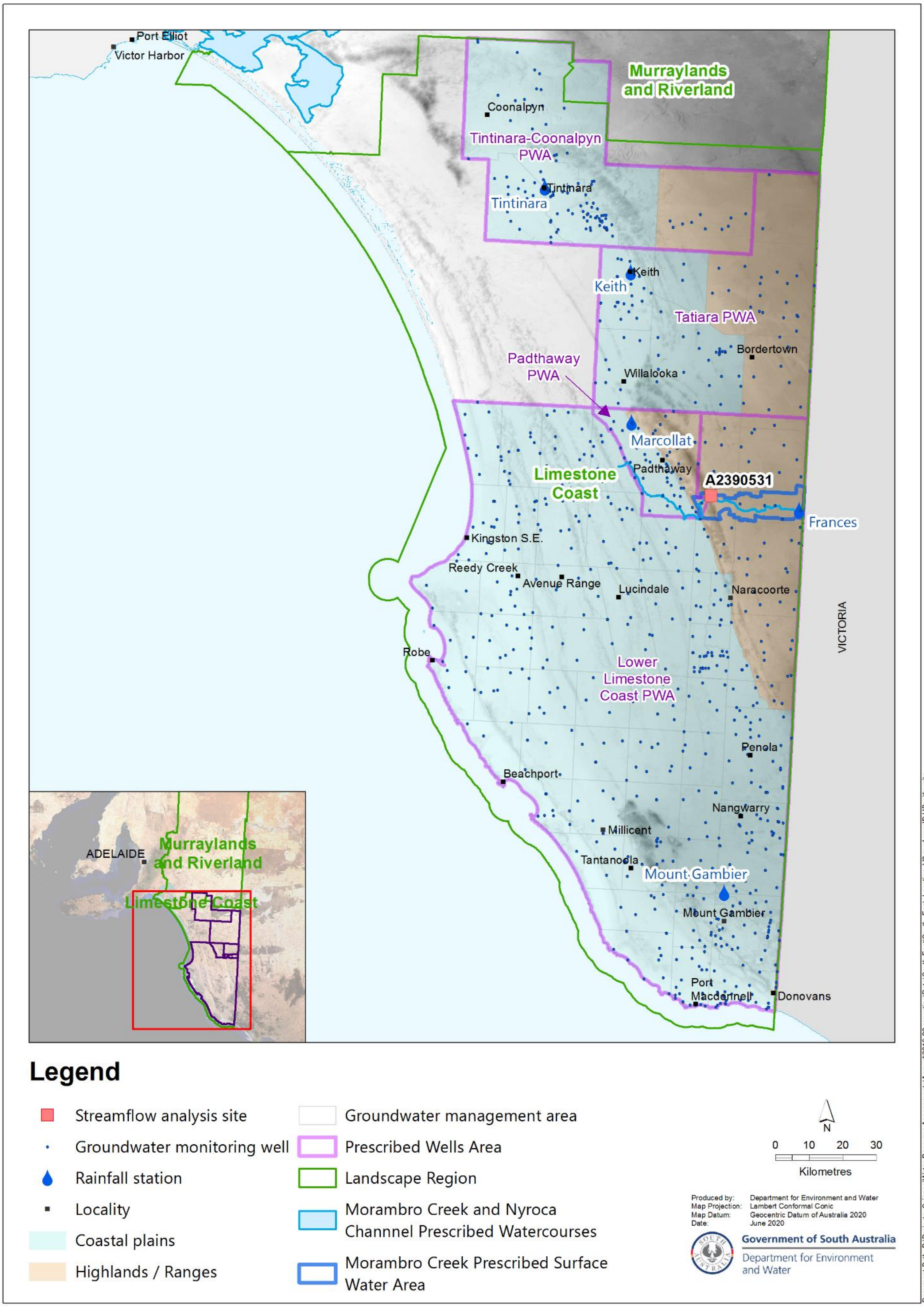


Figure 1.1. Location of prescribed areas of the South East

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 (see figures in Section 3).

Rainfall maps were compiled using gridded datasets obtained from the BoM (Figure 3.11). 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 Surface water

2.2.1 Annual streamflow

Low reliability of streamflow in Morambro Creek has meant there has been no systematic development of the surface water resource and consequently there is limited surface water monitoring in the prescribed area. The status of the sole streamflow gauging station on the Morambro Creek (A2390531) is determined by expressing the annual streamflow for the applicable year as a percentile[1] of the total period of data availability (1979–80 to 2018–19). Streamflow data were then given a description based on their percentile and decile[1] (Table 2.1).

Table 2.1. Percentile/decile descriptions*

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

* Deciles and descriptions as defined by the BoM[2]

Annual streamflow data (Figure 4.2) is presented as the deviation of each year's streamflow from the long-term average with the bars shaded using the BoM classification shown in Table 2.1.

[1] The nth percentile of a set of data is the value at which n% of the data is below it. For example, if the 75th percentile annual flow is 100 ML, 75% of the years on record had annual flow of less than 100 ML. Median streamflow: 50% of the records were above this value and 50% below. 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.

[2] BoM Annual climate statement 2019

2.2.2 Monthly streamflow

Monthly streamflow for the applicable year is assessed alongside the long-term monthly average streamflow (Figure 4.3A), for the period 1977–78 to 2018–19 and long-term monthly statistics including (a) high flows (25th percentile), (b) median flows (50th percentile) and low flows (75th percentile).

2.2.3 Daily streamflow

Daily streamflow is presented to show the detailed variability throughout the applicable year (Figure 4.3A).

2.2.4 Salinity

Box plots on a monthly basis are used to assess surface water salinity (Figure 2.1 and Figure 4.4). This enables the salinity (TDS; total dissolved solids in mg/L) for the applicable year to be presented against long-term salinity statistics (maximum, 75th percentile, median or 50th percentile, 25th percentile and minimum).

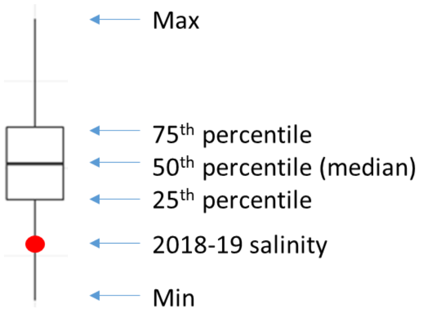


Figure 2.1 Box and whisker plot

2.3 Groundwater

2.3.1 Water level

Water level[3] data were obtained from wells in the monitoring network by both manual and continuous logger observations. All available water level data are verified and reduced to an annual maximum water level for each well for further analysis. The annual maximum level is used as this represents the unstressed or recovered water level following pumping each year for irrigation and other uses. The amount of pumping can vary from year to year, and the proximity of pumping wells to monitoring wells may affect the reliability of trends and historical comparisons. Therefore the recovered level is used as it is a more reliable indicator of the status of the groundwater resource. The period of recovery each year was reviewed for each well; in general the return to a maximum level varies across the area, but mostly occurs between July and December, although some wells do not recover until as late as March of the following year depending on irrigation patterns.

For those wells with suitable long-term records, the annual recovered water levels were then ranked from lowest to highest and given a description in the same way as annual streamflow, according to their decile range (see above, Table 2.1). The definition of a suitable long-term record varies depending on the history of monitoring activities in different areas; for the South East PWAs, any well with 10 years or more of recovered water levels is

[3] “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).

included, with the exception of unconfined aquifer monitoring wells in the Lower Limestone Coast PWA and in the coastal plains of the Tatiara PWA, where only those wells with 20 years or more of data are included. This is due to more extensive historical monitoring data in those areas. The number of wells in each description class for the most recent year is then summarised for each aquifer (for example see Figure 5.1). Hydrographs are shown for a selection of wells to illustrate common or important trends (for example see Figure 5.3).

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 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 summarised for each aquifer (for example see Figure 5.2). Sedimentary confined and unconfined aquifers such as those in the South East are given tolerance thresholds of 2 cm/y.

Thirty-year changes in water level were calculated as the difference between the average water level in a three-year period thirty years ago (i.e. 1988–1990) and the average water level in 2019. Twenty-year changes in water level were calculated in a similar way, using a comparison from the average water level in a three-year period twenty years ago (i.e. 1998–2000).

2.3.2 Salinity

Water samples are collected from monitoring wells located across the four PWAs by a variety of methods. Samples are collected from operating irrigation pumps, from flowing artesian wells in the confined aquifer, or by pumping samples from wells where necessary. These samples are tested for electrical conductivity (EC) and the salinity (total dissolved solids measured in mg/L, abbreviated as TDS) is calculated. Where more than one water sample has been collected in the course of a year, the annual mean salinity is used for analysis. An example of the results is shown in Figure 5.4.

Where multiple samples were submitted from a well in a calendar year, the mean salinity is used for analysis. The results are shown for each aquifer (for example see Figure 5.4).

Five-year salinity trends are calculated where there are at least five years of salinity data (i.e. at least one measurement per year). The trend line is calculated by linear regression and the percentage change in salinity is calculated through the following formula:

$$\text{Percentage change in salinity (\%)} = \frac{\text{Slope of linear trend line (mg/L/y)} * 5}{\text{Value of trend line at start of period (mg/L)}} * 100$$

If the percentage change is greater than 10% then the well is given a status of 'increasing' or 'decreasing' depending on how the salinity is changing, while if the absolute percentage change is less than 10% it is given a status of 'stable'. The latter is intended to reflect the fact that salinity measurements based on the measurement of the electrical conductivity of a water sample are often subject to small instrument errors. The number of increasing, decreasing and stable wells are then summarized in for each resource (e.g. Figure 5.5).

2.4 Water use

Meter readings are used to estimate licensed extraction volumes for both surface water and groundwater sources. Where meter readings are not available, licensed or allocated volumes are used for surface water sources (Section 0).

Further information on the number and type of farm dams in the prescribed surface water area is provided in Section 6.3. Dam capacity estimates are undertaken using different methods with data derived from aerial surveys one of the primary sources.

2.5 Further information

Both surface water and groundwater data can be viewed and downloaded using the *Surface Water Data* and *Groundwater Data* pages 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 South East are:

- Summary reports on the surface water (DEWNR, 2014) and groundwater resources (DEWNR, 2012a,b,c,d) of the South East, and annual groundwater level and salinity status reports (such as DEW 2019a,b,c,d,e) and the annual surface water status report (such as DEW, 2019f).
- The Lower Limestone Coast PWA water allocation plan, as amended in June 2019 (SE NRM Board, 2013).
- Wood (2017), Cranswick (2018), Cranswick and Herpich (2018), Harding et al. (2018) and Simmons et al. (2019), which provide detailed assessments of the hydrogeology and interaction between groundwater and surface water resources in the Lower Limestone Coast PWA.
- The Padthaway PWA water allocation plan (SE NRM Board, 2009).
- The Tatiara PWA water allocation plan (SE NRM Board, 2010).
- Li and Cranswick (2017) and Cranswick and Li (2018), which provide details of the hydrogeology and groundwater modelling for the Tatiara WAP.
- The Tintinara-Coonalpyn PWA water allocation plan (SE NRM Board, 2012).
- Cranswick and Barnett (2017), which provides details of the conceptual groundwater system in the Tintinara-Coonalpyn and Tatiara PWAs.
- The water allocation plan for the Morambro Creek and Nyroca Channel Prescribed Watercourses, including Cockatoo Land and the Prescribed Surface Water Area (SE NRM Board, 2006).
- Whiting and Savadamuthu (2018) provides a technical review of the current farm dam policy in the South East NRM Plan as well as reviewing and revising other hydrological principles underlying this plan.

3 Rainfall

Annual rainfall in the South East varies from approximately 750 mm on average in the southern coastal areas to about 450 mm in the north. The highest annual rainfall totals can be up to 1000 mm around Mount Burr. The past forty years of annual and monthly rainfall are shown below for Mount Gambier (in the Lower Limestone Coast PWA; Figure 3.1 and Figure 3.2), Frances (in the Morambro Creek PSWA; Figure 3.3 and Figure 3.4), Marcollat (in the Padthaway PWA; Figure 3.5 and Figure 3.6), Keith (in the Tatiara PWA; Figure 3.7 and Figure 3.8), and Tintinara (in the Tintinara-Coonalpyn PWA; Figure 3.9 and Figure 3.10).

3.1 Lower Limestone Coast PWA and Morambro Creek PSWA

The rainfall station at Mount Gambier's airport (BoM station 26021) is used as a representative rainfall station for the southern part of the Lower Limestone PWA. Frances rainfall station, 30 km north-east of Naracoorte, is representative of the Morambro Creek PSWA and the lower rainfall areas in the northern part of the Lower Limestone Coast PWA.

The annual total recorded at Mount Gambier in 2018–19 was 727 mm (Figure 3.1). This was 2% above the average annual rainfall of 716 mm (1970–71 to 2018–19). The annual total at Frances was 521 mm; just above the average annual rainfall of 515 mm (1970–71 to 2018–19; Figure 3.3). Above-average rainfall occurred in July, August and December 2018, and May 2019, at both Mount Gambier and Frances (Figure 3.2 and Figure 3.4), with October 2018 also above the monthly average at Frances. Both December 2018 and May 2019 were significantly wetter than average at both rainfall stations, while January and April 2019 were much drier than average at both stations.

The long-term trend (1970–71 to 2018–19) is almost stable at Mount Gambier, with a declining trend at Frances.

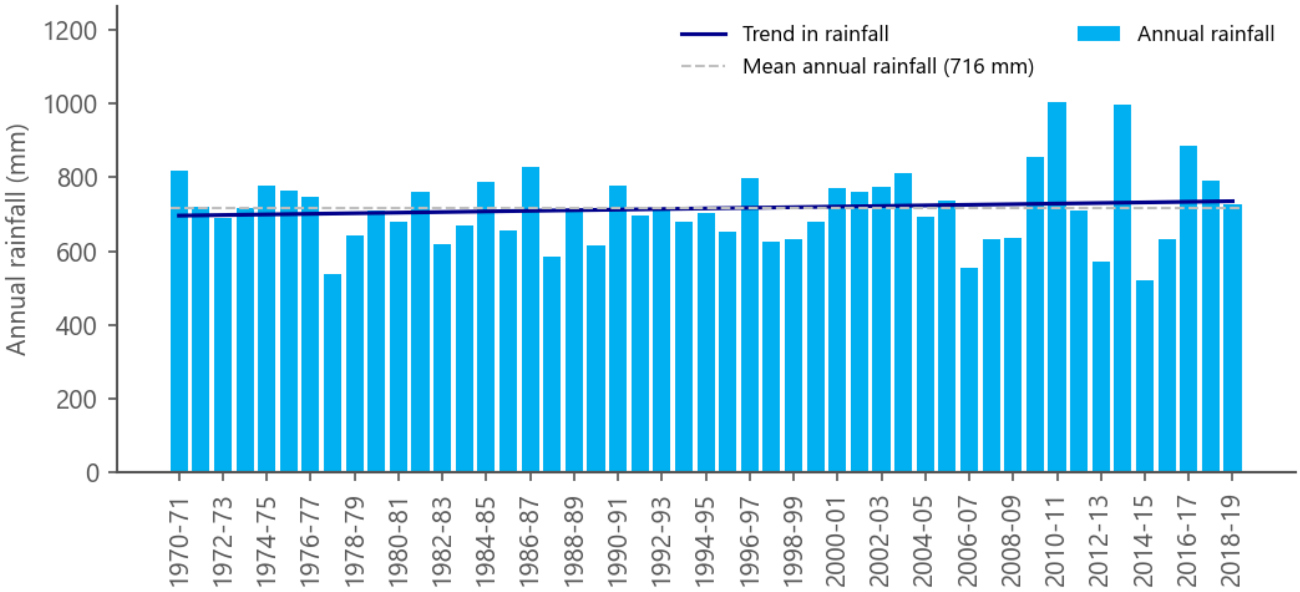


Figure 3.1. **Annual rainfall for 1970–71 to 2018–19 at the Mount Gambier rainfall station (26021)**

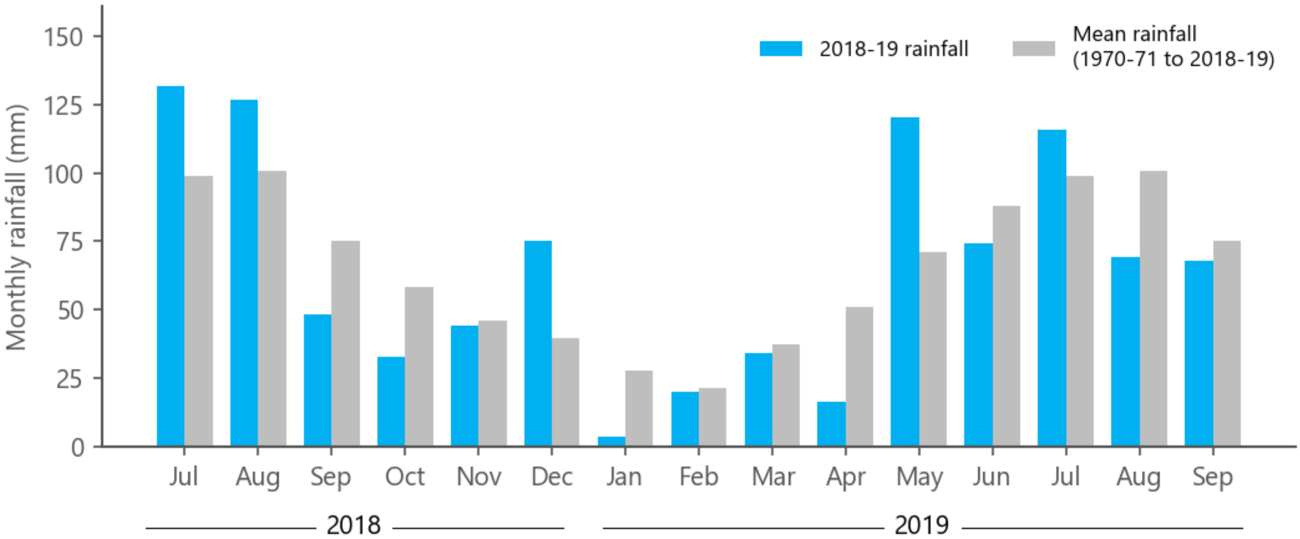


Figure 3.2. **Monthly rainfall between July 2018 and September 2019 at the Mount Gambier rainfall station (26021)**

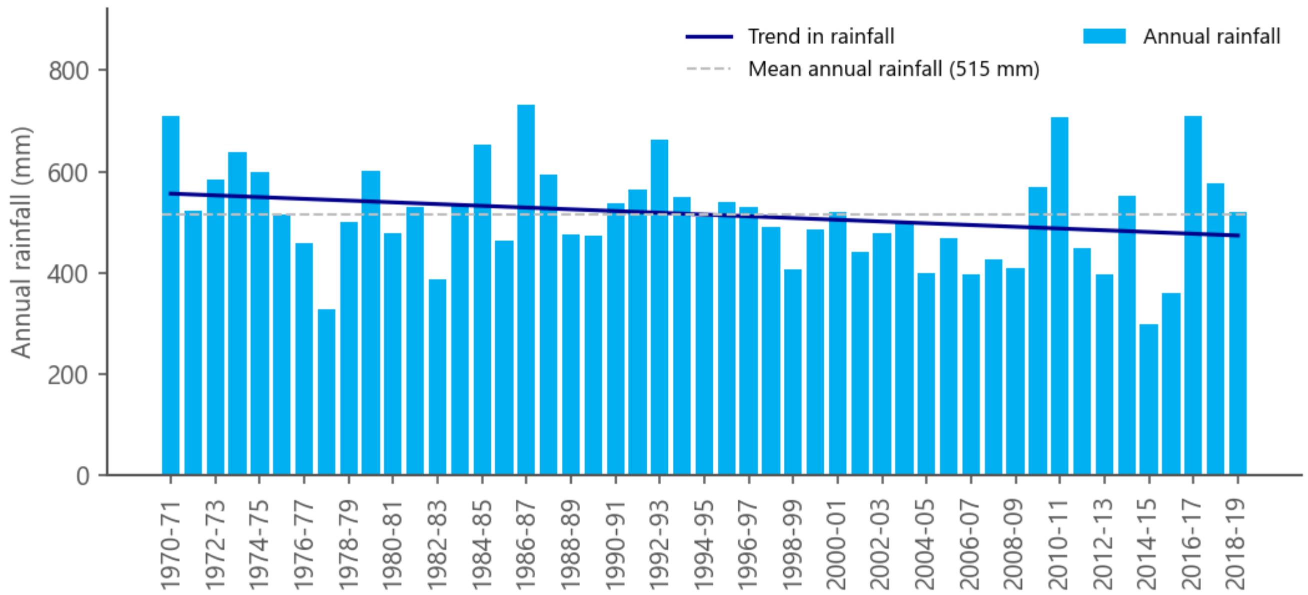


Figure 3.3. Annual rainfall for 1970–71 to 2018–19 at the Frances rainfall station (26007)

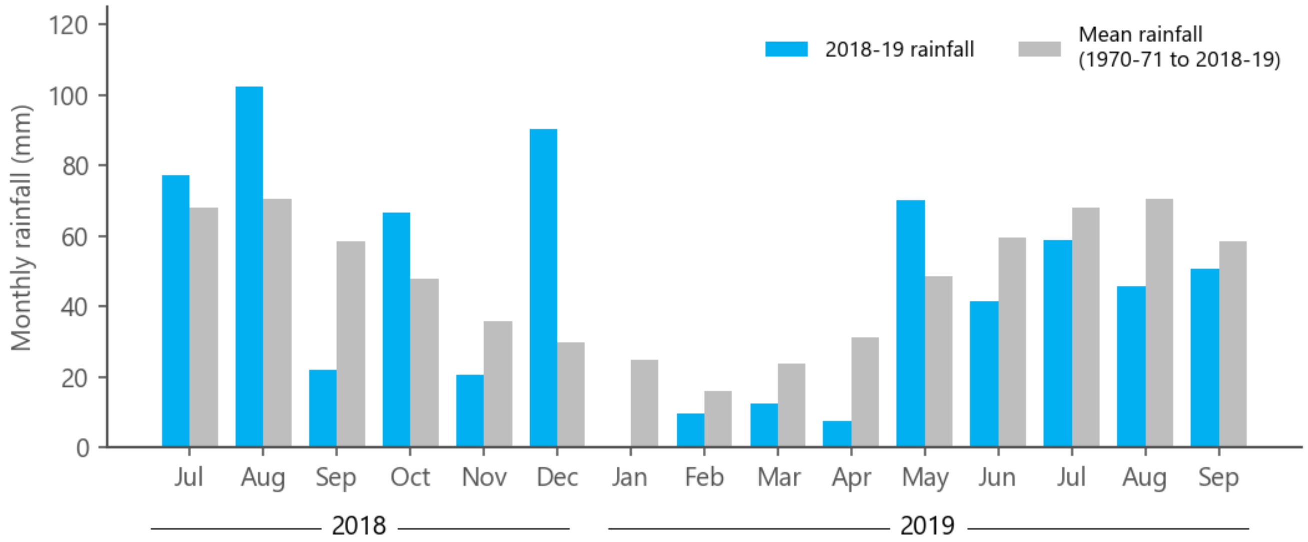


Figure 3.4. Monthly rainfall between July 2018 and September 2019 at the Frances rainfall station (26007)

3.2 Padthaway PWA

The Marcollat rainfall station (BoM station 26017) is located 15 km north-west of Padthaway and is used as a representative station for the area. The annual total recorded here in 2018–19 was 486 mm (Figure 3.5). This was 8% below the average annual rainfall of 509 mm (1970–71 to 2018–19). Above-average rainfall occurred in July, August and December 2018, and also May 2019, while below-average rainfall occurred between September and November 2018 and between January and April 2019 (Figure 3.6). In particular, January through April 2019 was very dry compared to average conditions.

The long-term trend (1970–71 to 2018–19) is declining for the Marcollat rainfall station.

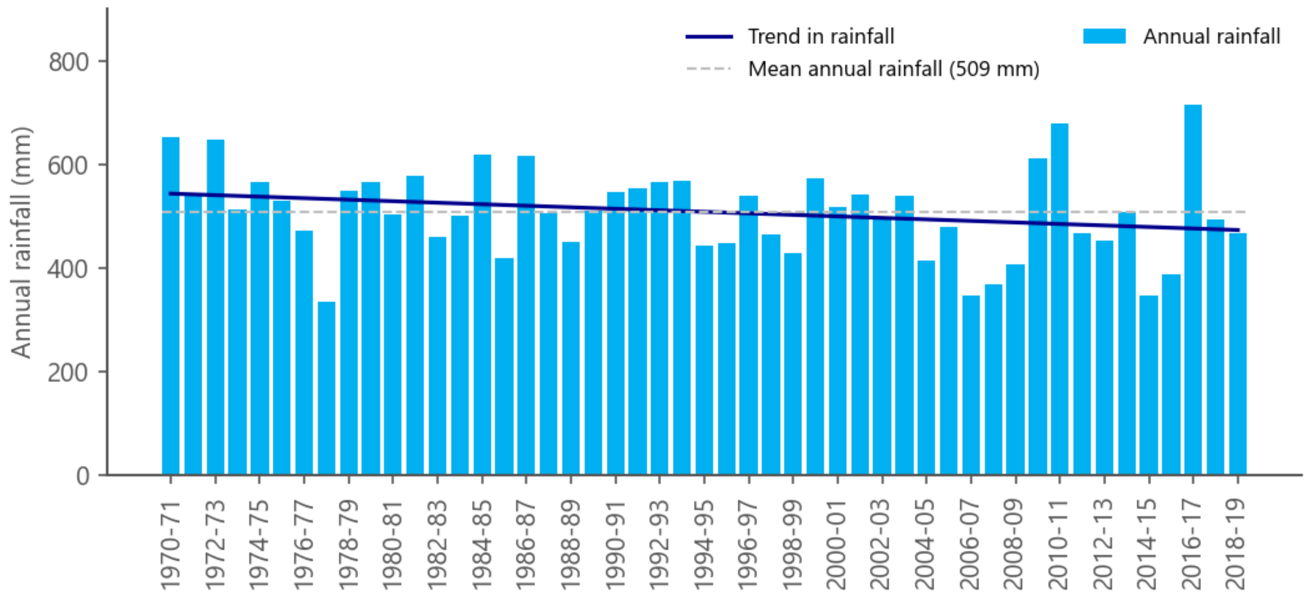


Figure 3.5. Annual rainfall for 1970–71 to 2018–19 at the Marcollat rainfall station (26017)

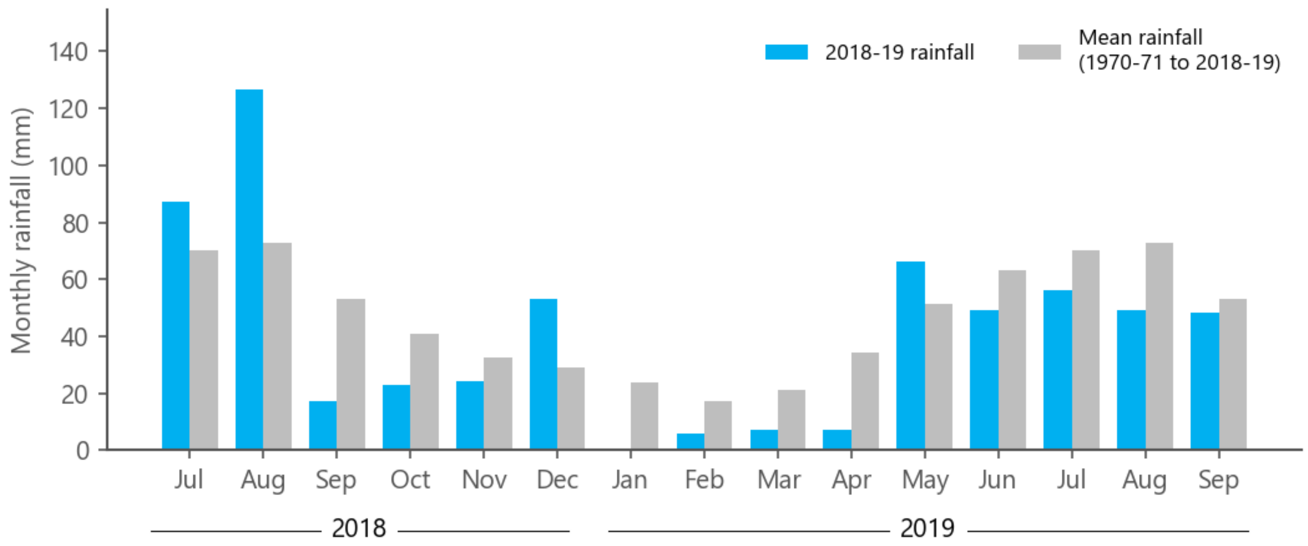


Figure 3.6. Monthly rainfall between July 2018 and September 2019 at the Marcollat rainfall station (26017)

3.3 Tatiara PWA

The rainfall station at Keith (BoM station 22507) is used as a representative station for the Tatiara PWA. The annual total recorded for 2018–19 was 390 mm (Figure 3.7). This was 14% below the average annual rainfall of 455 mm (1970–71 to 2018–19). Above average rainfall occurred in August, November and December 2018 and May 2019 (Figure 3.8). The months of September and October 2018 and January through April 2019 saw significantly below-average rainfall.

The long-term trend (1970–71 to 2018–19) is declining for the Keith rainfall station.

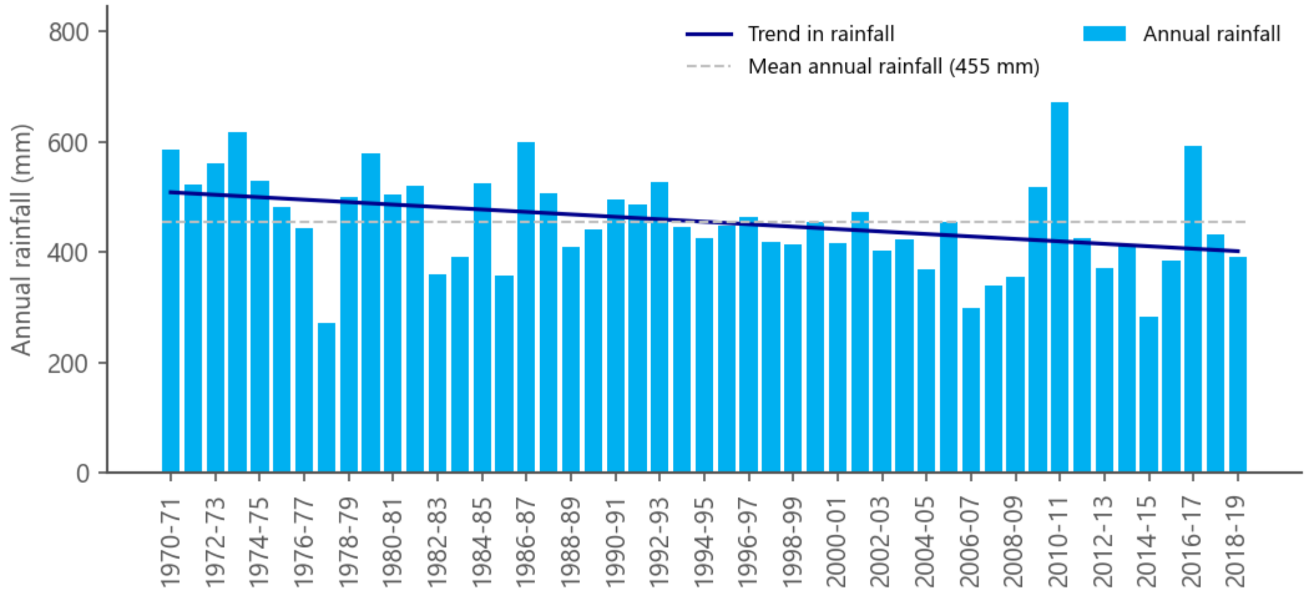


Figure 3.7. Annual rainfall for 1970–71 to 2018–19 at the Keith rainfall station (25507)

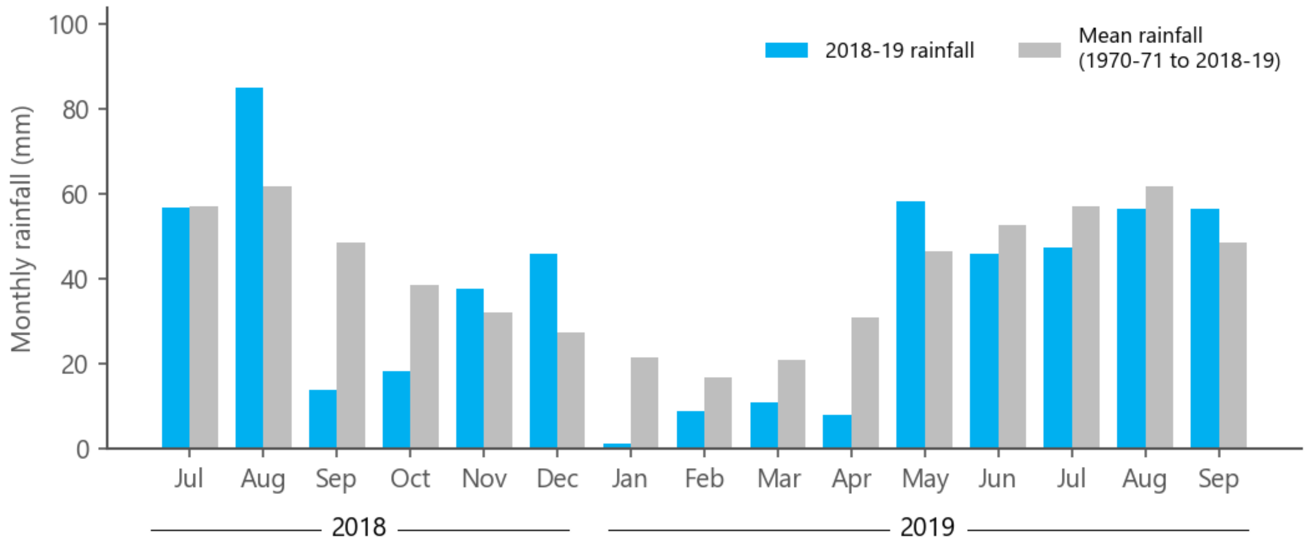


Figure 3.8. Monthly rainfall between July 2018 and September 2019 at the Keith rainfall station (25507)

3.4 Tintinara-Coonalypn PWA

The rainfall station at Tintinara (BoM station 25514) is used as a representative station for the Tintinara-Coonalpyn PWA. The annual total recorded for 2018–19 was 357 mm (Figure 3.9). This was 15% below the average annual rainfall of 426 mm (1970–71 to 2018–19). Above-average rainfall occurred in July, August and November 2018 and May and June 2019 (Figure 3.10). The months of September and October 2018 and January through April 2019 saw significantly below-average rainfall.

The long-term trend (1970–71 to 2018–19) is declining for the Tintinara rainfall station.

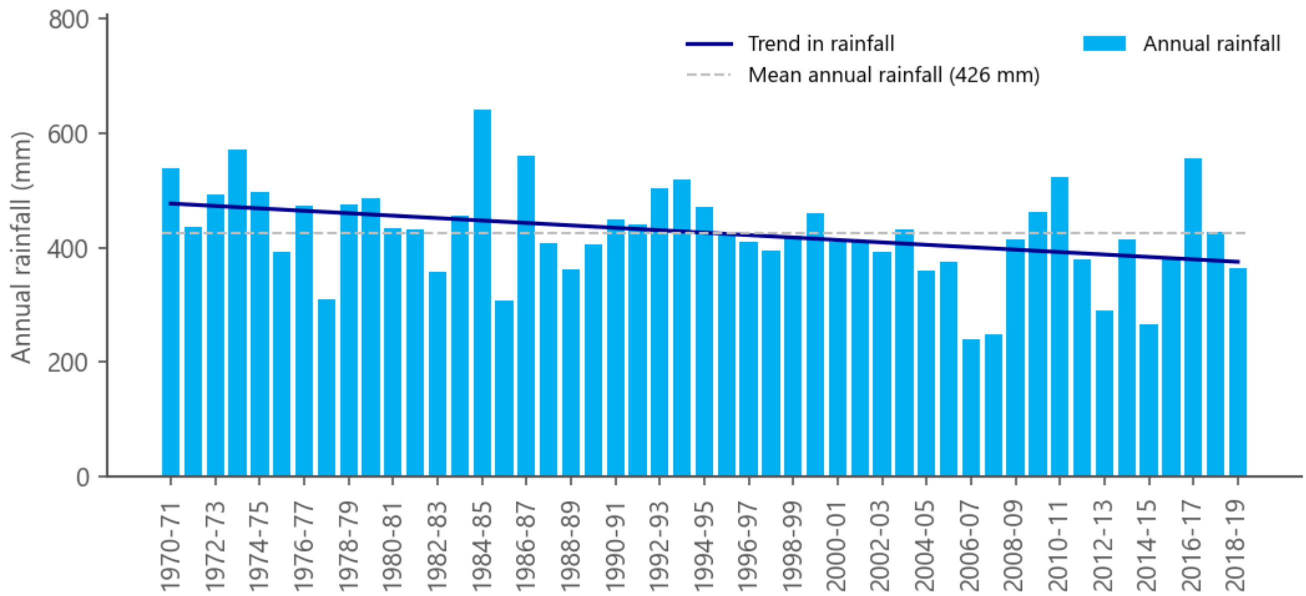


Figure 3.9. Annual rainfall for 1970–71 to 2018–19 at the Tintinara rainfall station (25514)

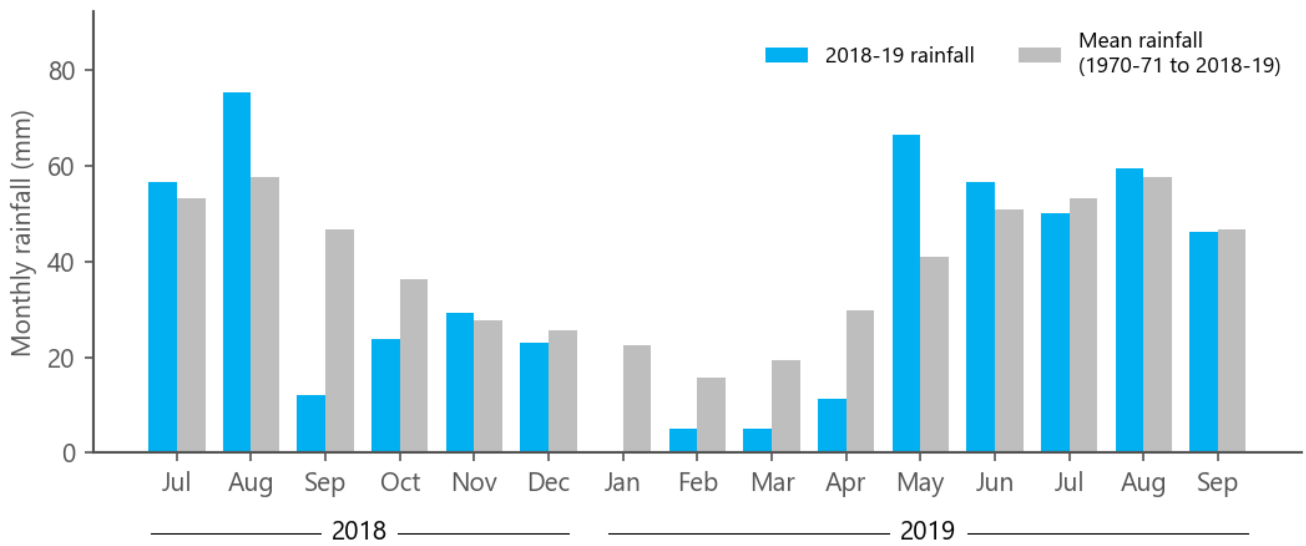


Figure 3.10. Monthly rainfall between July 2018 and September 2019 at the Tintinara rainfall station (25514)

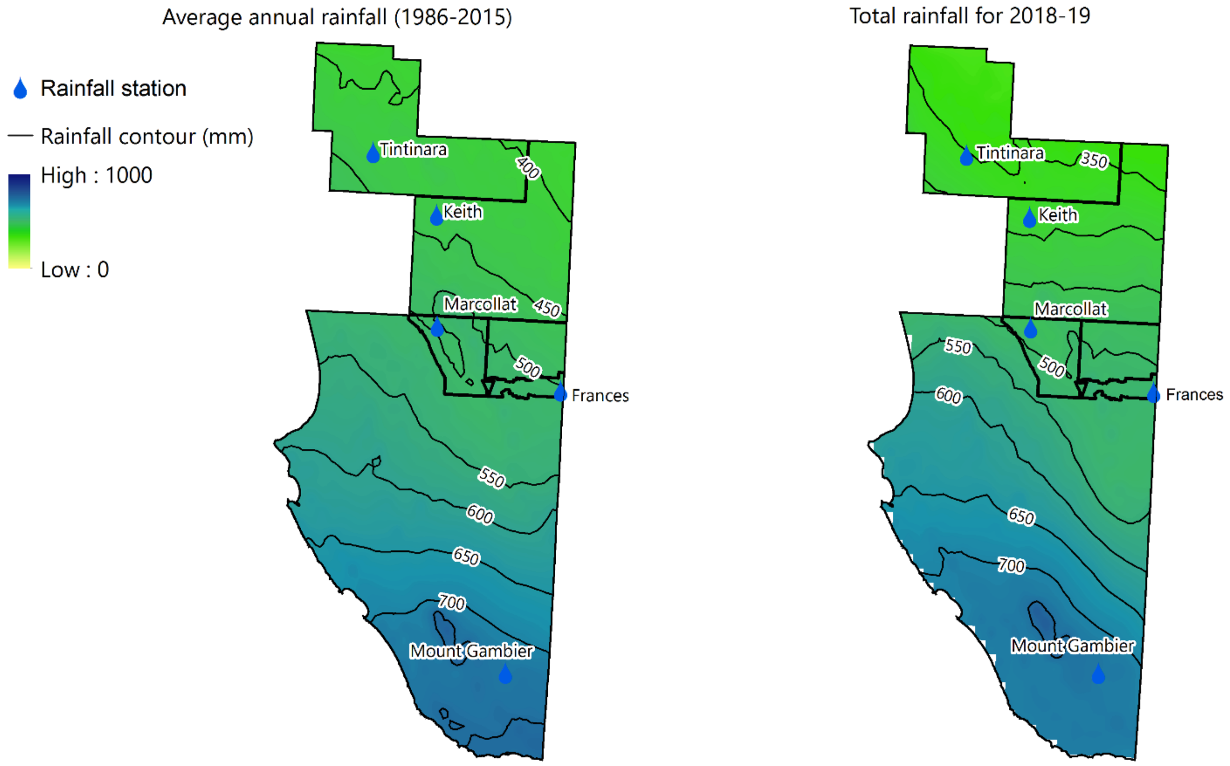


Figure 3.11. Rainfall in the South East PWAs for 2018–19 compared to the 30-year average (1986–2015)

Rainfall in 2018–19 was lower in the central and northern parts of the South East, compared to the long-term average (Figure 3.11)[4]. In particular, spring 2018 and summer 2019 were much drier than average. In the higher rainfall southern parts of the Lower Limestone Coast PWA around Millicent and Mount Gambier, rainfall was similar to the long-term average, with spring and summer rainfall below average but not to the extent as elsewhere.

[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.

4 Surface water

4.1 Streamflow

The main watercourse within the prescribed surface water area (PSWA) is the Morambro Creek, an ephemeral system with headwaters originating in the Wimmera region of western Victoria, travelling east to west through the prescribed area, before terminating in Cockatoo Lake. From here, a spillway allows water to enter the Nyroca Channel, flowing for approximately 30 km in a north-westerly direction before discharging into the Marcollat watercourse. Analysis of available data indicates that 70-90% of the Morambro Creek's flow originates from the headwater catchment area in Victoria. The characteristics of creek flows are influenced by the occurrence of dams, drainage wells and natural runaway holes west of Frances. Surface water resources in the Morambro Creek PSWA are highly dependent on rainfall, with trends in streamflow and salinity primarily climate driven, i.e. lower than average winter rainfall will result in reduced annual streamflow volumes. Conversely, higher rainfall will result in increased surface water availability.

Morambro Creek streamflow gauging station (A2390531) at Bordertown-Naracoorte Road Bridge is the only station located within the PSWA. Streamflow was historically recorded at Cockatoo Lake, 15 km downstream of Morambro Creek gauging station, but this site has been decommissioned. Data from this site is not presented in this report.

In 2018–19, 'average' streamflow was recorded at the Morambro Creek streamflow gauging station (Figure 4.1). Further detail on the methodology used for analysis can be found in Section 2.

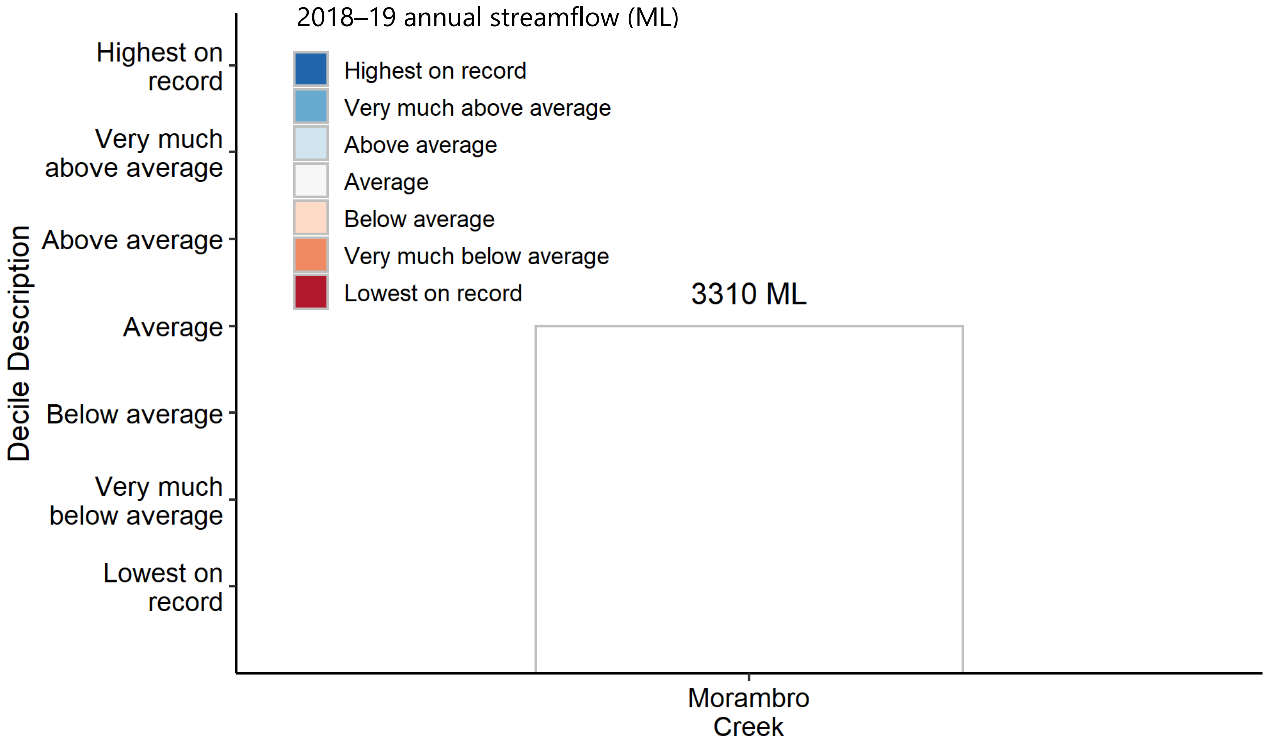


Figure 4.1. Morambro Creek PSWA annual streamflow summary 2018–19

4.1.1 Morambro Creek (A2390531)

The Morambro Creek streamflow gauging station has a catchment area of 1169 km^2 (301 km^2 is located within South Australia), and is located towards the western boundary of the PSWA prior to Morambro Creek entering Cockatoo Lake.

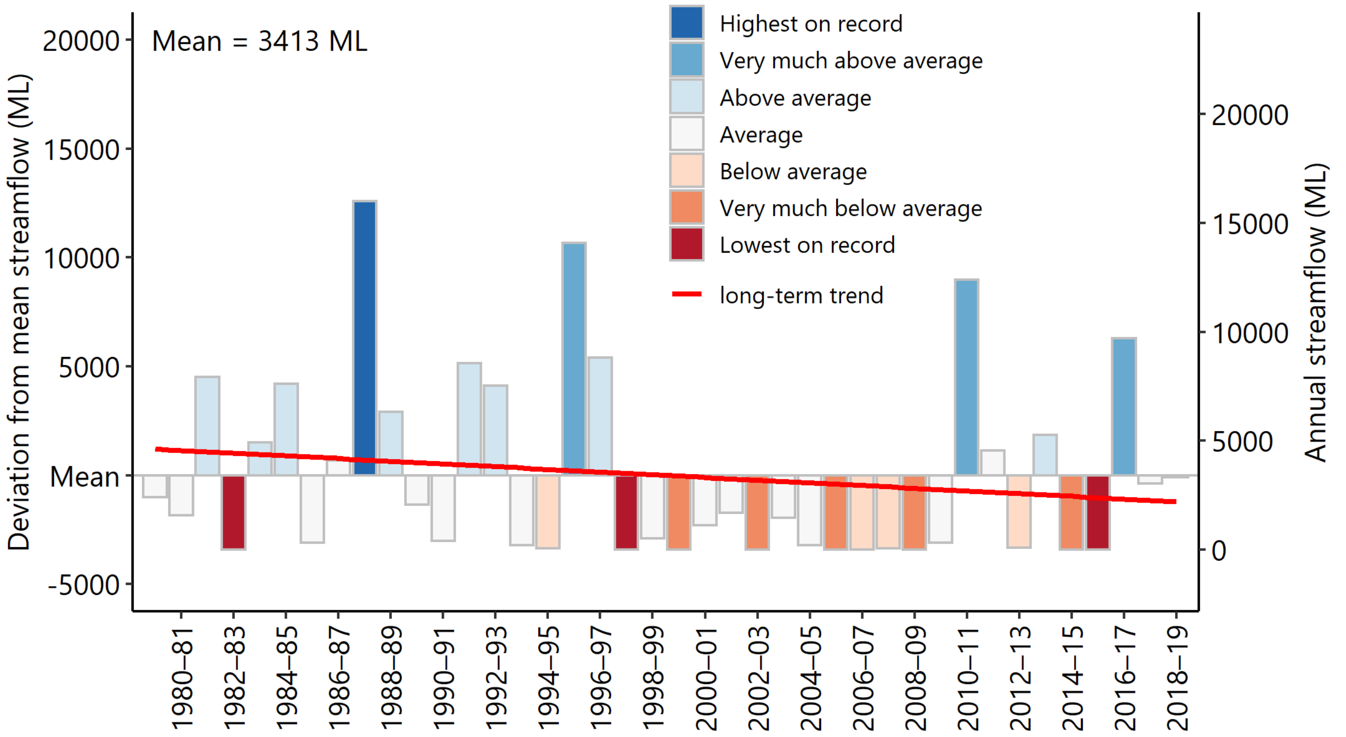


Figure 4.2. Annual deviation from mean streamflow at Morambro Creek (1979–80 to 2018–19)

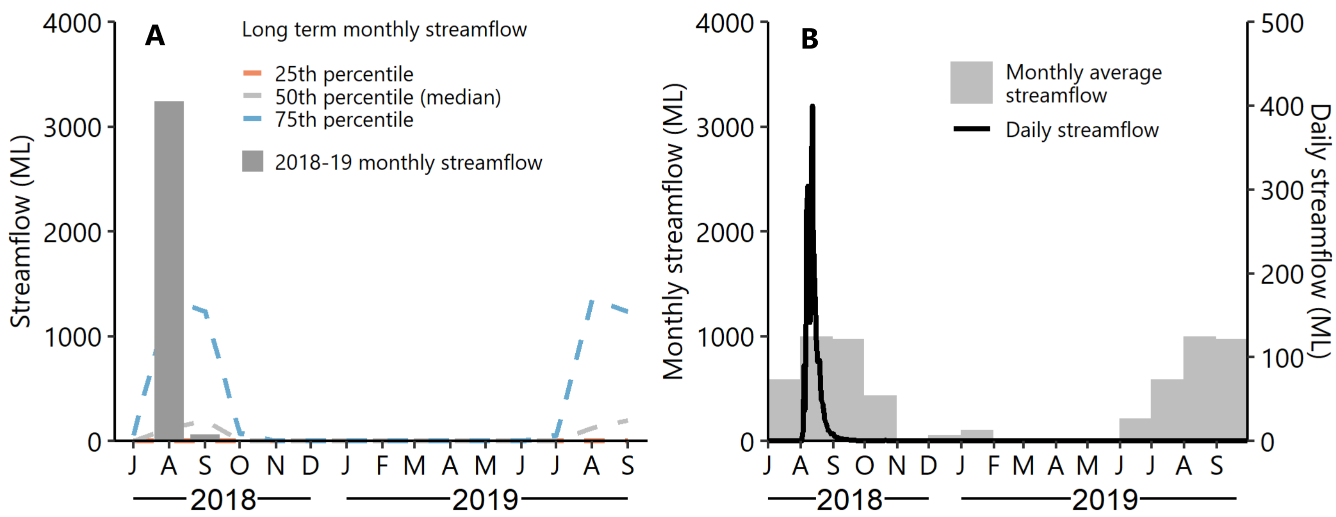


Figure 4.3. (A) Long-term monthly statistics and 2018–19 monthly streamflow at Morambro Creek; (B) Long-term average monthly streamflow and 2018–19 daily streamflow at Morambro Creek

The deviation of each individual year's streamflow from the long-term average is shown in Figure 4.2. The annual streamflow in Morambro Creek was 3310 ML in 2018–19, which is slightly below the average annual streamflow of 3413 ML (1979-80 to 2018–19). The annual streamflow for 2018–19 is ranked as 'average' assessed for the period 1979–80 to 2018–19. The data indicates long-term declining trend.

Figure 4.3A shows the monthly streamflow for 2018–19 (grey bars) relative to the long-term monthly streamflow (1979–80 to 2018–19) for (a) low flows (25th percentile), (b) median flows (50th percentile) and high flows (75th percentile). Morambro Creek is an ephemeral system and flows are not typically recorded between December and May. The majority of streamflow occurs between July and October and typically accounts for over 90% of the total annual flow in any given year. In 2018–19, streamflow occurred from August to October 2018 and no flow was recorded between November 2018 and June 2019. All months except August 2018 were drier than average in 2018–19. A flow of 3245 ML was recorded in August 2018 which was above the 75th percentile and would be classified as 'very much above average'. However, this was based on unverified telemetry data. September and October 2018 were below the 50th percentile streamflow.

Figure 4.3B presents the long-term average monthly streamflow (1979–80 to 2018–19) and the daily flows for 2018–19. Maximum daily flows were recorded in August 2018 and there were 289 zero flow days experienced in 2018–19 due to the ephemerality of the system. In the period from July to September 2019, there continued to be no flow recorded.

4.2 Salinity

Below-average summer rainfall can result in increased irrigation extractions. These two elements can cause salinities to increase by reducing the amount of streamflow available to dilute salts. Conversely, higher rainfall will result in increased surface water availability and decreased irrigation extractions, resulting in a reduction or stabilisation of salinity.

Salinity is recorded routinely in the PSWA at the Morambro Creek streamflow gauging station (A2390531). Due to the ephemeral nature of Morambro Creek, at times the watercourse is dry and salinity cannot be recorded. This has been the case for the majority of 2018–19 (November 2018 to June 2019). Figure 4.4 shows the long-term monthly salinity statistics for the period 2007–18 and median monthly values for 2018–19 (red dots) at the Morambro Creek streamflow gauging station. The box-and-whisker plots are not presented between November and June due to unreliable data.

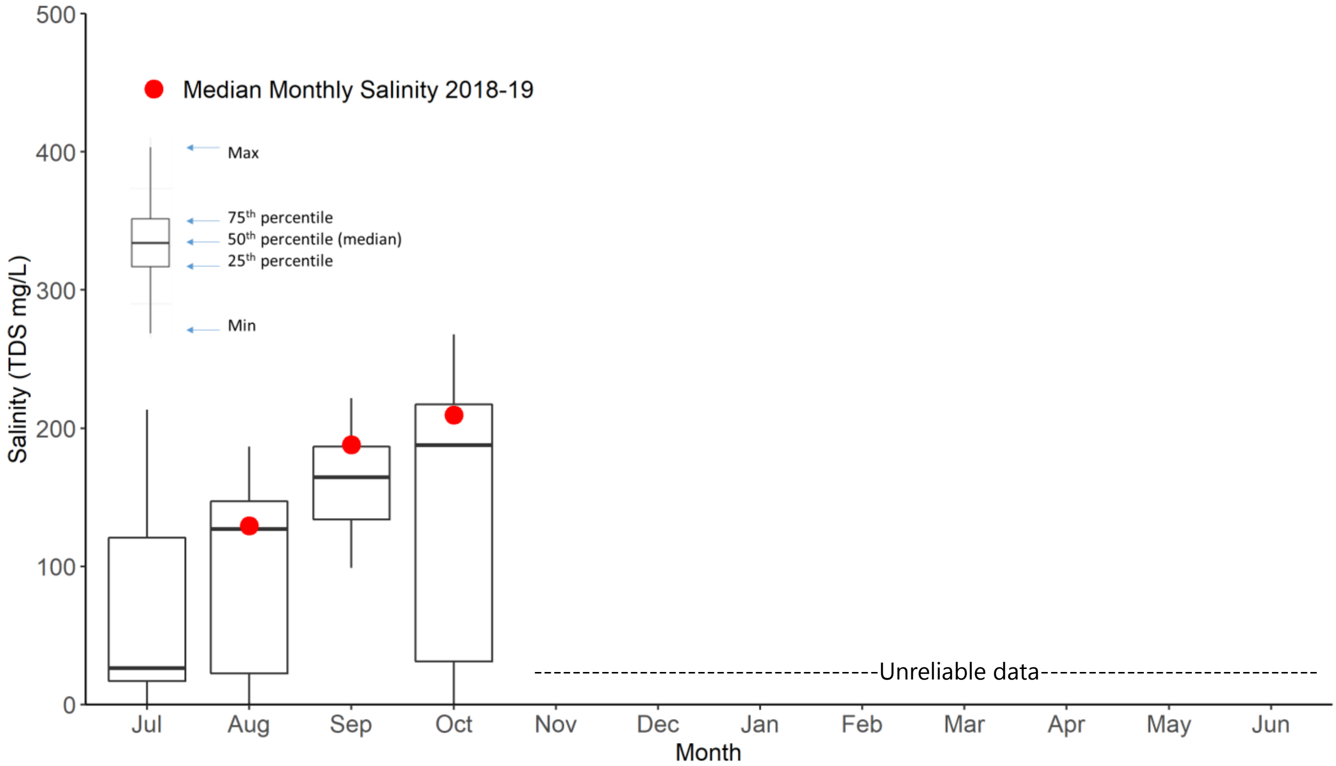


Figure 4.4. Long-term and 2018–19 monthly salinity at Morambro Creek streamflow gauging station (A2390531)

The majority of the salinity data is less than 250 mg/L over the period of record, indicating a very fresh section of watercourse. Figure 4.4 shows that in 2018–19 salinity remained within the historical ranges experienced for these months. The highest salinity recorded at Morambro Creek was 227 mg/L in late-October 2018.

5 Groundwater

5.1 Hydrogeology

The South East region is underlain by Tertiary sediments of the Otway Basin in the south, with a continuous transition to similar sediments of the Murray Basin in the north. Groundwater occurs within two major two regional aquifer systems within these sediments:

- the upper unconfined aquifer comprising Quaternary and Tertiary limestone;
- the underlying Tertiary confined sand aquifer, which consists of quartz sands, interbedded with dark brown carbonaceous clays.

The confined and unconfined aquifers are generally separated by a low permeability aquitard. The main source of recharge to the unconfined aquifer is the direct infiltration of local rainfall. Groundwater in both systems flows from the topographic high of the Dundas Plateau, located in western Victoria, to the south east in a radial direction, heading westward and southward towards the coast.

The South East can be divided topographically into two landforms, each with different hydrogeological characteristics and different groundwater management issues. There are low-lying coastal plains or flats in the south and west, with highlands or ranges to the east and north. The northern and central parts of the Lower Limestone Coast PWA are characterised by northwest-trending remnants of former coastal dunes, separated by inter-dunal flats.

For the purpose of these reports, each prescribed area is split into plains and highlands sub-areas based on unconfined aquifer groundwater management areas, which are shown in Table 5.1.

Table 5.1. Groundwater management areas used for the plains and highlands areas

Prescribed Wells Area	Sub-area	Groundwater management areas (GMAs)
Lower Limestone Coast	Highlands	Comaum, Joanna, Zone 5A, Hynam East, Frances, Beeamma, Bangham, Western Flat
	Coastal Flats and Donovans	*All other unconfined management areas*
Padthaway	Flats	Padthaway Flats
	Ranges	Padthaway Range
Tatiara	Coastal Plain	Willalooka, Stirling, North Pendleton, Wirrega
	Highlands	Cannawigara, Shaugh, Zone 8A Senior, Tatiara
Tintinara-Coonalpyn	Coastal Plain	Coonalpyn, Boothby, Tintinara
	Mallee Highlands	Sherwood

5.1.1 Unconfined aquifer

The Quaternary Padthaway, Coomandook and Bridgewater Formations form the unconfined aquifer in the northern and central parts of the South East. In the southern part of the Lower Limestone Coast PWA, the Tertiary Gambier Limestone forms the main unconfined aquifer and generally comprises a creamy bryozoal limestone which varies in thickness and is up to 400 m thick offshore to the south. The permeability of the aquifer is highly variable, with very high values associated with karst solution features. Beneath the highlands, the unconfined aquifer is contained in the Tertiary Murray Group Limestone, which is in the Murray Basin and is equivalent to the Gambier Limestone of the Otway Basin.

5.1.2 Confined aquifer

The confined aquifer in the Murray Basin to the north occurs in the Renmark Group, which consists of interbedded sands, silt and carbonaceous clay up to 100 m thick.

In the northern part of the South East, the confined aquifer is thin or absent due to the presence of shallow basement rocks around the Padthaway Ridge. In these areas it is not widely used due to comparatively low well yields of 10–20 L/s and the availability of much larger supplies in the overlying unconfined aquifer.

Over most of the southern and central parts of the South East, the main confined aquifer occurs in the Dilwyn Formation, which consists of quartz sands interbedded with dark brown carbonaceous clays. The confined aquifer in these areas is a complex multi-aquifer system; however, for management and reporting purposes it is considered regionally as one aquifer.

5.2 Unconfined aquifer

5.2.1 Lower Limestone Coast PWA – Coastal Flats and Donovans area – water level

Following the 2018–19 irrigation season, 46% of unconfined aquifer monitoring wells with long-term records were at their average water level compared to historic levels (Figure 5.1). These wells are spread across the aquifer with the majority located in areas of shallow watertables (less than 10 m below ground level) and within the inter-dunal flats. A small number of wells (3%) recorded their lowest recovered water level on record; these were generally located near areas of intensive irrigation south of Mount Gambier, forest plantations or near drainage networks.

Five-year trends in water levels are showing rising trends for 260 wells (71%) with rates of rise ranging from 0.02 m/y to 0.60 m/y (median 0.10 m/y; Figure 5.2). Over a longer period of 30 years, water levels have declined in 148 of 155 wells (95%), with the median change in water level over that 30-year period being a decline of 0.97 m.

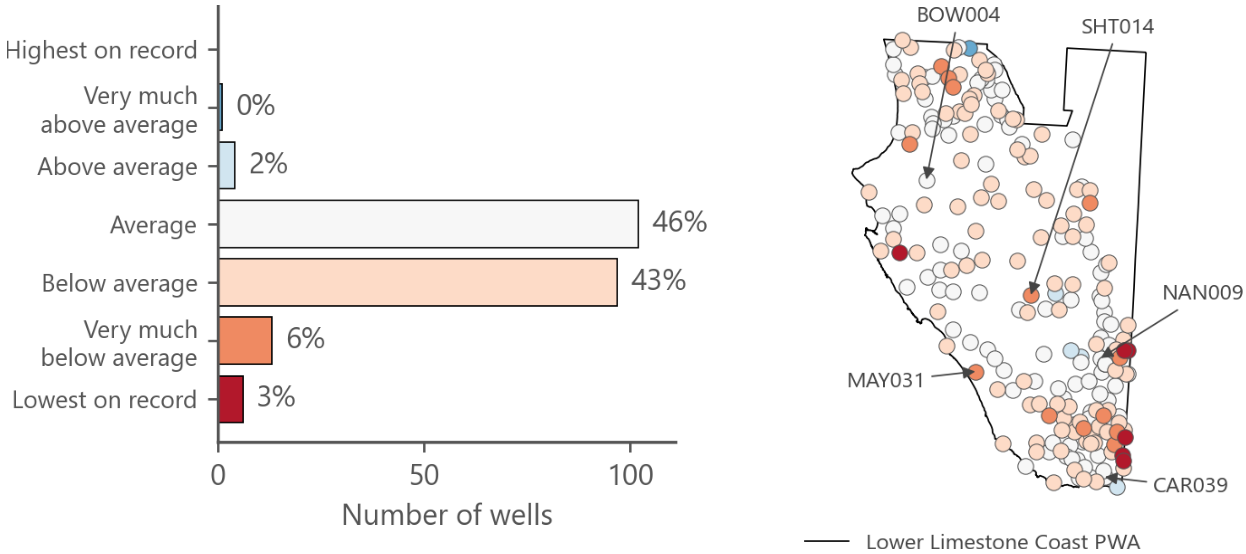


Figure 5.1. 2019 recovered water levels for wells in the unconfined aquifer in the Lower Limestone Coast PWA Coastal Flats and Donovans area

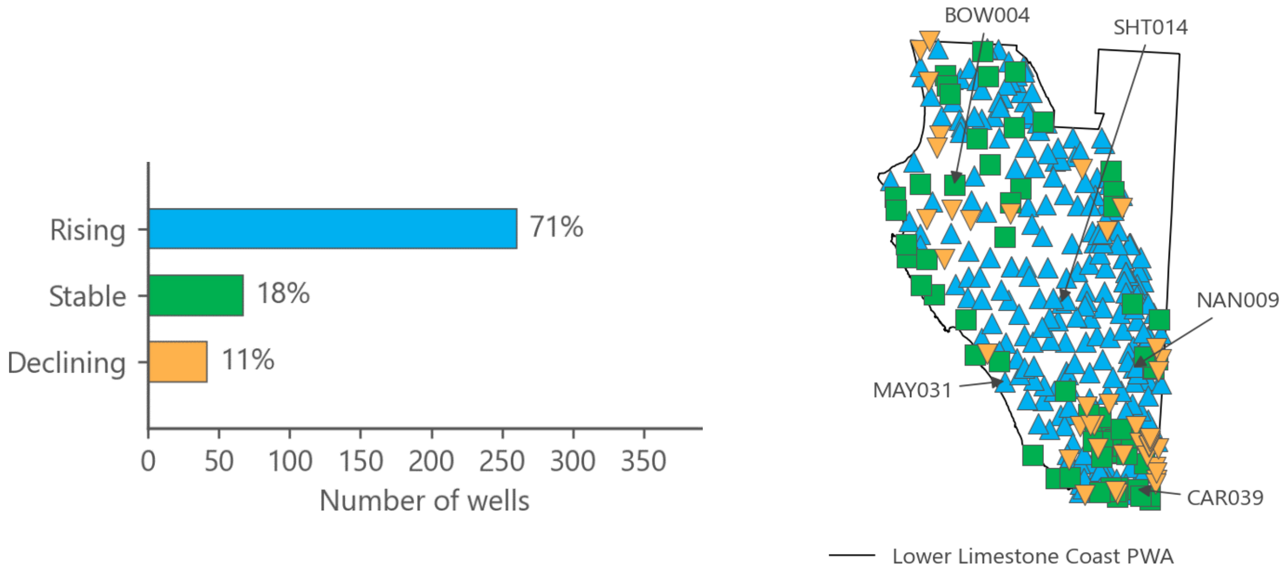


Figure 5.2. 2015–2019 trend in recovered water levels for wells in the unconfined aquifer in the Lower Limestone Coast PWA Coastal Flats and Donovans area

Groundwater levels from some monitoring wells located in those parts of the coastal plain with a shallow watertable show a consistent decline in groundwater levels since 1993, e.g. MAY031 (Figure 5.3). The groundwater levels in these monitoring wells are driven by rainfall trends, as they are not influenced by extraction. Wetter conditions from 2009 onwards have led to some recovery of water levels in these areas (e.g. BOW004; Figure 5.3). Water levels in CAR039, located in an area of intensive irrigation for dairy south of Mt Gambier, are declining due to the combined effects of reduced rainfall recharge since 1993 and increased irrigation activities, with the large seasonal fluctuations being a response to irrigation extraction during summer (Figure 5.3).

Monitoring wells SHT014 and NAN009 are located near forest plantations and show a typical decline of several metres in the watertable in response to the establishment of large plantings of blue gums in the late 1990s. NAN009 also shows a rise in water level after the 1983 Ash Wednesday bushfire due to the effect the latter had on forested areas (Figure 5.3).

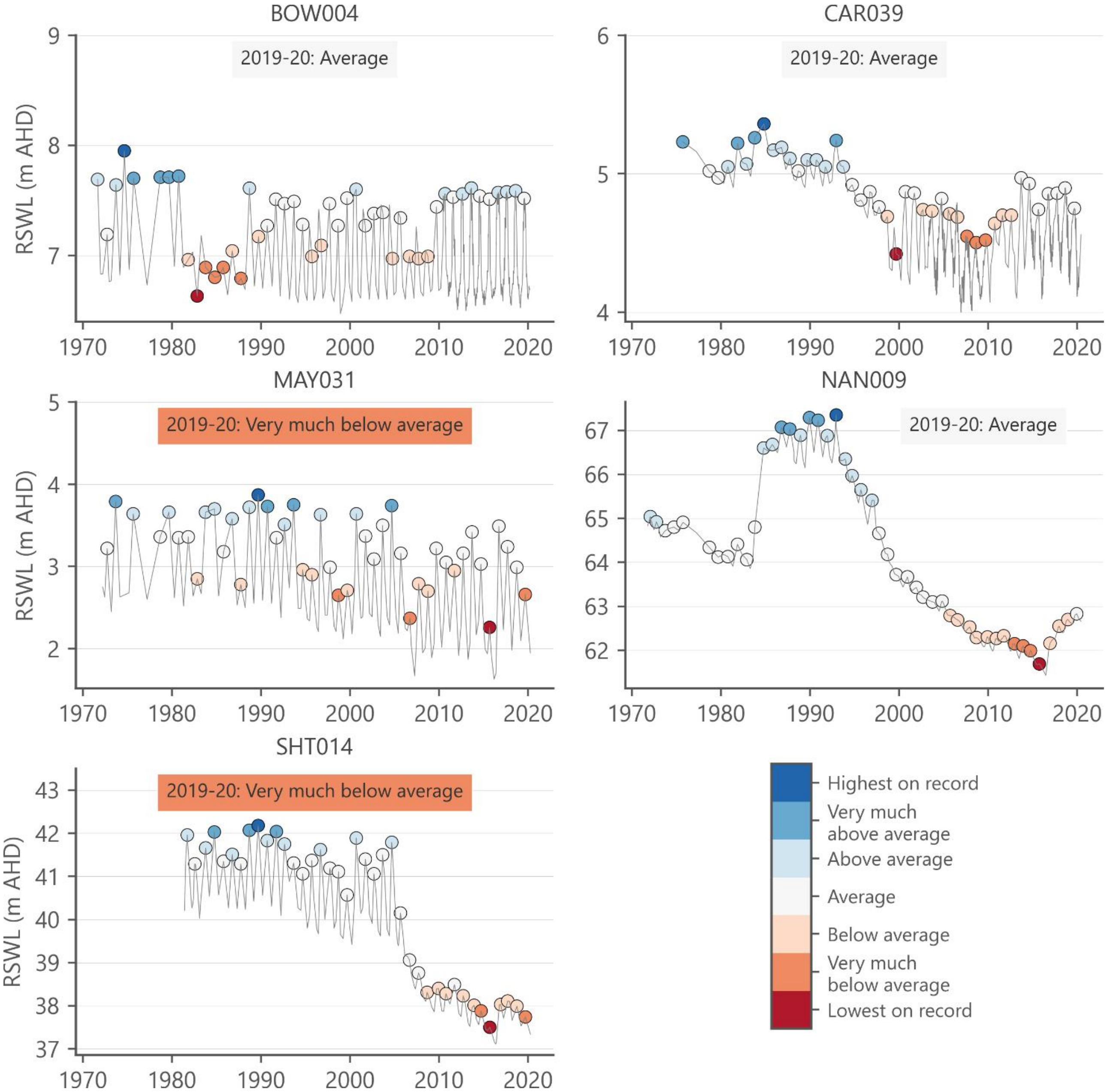


Figure 5.3. Selected hydrographs for wells in the unconfined aquifer in the Lower Limestone Coast PWA Coastal Flats and Donovans area

5.2.2 Lower Limestone Coast PWA – Coastal Flats and Donovans area – salinity

In 2019 the groundwater salinity ranged from about 185 mg/L to 33000 mg/L, although 98% of wells had salinities below 5000 mg/L and 72% of wells had salinities below 1000 mg/L (Figure 5.4). Those wells with salinity under 1000 mg/L are spread across the aquifer with the majority located in the southern part of the PWA. The median salinity from all wells was 697 mg/L.

Five-year trends in salinity are stable or decreasing for the majority of wells (89%), with only a small number of wells (15 wells; 11% of all wells) showing rising salinity trends, with a median rate of increase of 22% over the last five years (Figure 5.5). The median rate of change for all wells is a decrease in salinity of 2% over the last five years.

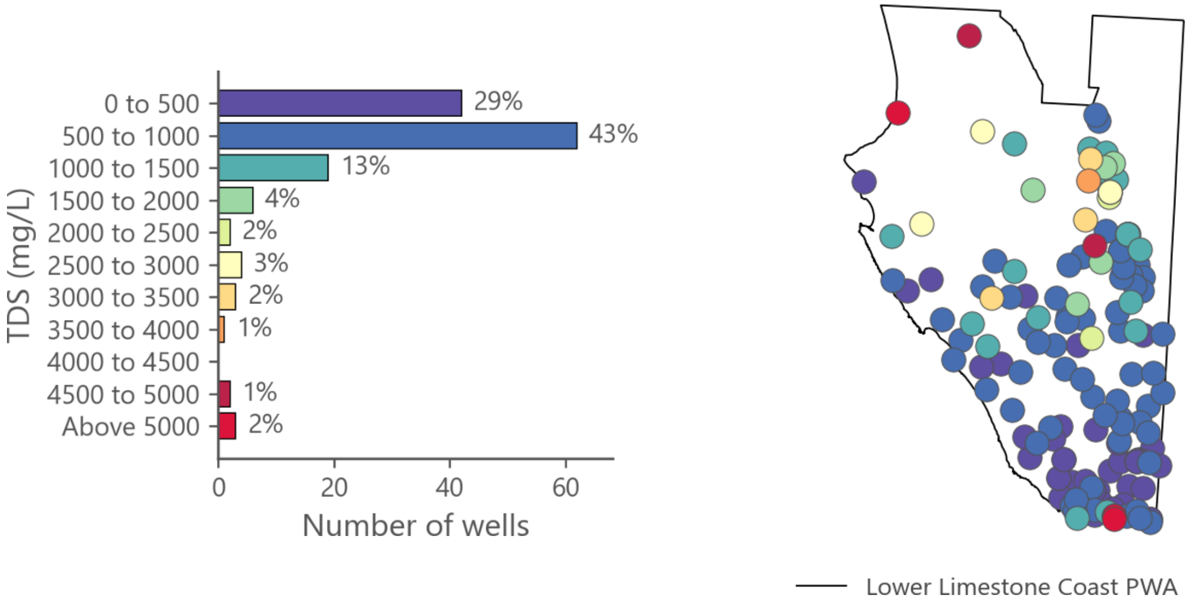


Figure 5.4. 2019 salinity observations from wells in the unconfined aquifer in the Lower Limestone Coast PWA Coastal Flats and Donovans area

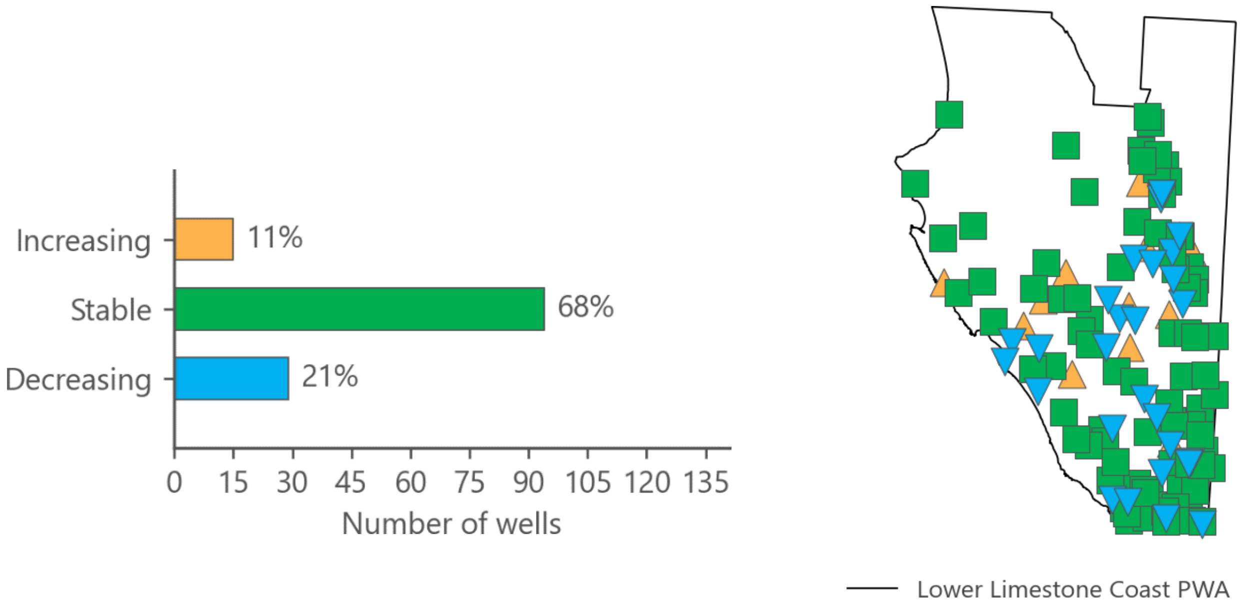


Figure 5.5. 2015–2019 trend in water salinity for wells in the unconfined aquifer in the Lower Limestone Coast PWA Coastal Flats and Donovans area

5.2.3 Lower Limestone Coast PWA – Highlands area – water level

Following the 2018–19 irrigation season, the majority (75%) of wells with long-term records were observed to have recovered water levels which were lower than the historical average (Figure 5.6), while 29% of wells were observed to have their lowest recovered level on record. Only 25% of wells recovered to average or above average levels; these wells are mostly located in the transitional zone, between the highlands and the coastal flats to the west. Of wells with water level records ranging back 30 years, 19 of 22 wells had declines in water level overall; the change ranged from 0.11 to 3.74 m (median change was a decline of 1.51 m).

Five-year trends in water level are more variable, with 39% of wells showing a rising trend and 45% of wells showing declining trends (Figure 5.7). A small number of wells are stable (16%). Rising trends range from 0.02 m/y to 0.25 m/y (median 0.09 m/y), while declining trends vary from 0.03 m/y to 0.14 m/y (median decline of 0.07 m/y). Most wells with rising trends are located in the transitional area between the highlands and coastal flats, while most wells with declining trends are located in the northern part of the area where the depth to the watertable is greater.

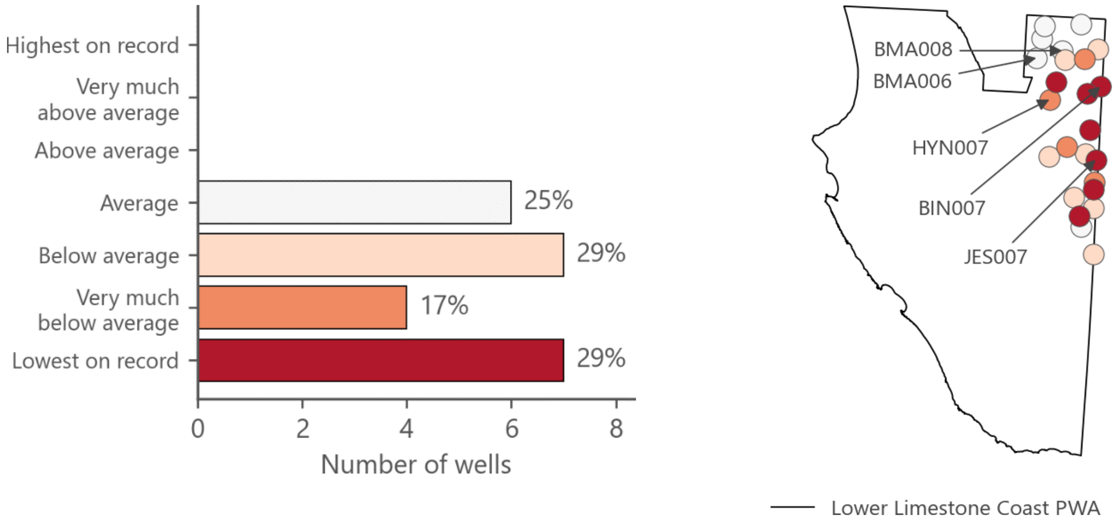


Figure 5.6. 2019 recovered water levels for wells in the unconfined aquifer in the Lower Limestone Coast PWA highlands area

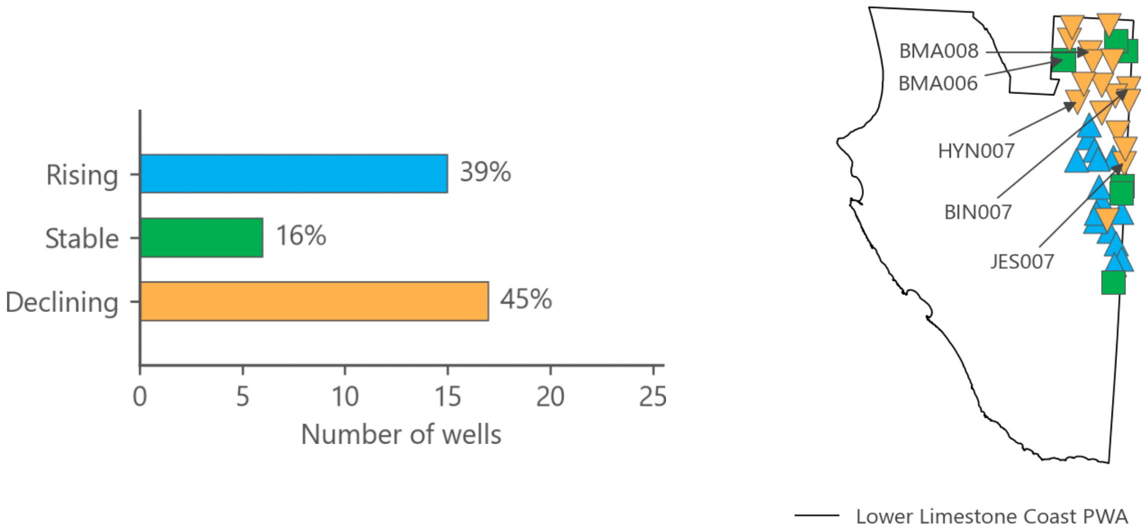


Figure 5.7. 2015–2019 trend in recovered water levels for wells in the unconfined aquifer in the Lower Limestone Coast PWA highlands area

In the unconfined aquifer beneath the highlands, where the depth to the watertable is generally more than 10 m, groundwater level trends are responding to widespread clearance of native vegetation, which has resulted in increased recharge rates and rising groundwater levels. Figure 5.6 shows gradually rising trends of up to 0.2 m/y in several representative wells (e.g. BMA006, BMA008, HYN007, JES007) or generally stable periods (e.g. BIN007) prior to the mid to late 1990s. This rising trend persisted for several years after the prolonged period of below-average rainfall commenced around 1997 as measured at the nearby Frances rainfall station (Figure 3.3), but levels have subsequently fallen due to persistent low rainfall years in the mid-2000s and mid-2010s.

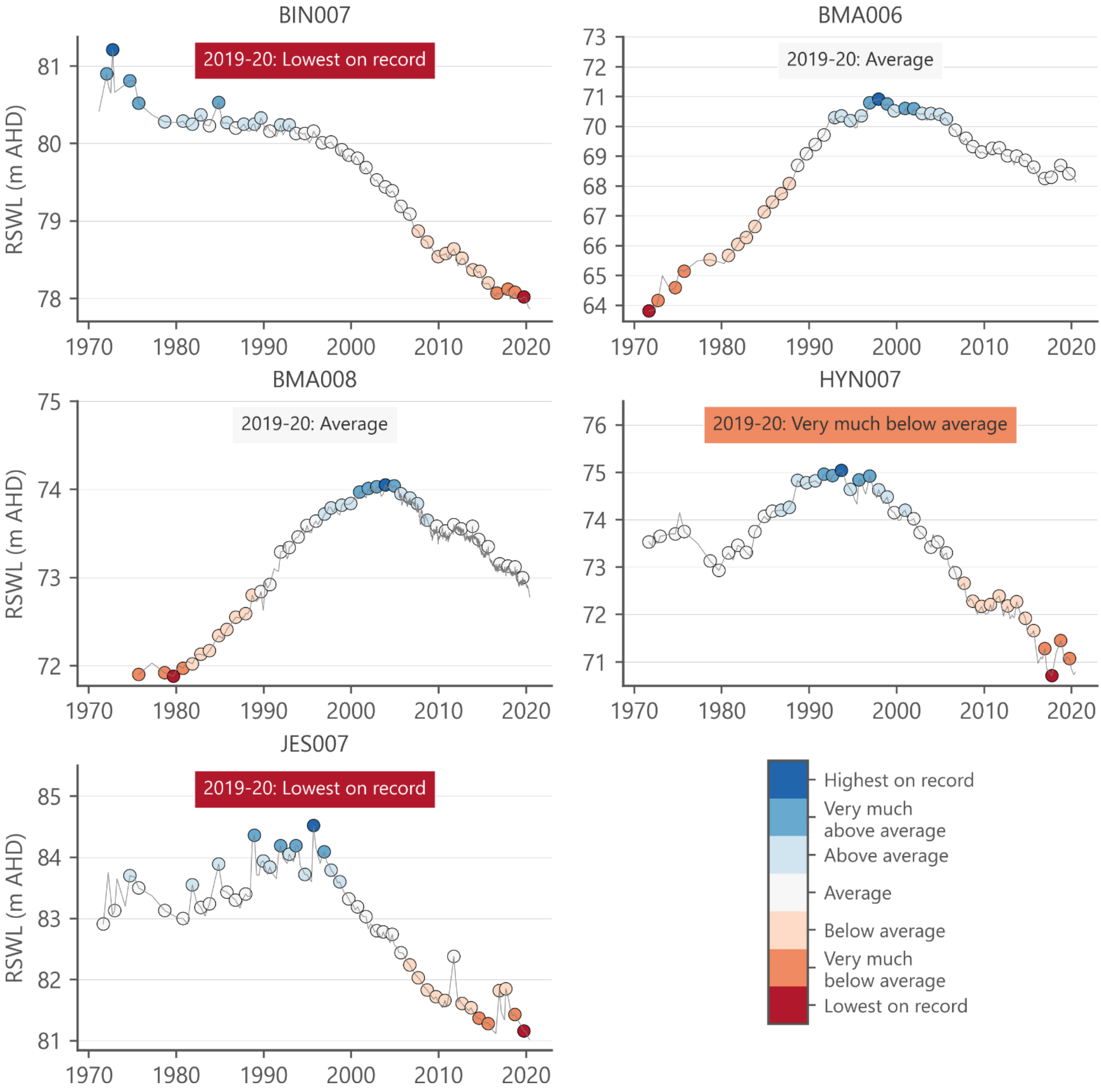


Figure 5.8. Selected hydrographs for wells in the unconfined aquifer in the Lower Limestone Coast PWA highlands area

5.2.4 Lower Limestone Coast PWA – Highlands area – salinity

In 2019 the groundwater salinity ranged from about 350 mg/L to 2000 mg/L. The majority of wells (78%) have salinities between 900 and 1800 mg/L, with a median of 1075 mg/L overall (Figure 5.9).

Five-year trends in salinity are stable for the majority of wells (82%), with only four wells (18%) either increasing or decreasing in salinity (Figure 5.10).

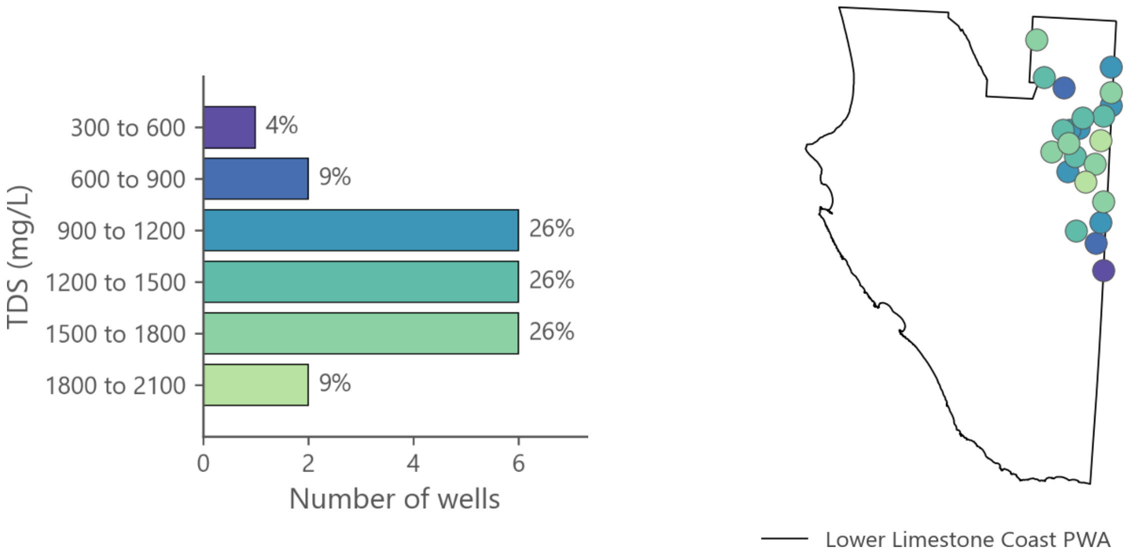


Figure 5.9. 2019 salinity observations from wells in the unconfined aquifer in the Lower Limestone Coast PWA highlands

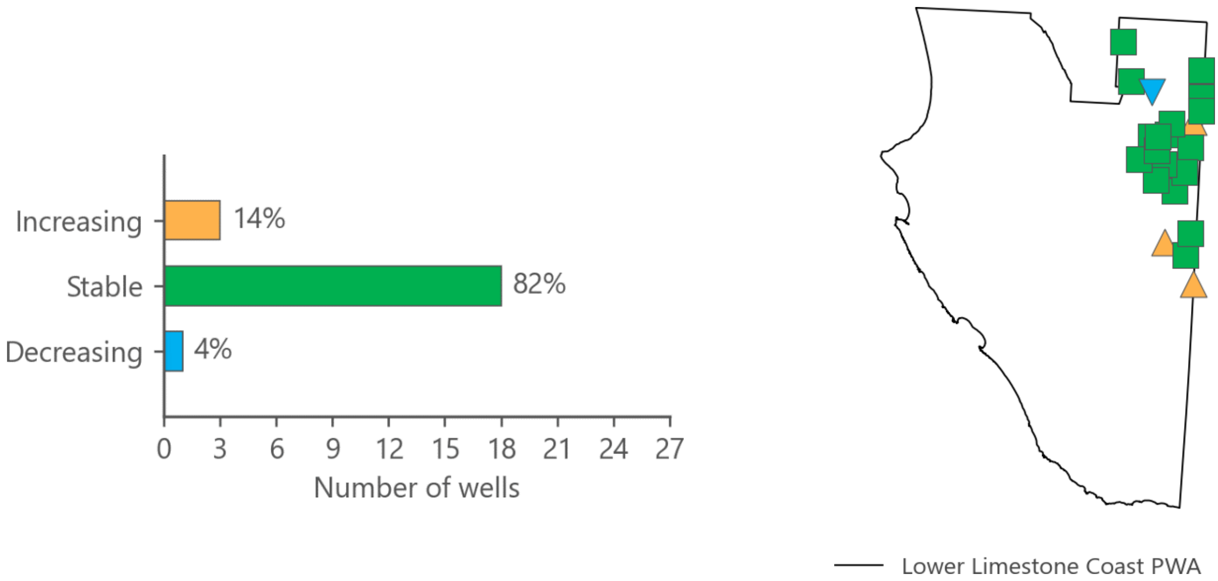


Figure 5.10. 2015–2019 trend in water salinity for wells in the unconfined aquifer in the Lower Limestone Coast PWA highlands

5.2.5 Padthaway PWA – Padthaway Flats GMA – water level

Following the 2018–19 irrigation season, 13 (54%) of those monitoring wells with long-term records had water levels below average compared to their historical record (Figure 5.11). The majority of those wells with below-average water levels are located in the western part of the PWA, down-gradient of the intensive groundwater extraction area. All remaining wells (11 wells; 46%) showed average or above-average levels; these are located along the transitional zone between the flats and ranges.

All wells with suitable long-term records showed a decline in water levels compared to 30 years ago; the median decline over this period was 1.70 m, with a maximum decline of 2.35 m. However, five-year water level trends (Figure 5.12) show a rising trend in all monitoring wells, at rates of rise ranging from 0.13 m/y to 0.29 m/y (median 0.21 m/y).

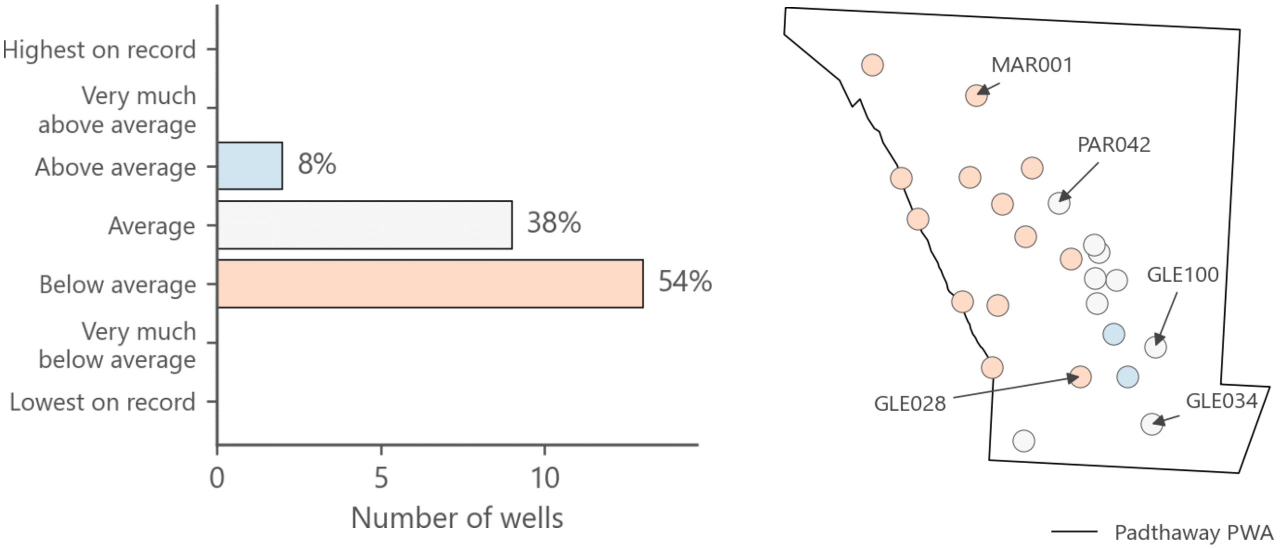


Figure 5.11. 2019 recovered water levels for wells in the unconfined aquifer in the Padthaway Flats management area

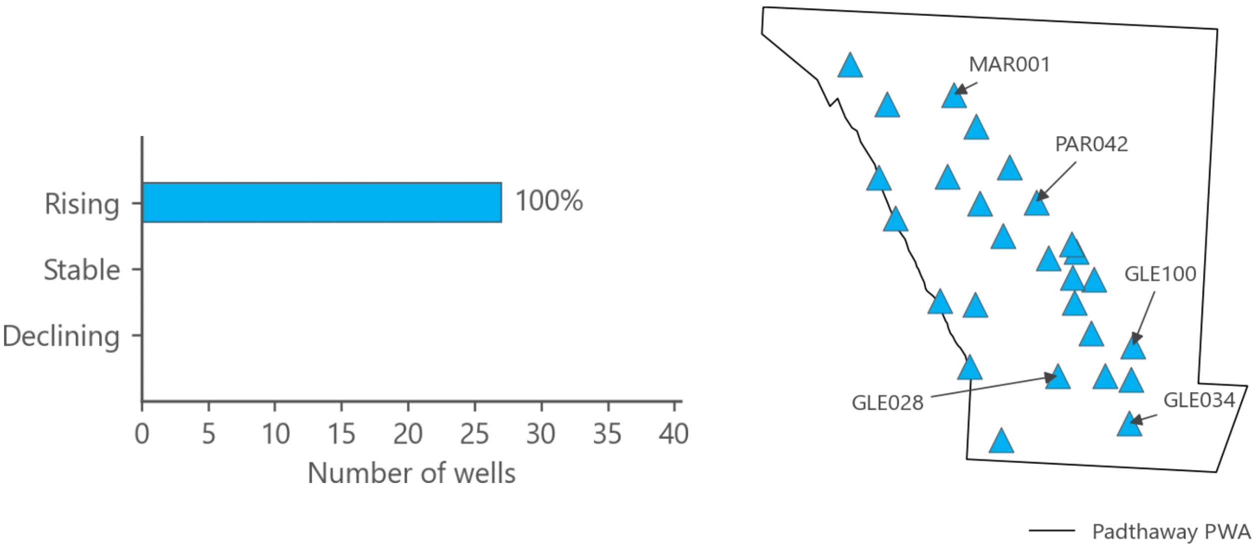


Figure 5.12. 2015–2019 trend in recovered water levels for wells in the unconfined aquifer in the Padthaway Flats management area

The depth to the watertable in much of the Padthaway Flats management area is less than 5 m, resulting in groundwater level trends being very responsive to rainfall. Long-term trends from representative monitoring wells such as MAR001, PAR042, GLE028, GLE100, and GLE034 (Figure 5.13) show a close correlation with rainfall. Below-average rainfall since 1993 has resulted in declines of between 1 m and 2 m. Average and above-average periods of rainfall in the early 2000s, 2009 to 2010 and 2017 to 2018 have resulted in water levels stabilising.

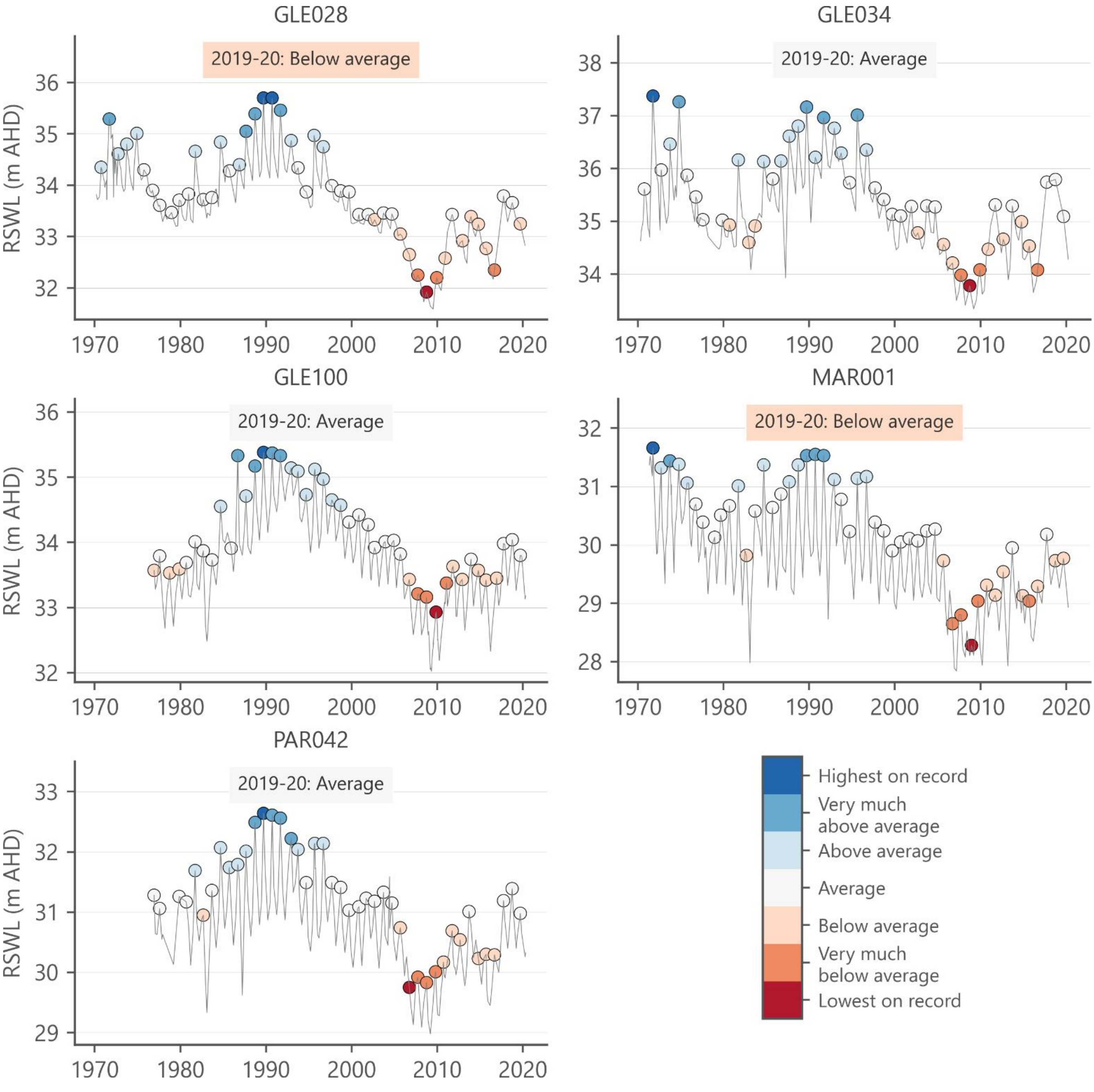


Figure 5.13. Selected hydrographs for wells in the unconfined aquifer in the Padthaway Flats management area

5.2.6 Padthaway PWA – Padthaway Flats GMA – salinity

In 2019 the groundwater salinity ranged from 974 mg/L to 9370 mg/L; 94% of wells had salinities below 2100 mg/L (Figure 5.14). Overall the median salinity was 1308 mg/L.

Five-year trends in water salinity are either stable (9 out of 18 wells) or rising (also 9 out of 18 wells; Figure 5.15). The percentage change in salinity over the last five years ranges from a decrease of 8% to an increase of 31% (median change of 12%).

The wells with stable trends in salinity are located on the eastern margin of the irrigated areas; this is likely related to the inflow of fresher water from the adjacent Padthaway Range area to the east. Wells with rising salinity trends are located on the western edge (down-gradient) of the irrigation area and may be influenced by the recycling of irrigation water in the shallow aquifer.

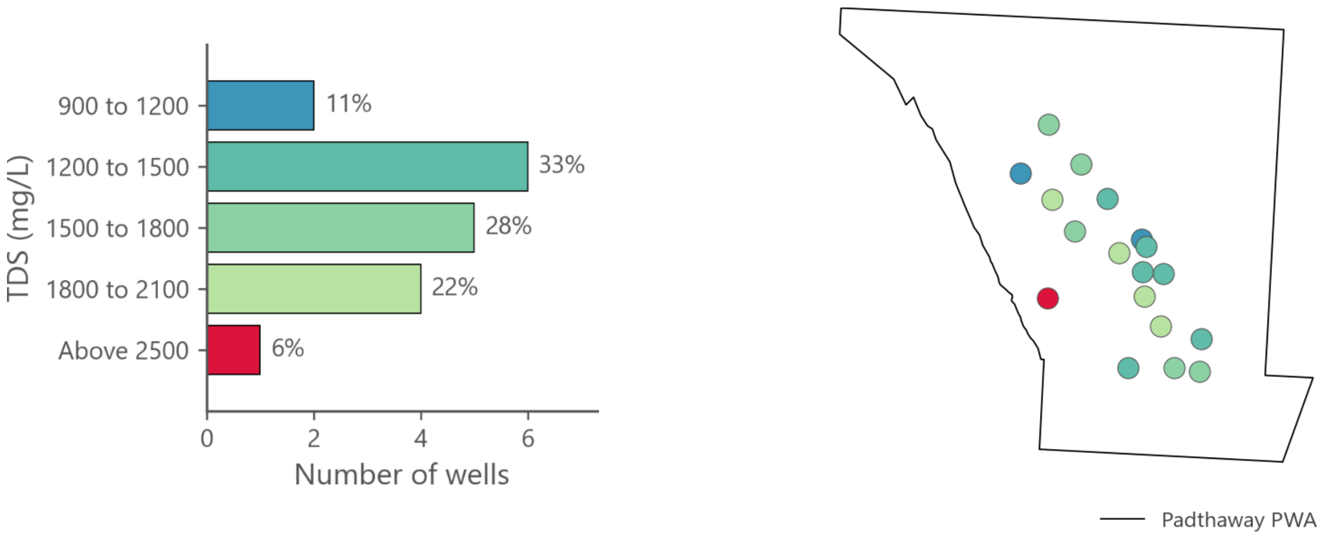


Figure 5.14. 2019 salinity observations from wells in the unconfined aquifer in the Padthaway Flats management area

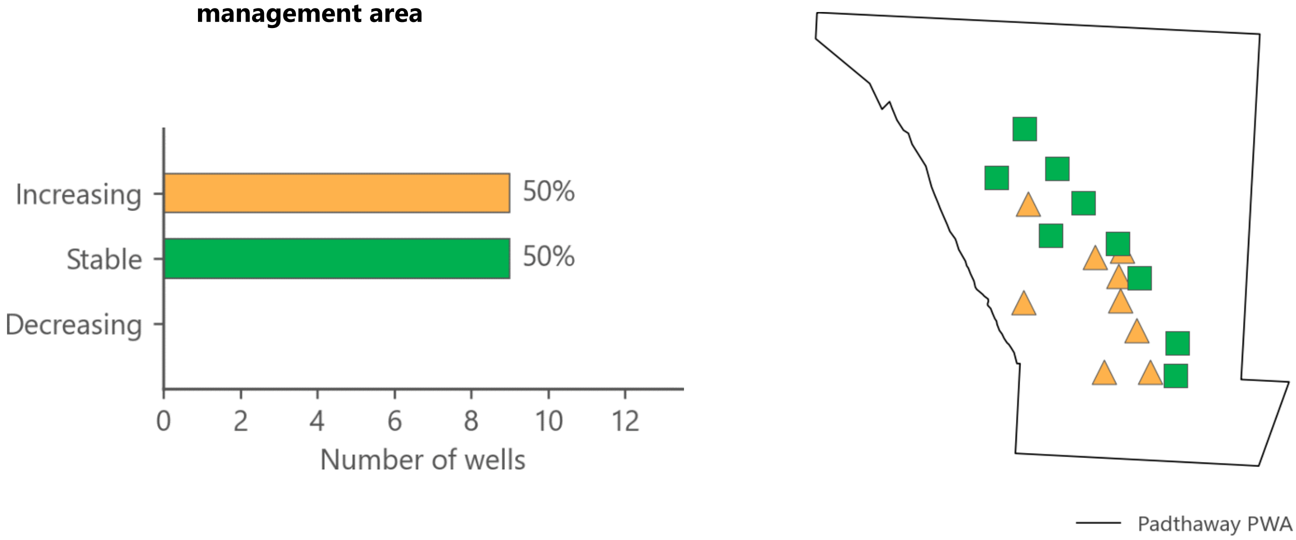


Figure 5.15. 2015–2019 trend in water salinity for wells in the unconfined aquifer in the Padthaway Flats management area

5.2.7 Padthaway PWA – Padthaway Range GMA - water level

Following the 2018–19 irrigation season, the majority of monitoring wells (83%) with long-term records were at average or above-average water levels (Figure 5.16). One well was at its highest level on record. Two wells had below-average water levels. Over the past 30 years, water levels have remained generally stable. The median change in water levels over the last 30 years is a rise of 0.78 m; overall, changes range from a decline of 1.82 m to a rise of 1.76 m.

Five-year trends (2015–2019) show a variety of changes (Figure 5.17). Most wells are either stable (33%) or rising (50%), with rates of rise ranging from 0.03 to 0.19 m/y. Wells with rising trends are located near the transitional zone between the flats and the ranges.

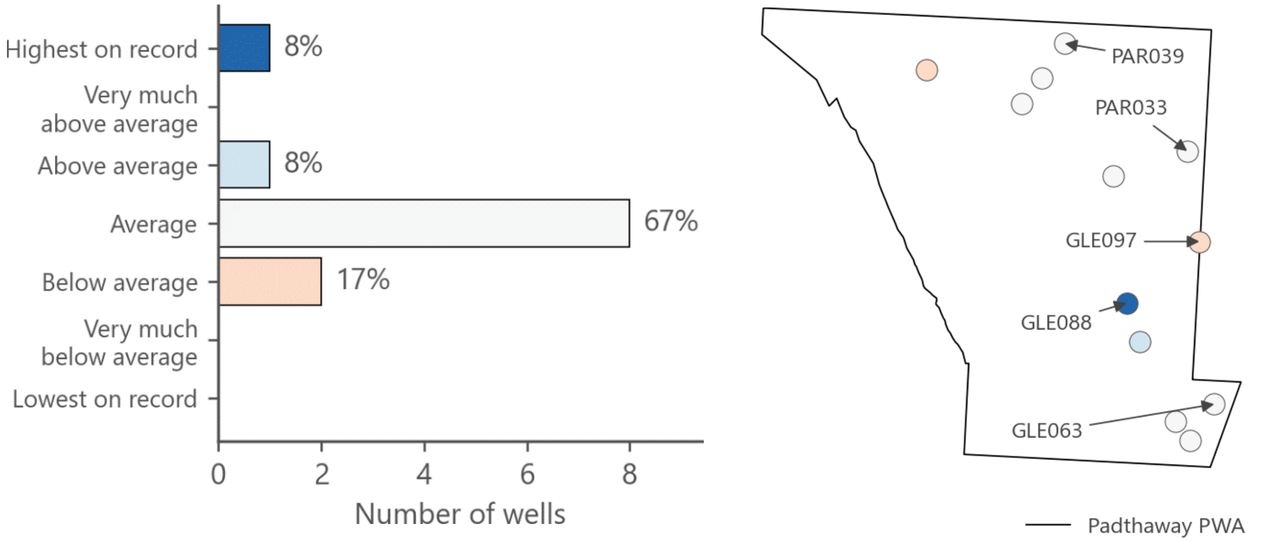


Figure 5.16. 2019 recovered water levels for wells in the unconfined aquifer in the Padthaway Range management area

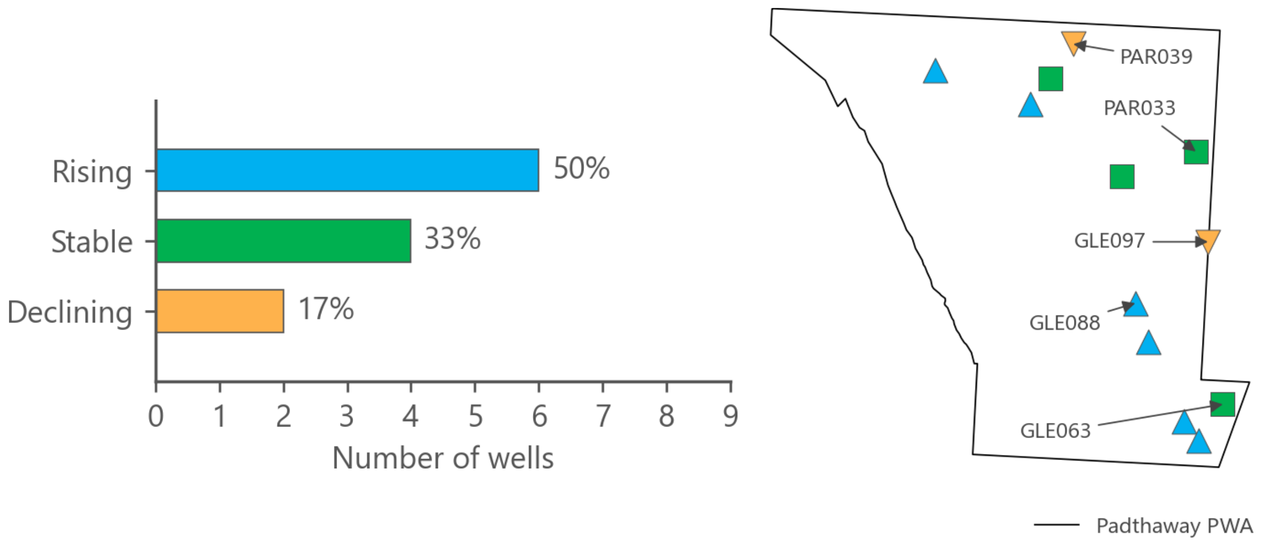


Figure 5.17. 2015–2019 trend in recovered water levels for wells in the unconfined aquifer in the Padthaway Range management area

In the unconfined aquifer beneath the Padthaway Range management area, where the depth to the watertable is generally more than 10 m, water level trends are responding to different processes than those found on the flats. The widespread clearance of native vegetation has resulted in increased recharge rates and rising groundwater levels. Figure 5.18 shows several representative monitoring wells (PAR039, PAR033, GLE097, GLE088, GLE063) which illustrate gradually rising water levels from the 1980s to the mid 2000s. In some wells, this rising trend persisted through a prolonged period of below-average rainfall in the mid to late 1990s, although the Millenium drought from 2004–05 to 2008–09 did result in brief declines in water level in several wells.

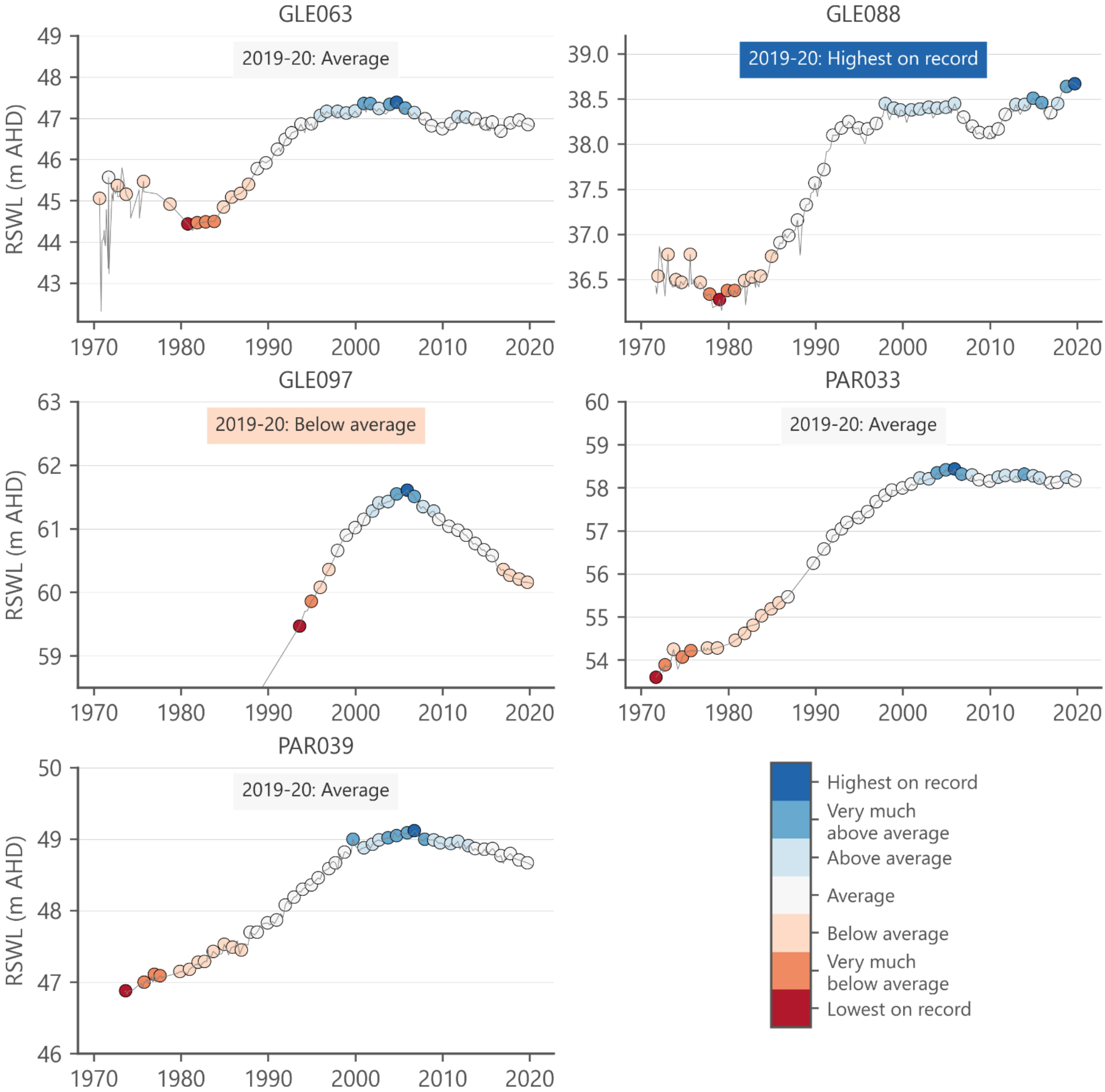


Figure 5.18. Selected hydrographs for wells in the unconfined aquifer in the Padthaway Range management area

5.2.8 Padthaway PWA – Padthaway Range GMA – salinity

In 2019 the groundwater salinity from all monitoring wells was less than 2000 mg/L, ranging from 1052 mg/L to 1993 mg/L (median 1124 mg/L; Figure 5.19). Generally, salinity increases to the north and west.

Five-year trends in salinity are stable across the area, with only one out of eight wells showing a rising trend, with a 10% change in salinity over the last five years (Figure 5.20).

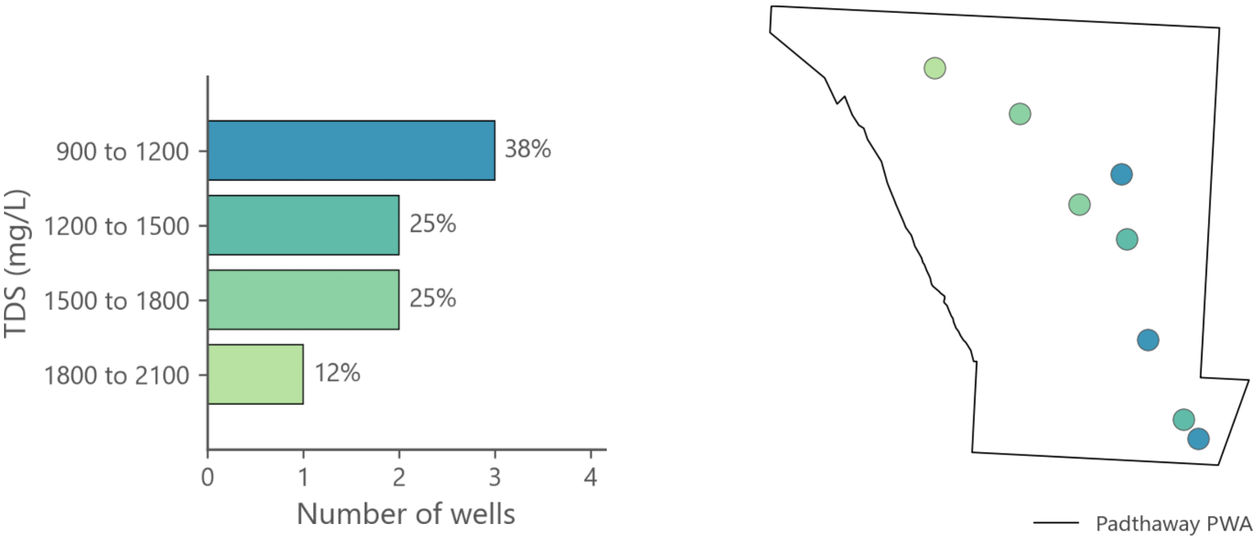


Figure 5.19. 2019 salinity observations from wells in the unconfined aquifer in the Padthaway Range management area

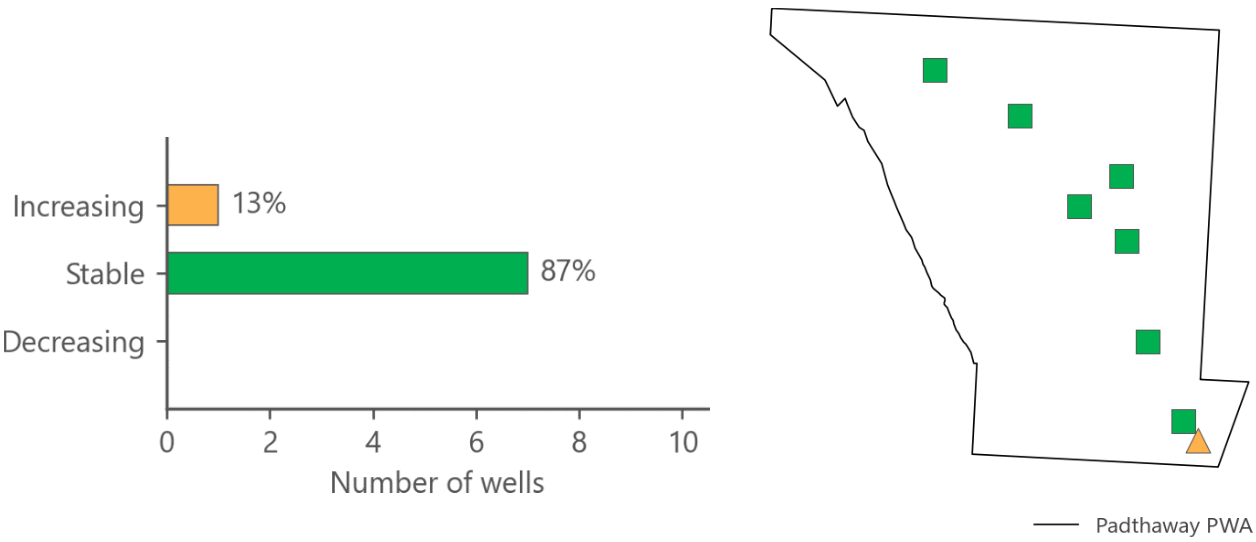


Figure 5.20. 2015–2019 trend in water salinity for wells in the unconfined aquifer in the Padthaway Range management area

5.2.9 Tatiara PWA – Plains area – water level

Following the 2018–19 irrigation season, 42 monitoring wells (95% of those with long-term records) were below their average recovered water level on record and 17 wells (39%) were observed to have their lowest recovered water level on record (Figure 5.21). Those wells which are 'lowest on record' are mainly located in the transitional zone between the Plains and Mallee Highlands. The change in water level over the last 30 years has been a decline in 40 of 42 wells with suitable records (95%), with the declines ranging from 0.16 to 11.99 m; the median decline is 3.78 m.

Five-year trends in water levels are showing a similar contrast between the plains in the western part of the Tatiara PWA, where most wells show rising trends, and the transitional zone in the centre of the Tatiara PWA, where most wells are showing declining trends (Figure 5.22); these are generally those same wells which have seen their lowest recovered water level on record in 2019. Overall, 31% of wells are showing rising trends, at rates of up to 0.17 m/y (median rate of rise is 0.08 m/y) and 52% are showing declining trends, at rates of up to 0.30 m/y (median rate of decline is 0.06 m/y).

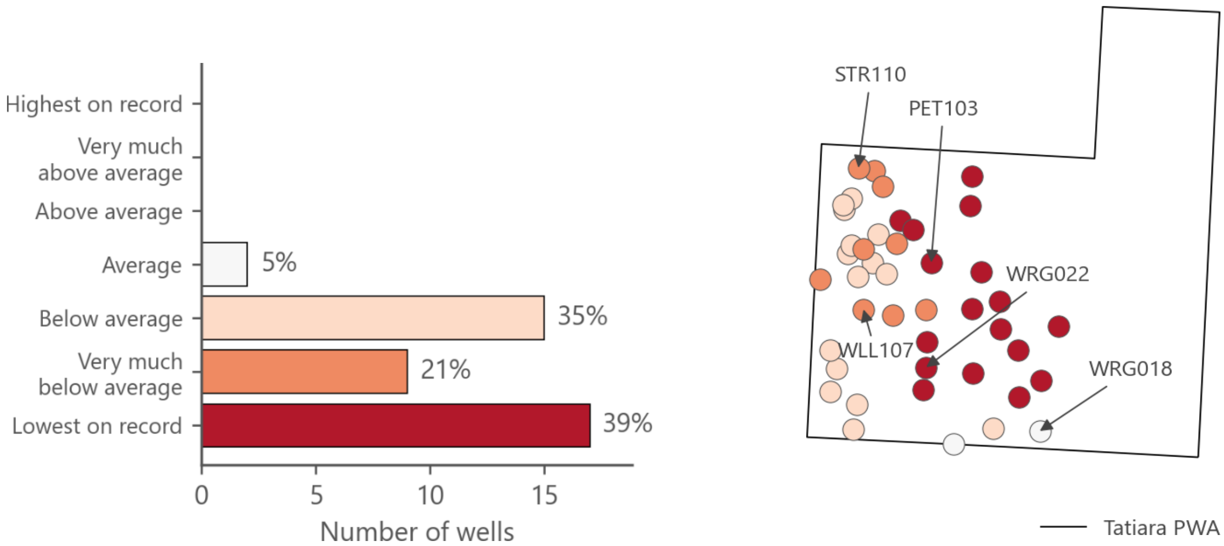


Figure 5.21. 2019 recovered water levels for wells in the unconfined aquifer in the Tatiara PWA Plains area

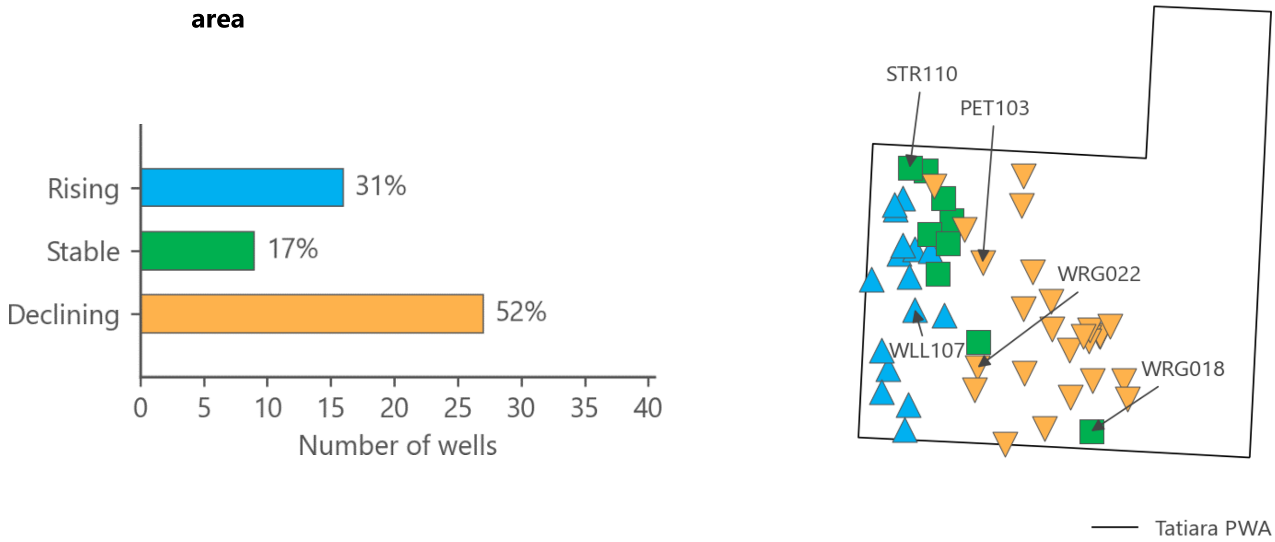


Figure 5.22. 2015–2019 trend in recovered water levels for wells in the unconfined aquifer in the Tatiara PWA Plains area

The shallow depth to the watertable of 5 to 10 m in the unconfined aquifer on the low-lying Plains results in groundwater levels being responsive to rainfall. Figure 5.23 depicts representative wells from across the Tatiara PWA plains area. Two wells from an area of intensive irrigation near Keith (WLL107 and STR110) show seasonal drawdowns due to pumping for irrigation, with a steady and consistent declining trend in water levels of about 0.2 m/y, corresponding with the prolonged period of below average rainfall since 1996. Levels have stabilised over the last five to six years.

Further east and to the south, wells in the transitional zone between the plains and highlands show water levels continuing to decline in recent years (PET103, WRG018, and WRG022; Figure 5.23).

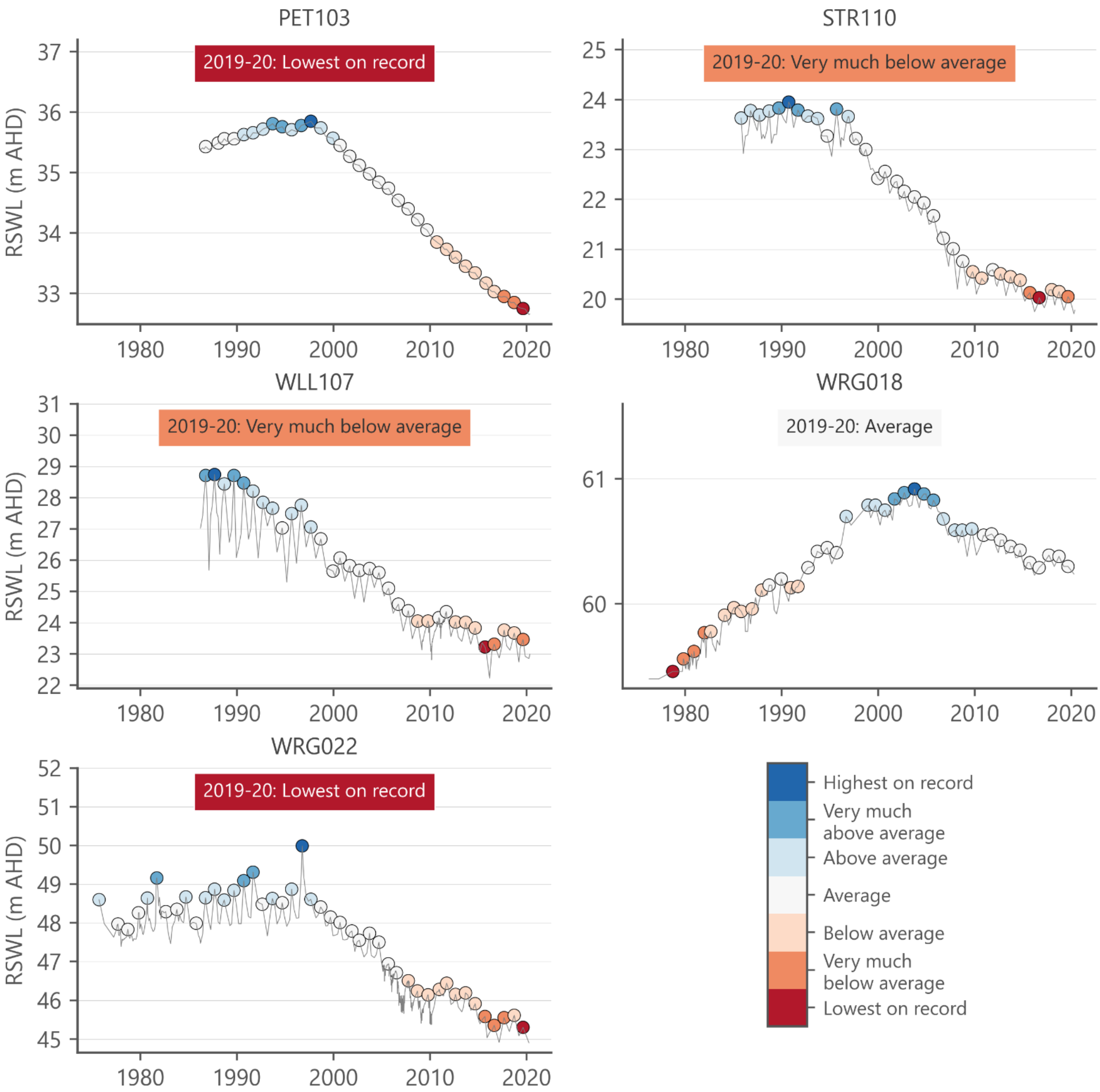


Figure 5.23. Selected hydrographs for wells in the unconfined aquifer in the Tatiara PWA Plains area

5.2.10 Tatiara PWA – Plains area – salinity

In 2019, the groundwater salinity ranged from 393 mg/L to 8748 mg/L (median 2702 mg/L; Figure 5.24). In general, higher salinities above 4500 mg/L are found in the north-western part of the Tatiara PWA, where intensive flood irrigation is carried out.

Five-year trends in groundwater salinity are almost entirely stable (97% of wells), with only one well showing a declining trend in salinity (Figure 5.25).

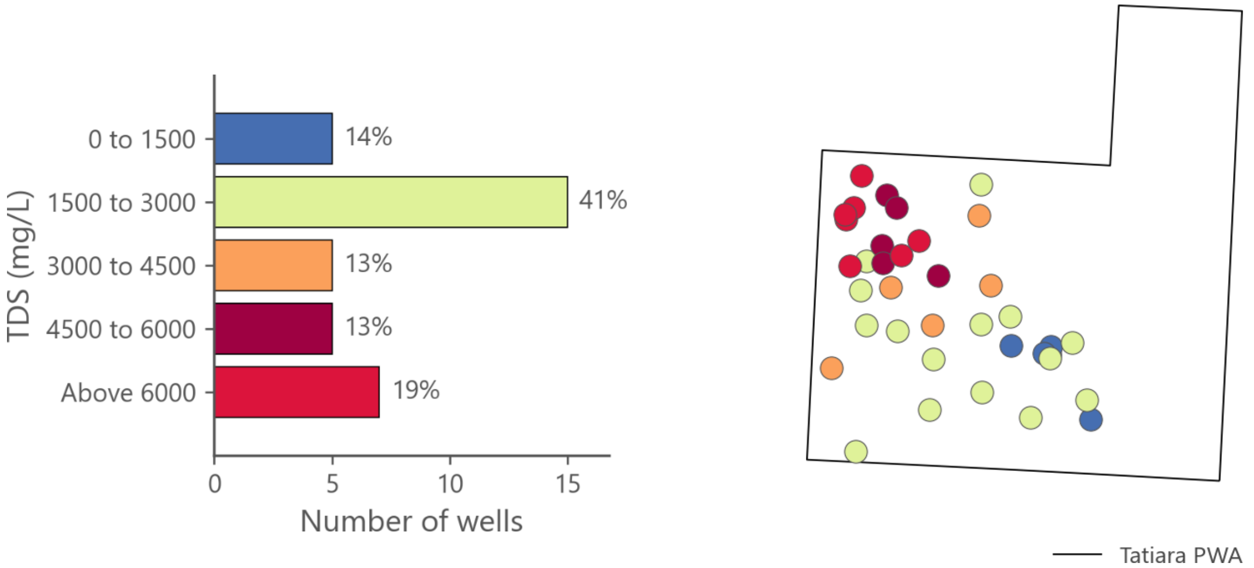


Figure 5.24. 2019 salinity observations from wells in the unconfined aquifer in the Tatiara PWA Plains area

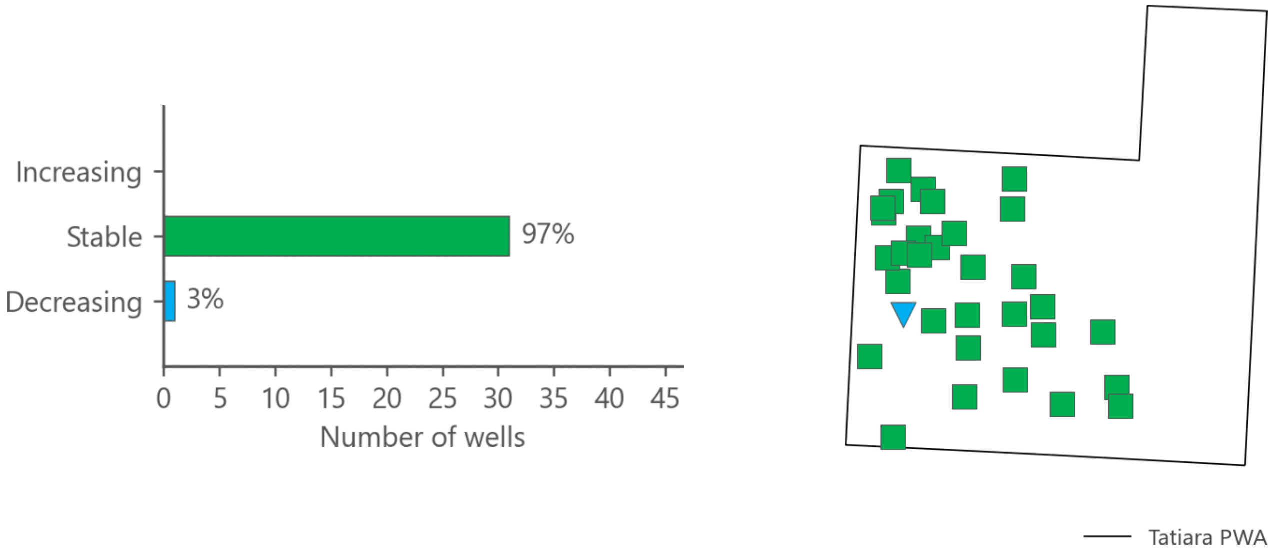


Figure 5.25. 2015–2019 trend in water salinity for wells in the unconfined aquifer in the Tatiara PWA Plains area

5.2.11 Tatiara PWA – Highlands area – water level

Following the 2018–19 irrigation season, all monitoring wells with long-term records were observed to have recovered water levels below the historical average, including 7 out of 24 wells (29%) which were at their lowest water level on record (Figure 5.26). These wells are spread throughout the eastern part of the Tatiara PWA. For wells with water level data over the last 30 years, 23 of 24 wells (96%) recorded declines in water level over that period. Changes ranged from a rise of 0.01 m to a decline of 2.07 m (median change is a decline of 0.17 m).

Five-year trends in water level are showing declining trends for 20 out of 23 wells (87%) wells, with rates of decline ranging from 0.02 to 0.09 m/y (median 0.04 m/y; Figure 5.27). The majority of the wells with declining trends are located in the northern part of the Tatiara PWA, where the depth to the watertable is greater than 30 m below ground surface.

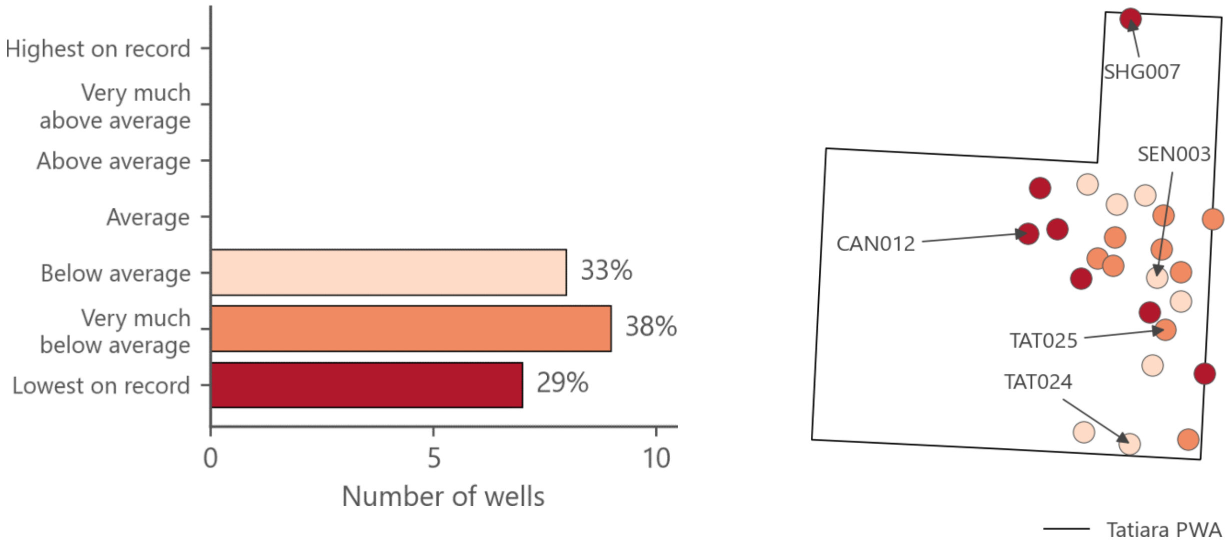


Figure 5.26. 2019 recovered water levels for wells in the unconfined aquifer in the Tatiara PWA Highlands area

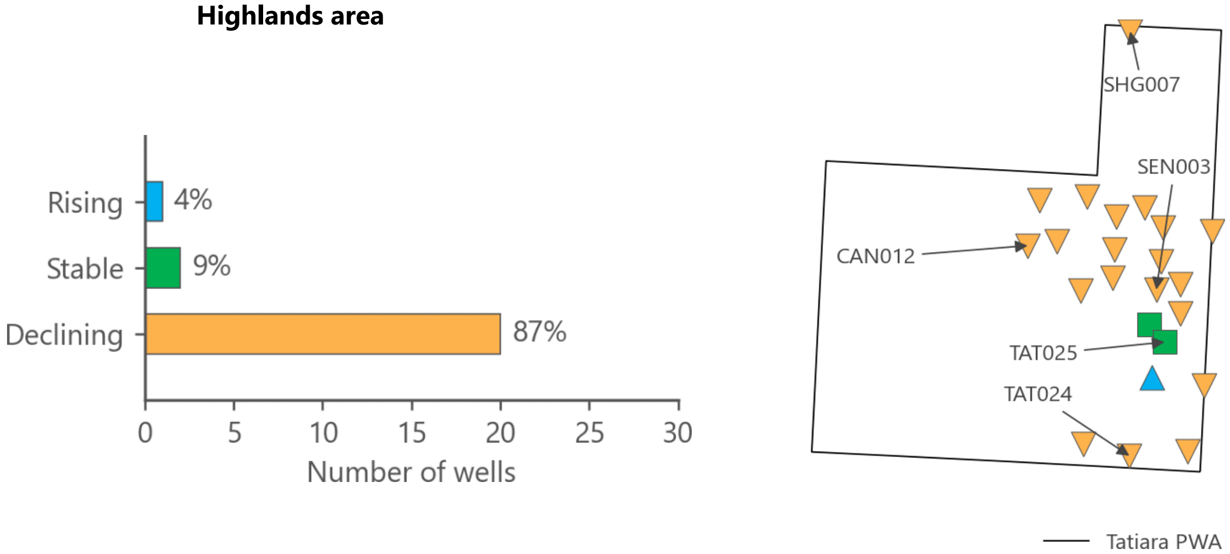


Figure 5.27. 2015–2019 trend in recovered water levels for wells in the unconfined aquifer in the Tatiara PWA Highlands area

In the unconfined aquifer beneath the Tatiara PWA Highlands, where the depth to the watertable is more than 10 m, groundwater levels are responding to different processes to those found on the plains to the west. The widespread clearance of native vegetation has resulted in increased recharge rates and rising groundwater levels across the Highlands zone throughout the 1980s and 1990s. A number of representative monitoring wells show this process in Figure 5.28, with gradual rises in water level (e.g. SEN003, SHG007, and TAT024) or generally stable levels in the first 20 years of their records (CAN012 and TAT025). A decrease in average annual rainfall following the early 2000s has led to declining water levels in most wells.

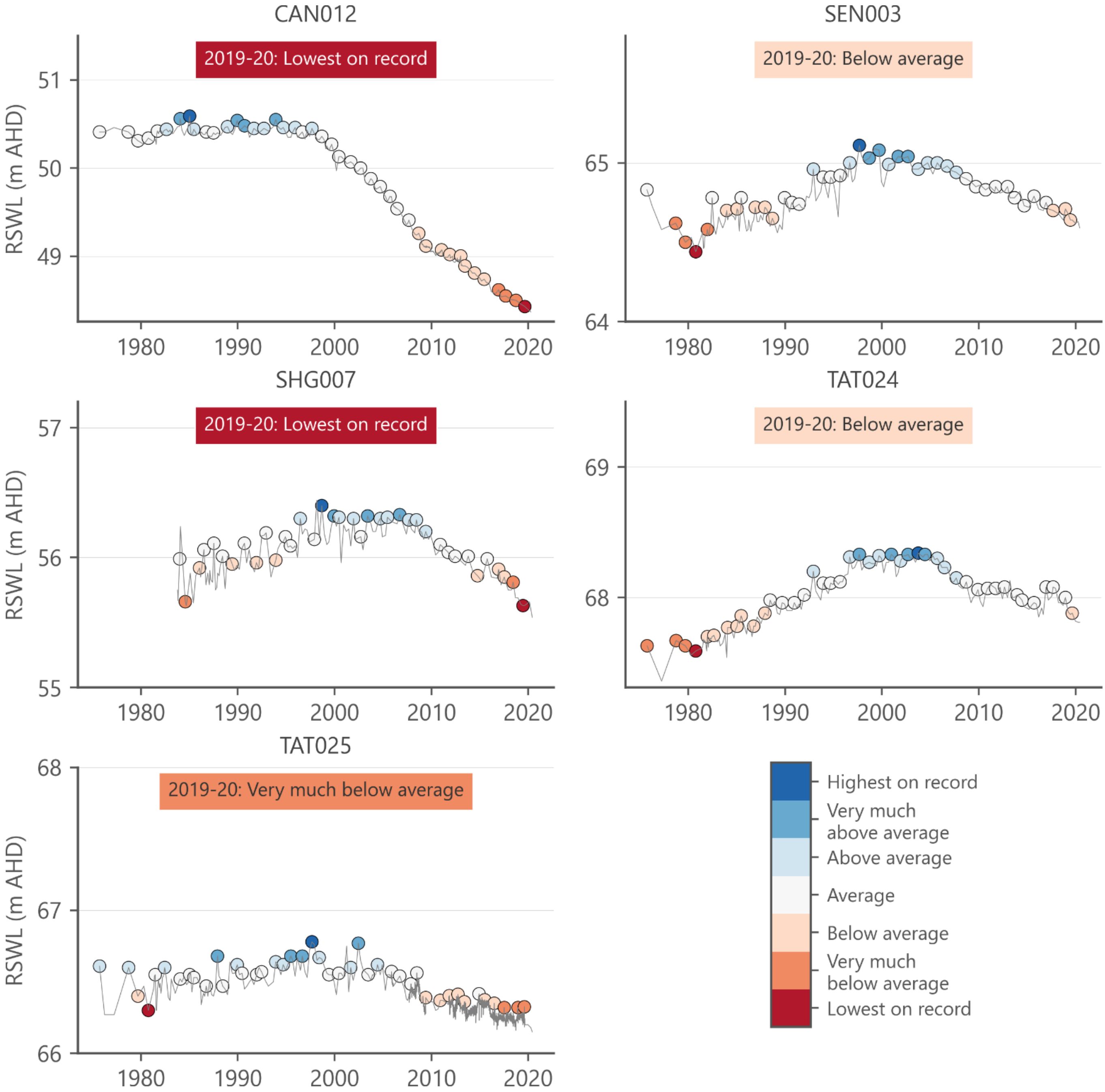
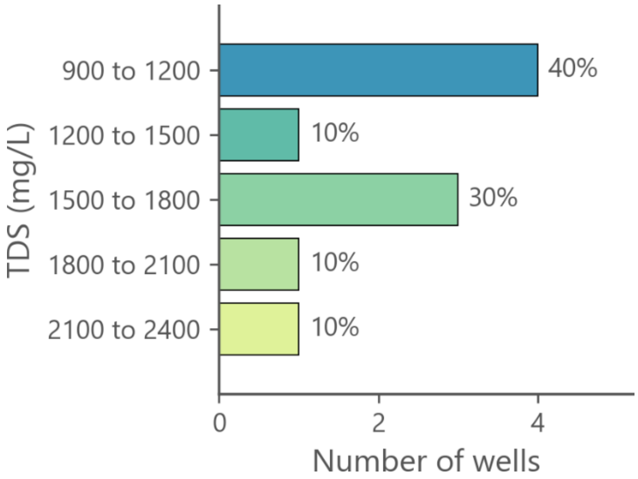


Figure 5.28. Selected hydrographs for wells in the unconfined aquifer in the Tatiara PWA Highlands area

5.2.12 Tatiara PWA – Highlands area – salinity

In 2019 the groundwater salinity ranged from 1019 mg/L to 2335 mg/L (median 1499 mg/L; Figure 5.29).

Five-year trends in water salinity are stable (i.e. less than 10% change over five years) in all nine monitoring wells with suitable datasets (Figure 5.30).



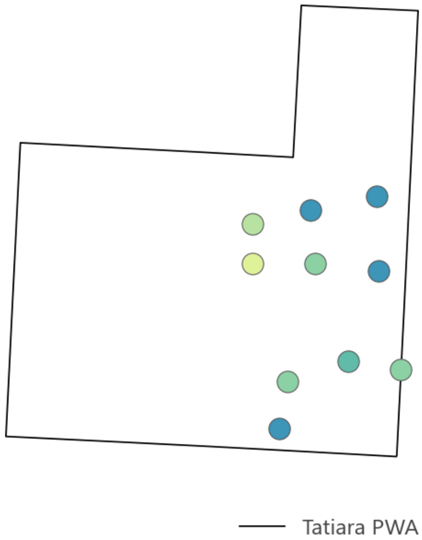
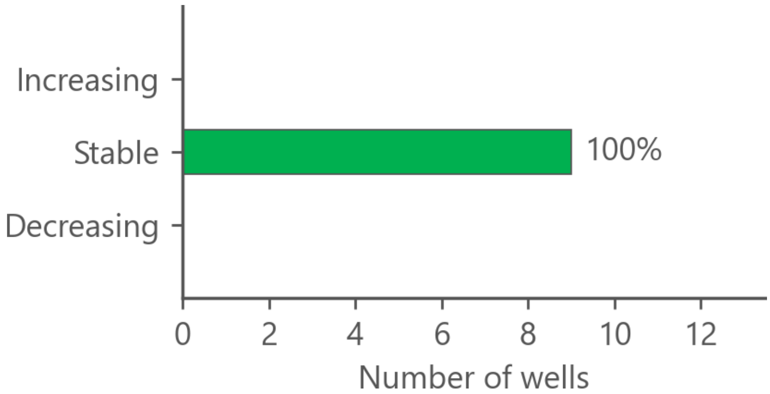


Figure 5.29. 2019 salinity observations from wells in the unconfined aquifer in the Tatiara PWA Highlands area



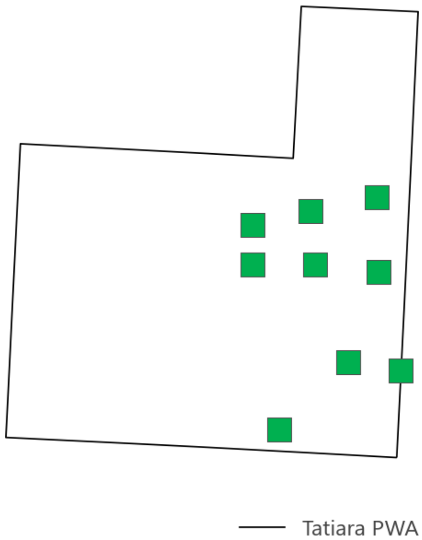


Figure 5.30. 2015–2019 trend in water salinity for wells in the unconfined aquifer in the Tatiara PWA Highlands area

5.2.13 Tintinara-Coonalpyn PWA – Plains area – water level

Following the 2018–19 irrigation season, the majority of monitoring wells were observed to have recovered water levels which were either below average compared to their historical record (14 wells; 50% of those with long-term records) or at their lowest level on record (9 wells; 32%; Figure 5.31). These wells are located in the central part of the Tintinara-Coonalpyn PWA, near an area of intensive groundwater extraction. The majority of wells (10 out of 12 wells; 83%) have declined in water level over the last 20 years, with changes overall ranging from a rise of 0.62 m to a decline of 3.73 m (median change is a decline of 0.90 m).

Five-year trends (2015–2019) are more variable, with declining water level trends occurring in 13 wells (57%) ranging from a decline of 0.02 m/y to 0.15 m/y (median 0.04 m/y; Figure 5.32). Six wells (26%) have stable water level trends and four wells (17%) have rising water level trends, ranging from rises of 0.03 m/y to 0.05 m/y (median 0.05 m/y).

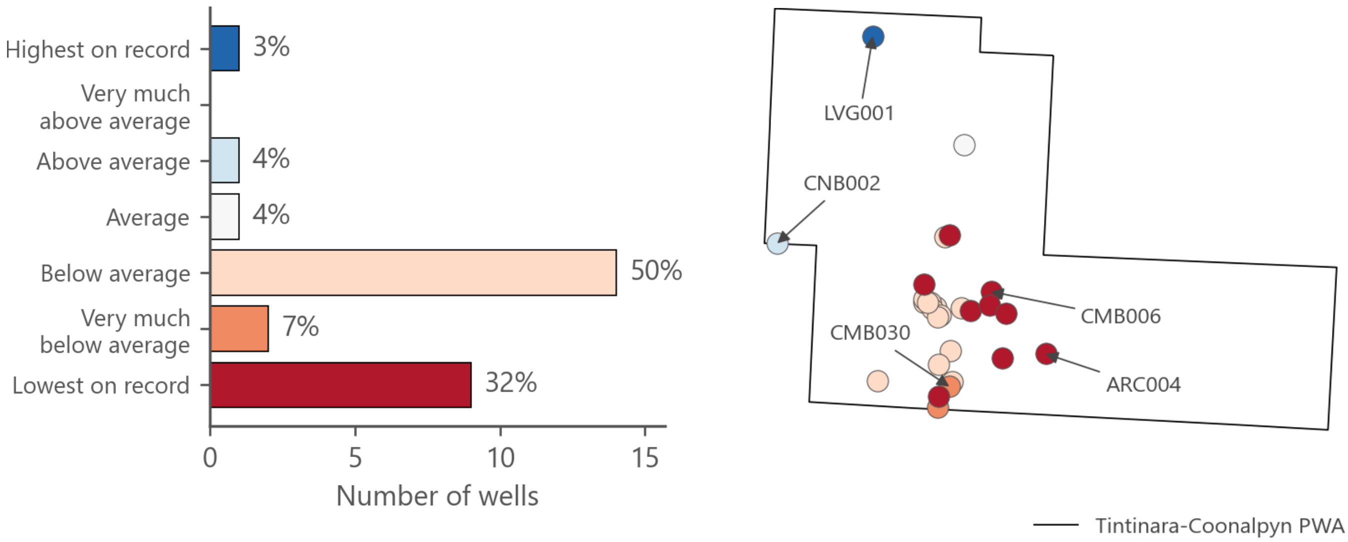


Figure 5.31. 2019 recovered water levels for wells in the unconfined aquifer in the Tintinara-Coonalpyn PWA Plains area

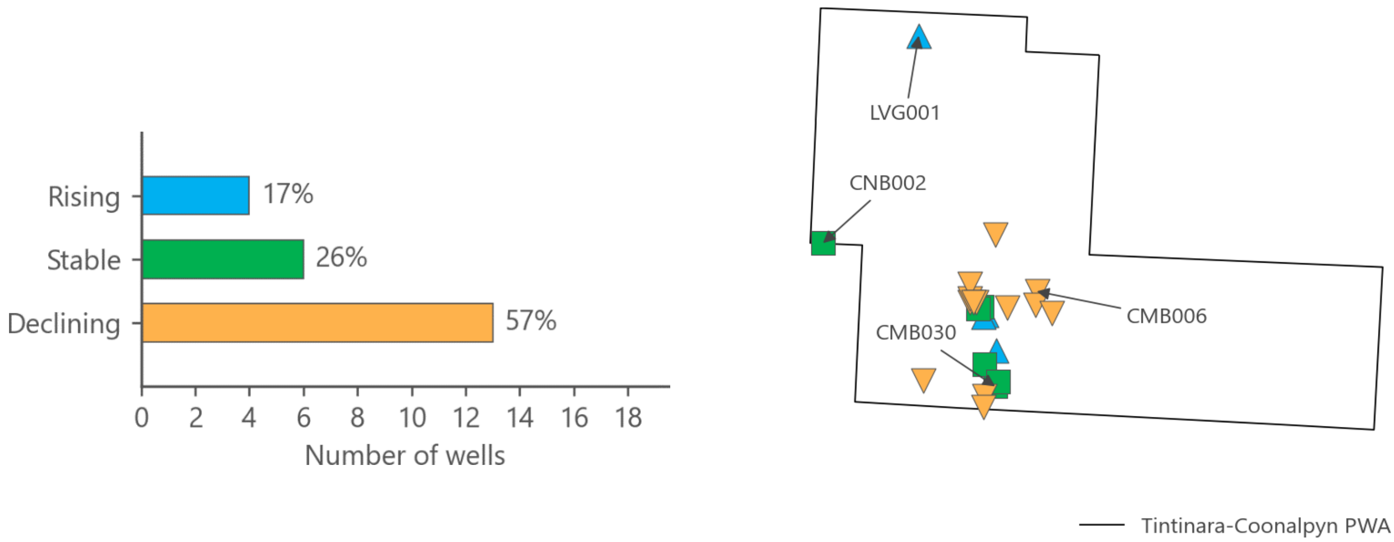


Figure 5.32. 2015–2019 trend in recovered water levels for wells in the unconfined aquifer in the Tintinara-Coonalpyn PWA Plains area

The shallow depth to the watertable of 5 to 10 m in the unconfined aquifer on the low-lying plains results in the groundwater level trends being very responsive to rainfall. Representative monitoring wells ARC004 and CMB006 show a declining trend in water levels since 1996 that corresponds with an increase in extraction and a prolonged period of below-average rainfall, particularly since 2004-05 (Figure 5.33). Monitoring well CMB030 shows large seasonal fluctuations as a response to groundwater extraction and rainfall events; the depth to water in the well is less than 2 m (Figure 5.33).

Water levels in LVG001, at the northern edge of the Tintinara-Coonalpyn PWA plains area, show a gradual rise in water level at a rate of 0.08 m/y since 1987, which is likely due to the widespread clearance of native vegetation that resulted in increased recharge rates (Figure 5.33).

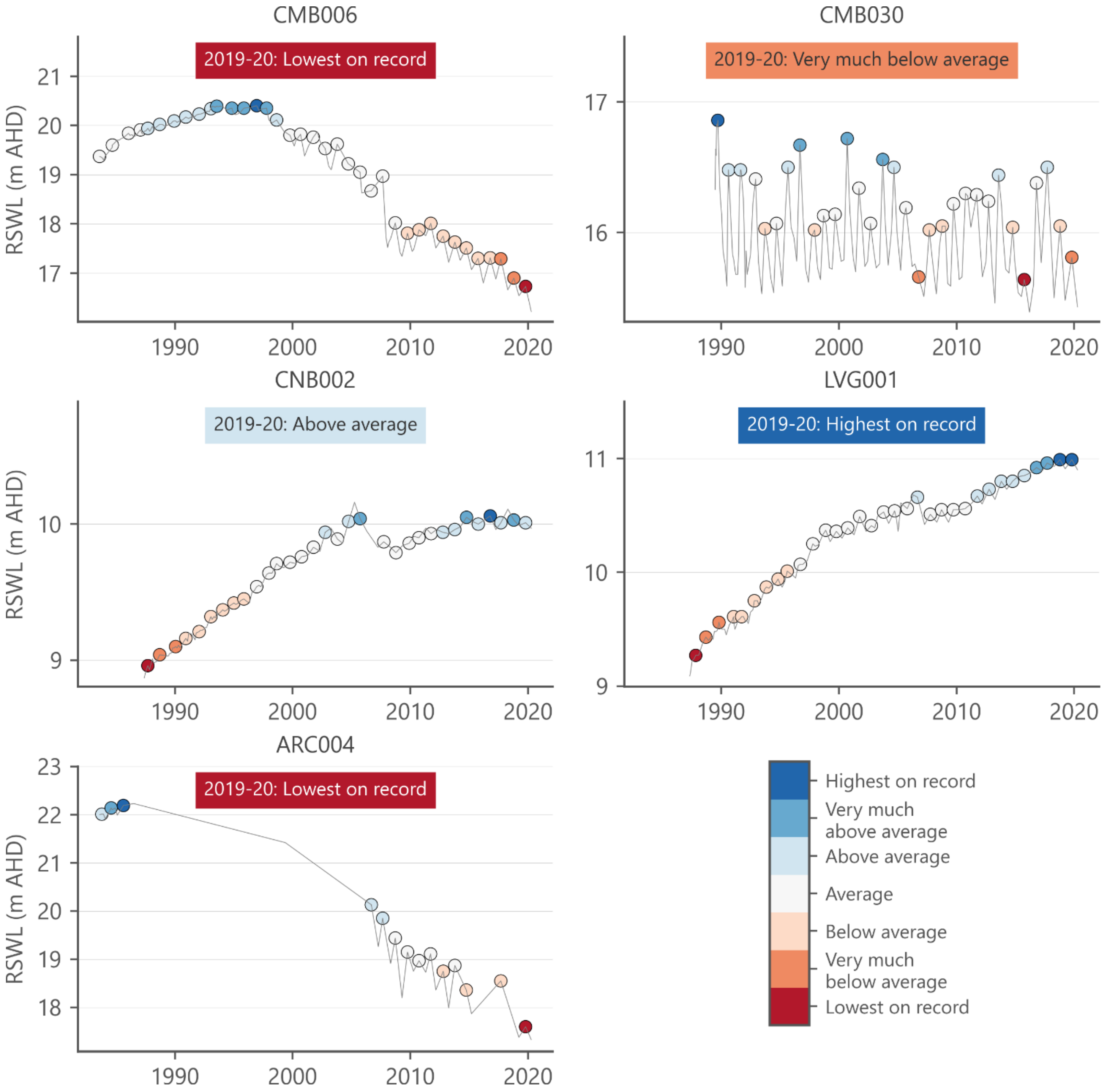


Figure 5.33. Selected hydrographs for wells in the unconfined aquifer in the Tintinara-Coonalpyn PWA Plains area

5.2.14 Tintinara-Coonalpyn PWA – Mallee Highlands area – water level

Following the 2018–19 irrigation season, all monitoring wells with long-term records were below their average water level on record, with five (63%) of these wells at their lowest level on record (Figure 5.34). Those wells at their lowest recovered level on record are in the easternmost part of the Tintinara-Coonalpyn PWA. All wells with suitable records have declined in water level over the last 20 years, with declines over that period ranging from 0.39 m to 2.11 m (median 1.22 m).

Five-year trends (2015–2019) in water levels are showing declining trends for most wells (seven out of eight; 87%) at rates of decline ranging from 0.05 m/y to 0.20 m/y (median 0.14 m/y; Figure 5.35). These wells are located close to an area of intensive irrigation.

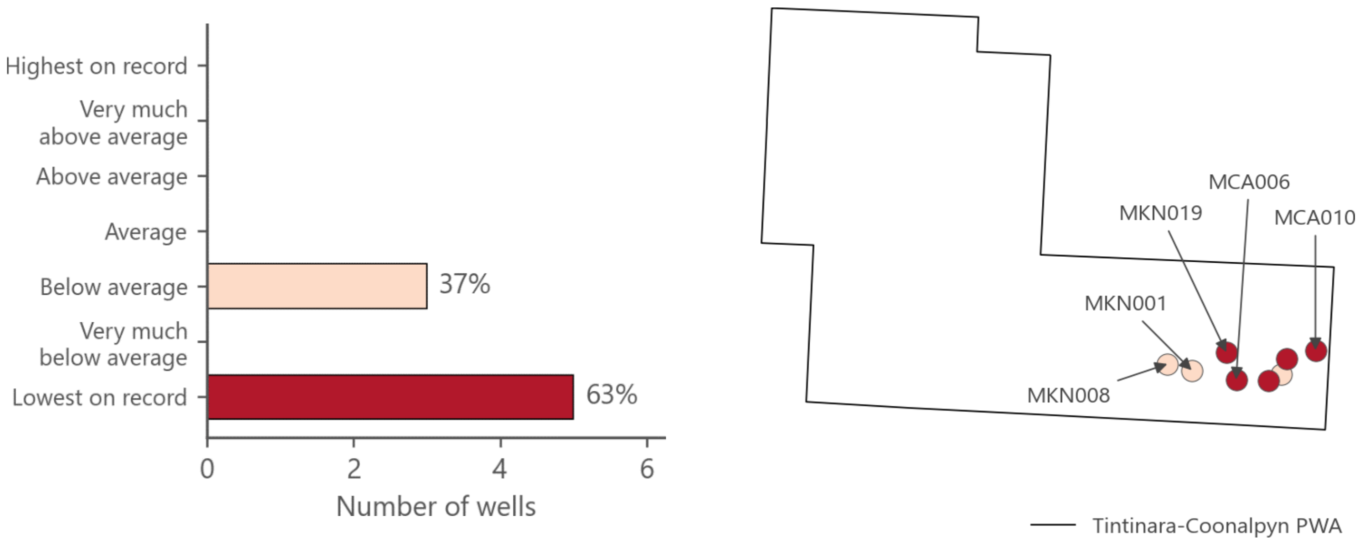


Figure 5.34. 2019 recovered water levels for wells in the unconfined aquifer in the Tintinara-Coonalpyn PWA Mallee Highlands area

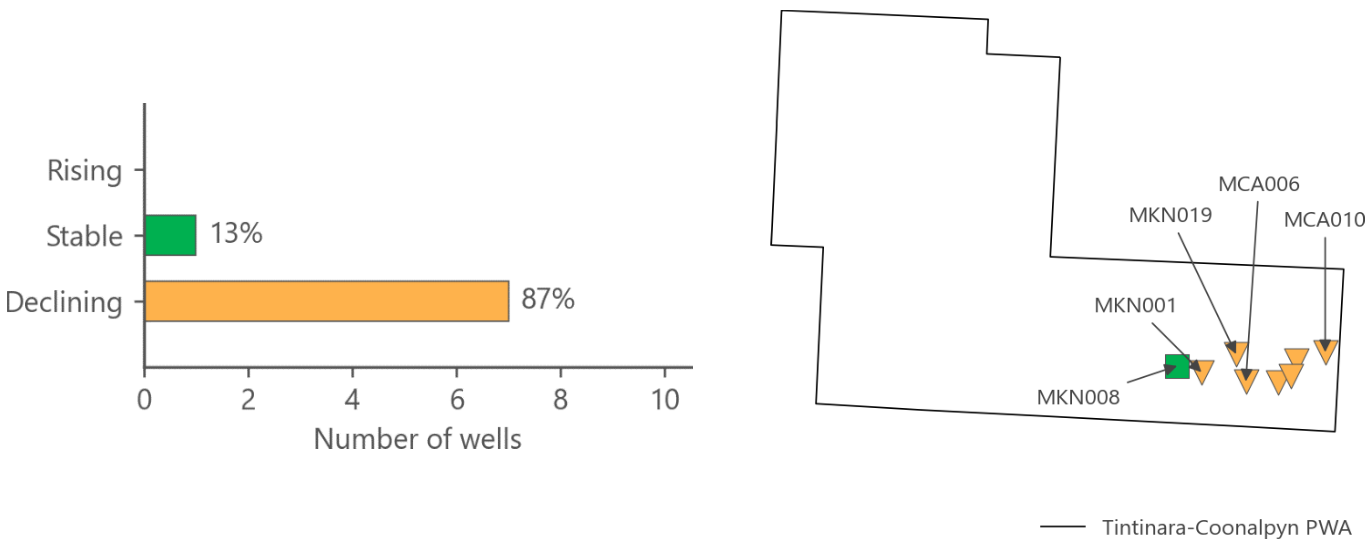


Figure 5.35. 2015–2019 trend in recovered water levels for wells in the unconfined aquifer in the Tintinara-Coonalpyn PWA Mallee Highlands area

A number of representative wells from the easternmost highlands area of the Tintinara-Coonalpyn PWA are shown below in Figure 5.36. Historical changes in water levels follow a similar pattern to wells in the neighbouring Tatiara PWA highlands area, with a generally rising water level from the early 1980s to the late 1990s, following the widespread clearance of native vegetation, which resulted in increased recharge rates (e.g. MKN019 and MKN008).

Declining water level trends have been occurring in the area since the early 2000s (Figure 5.36, likely caused by a decrease in average annual rainfall (Figure 3.9).

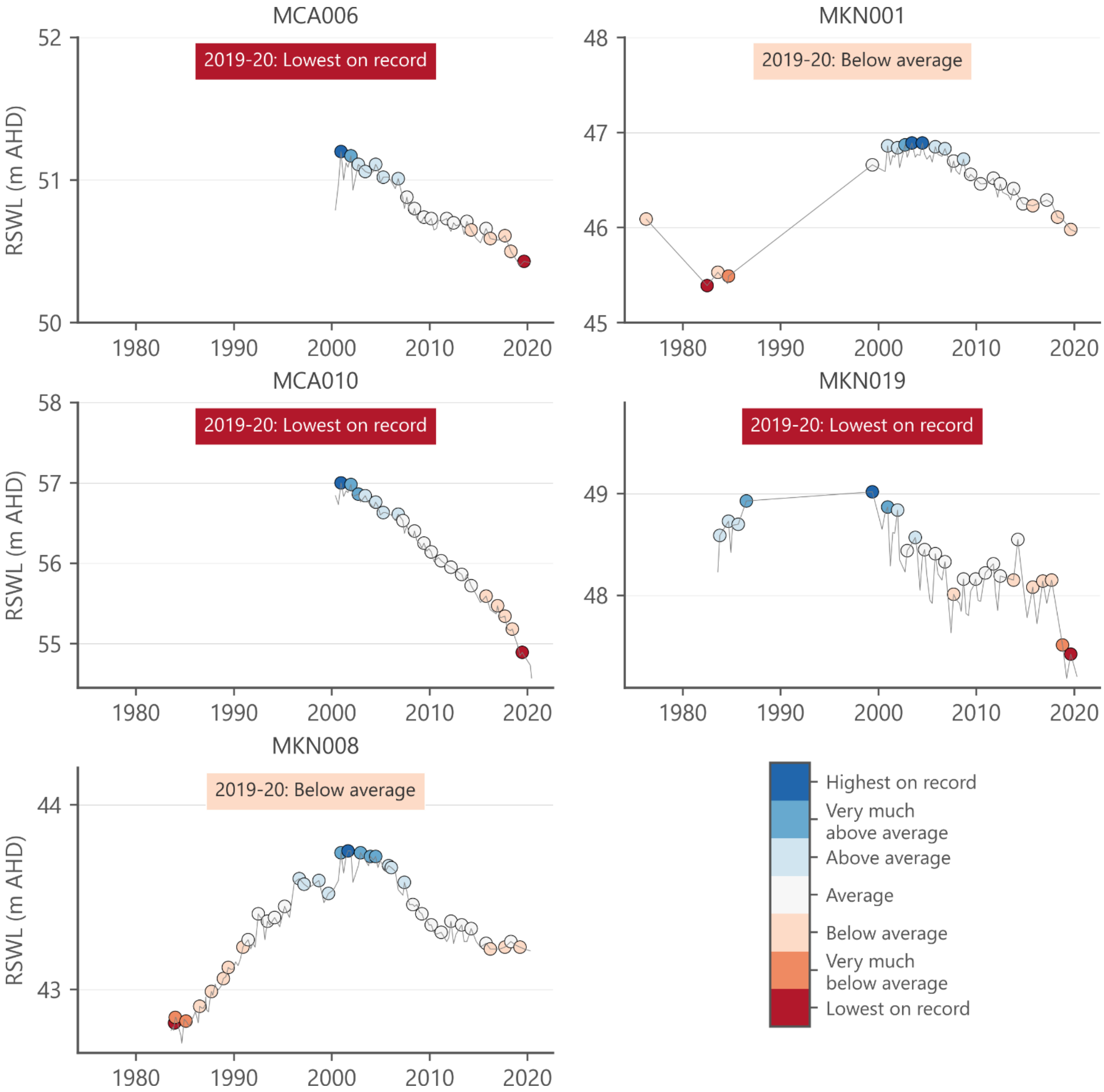
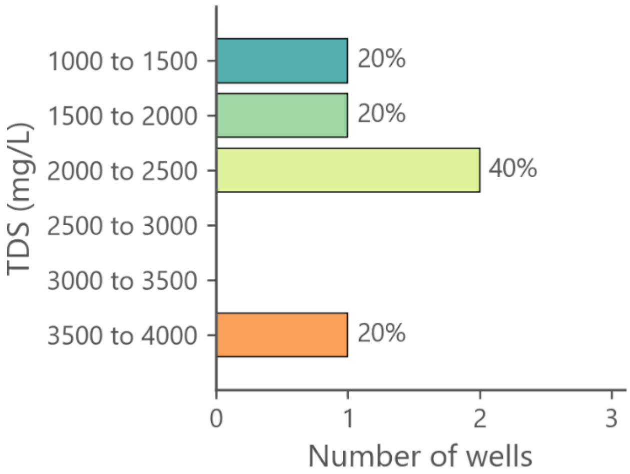


Figure 5.36. Selected hydrographs for wells in the unconfined aquifer in the Tintinara-Coonalpyn PWA Mallee Highlands area

5.2.15 Tintinara-Coonalpyn PWA – salinity

In 2019 the groundwater salinity ranged from 1285 mg/L to 3692 mg/L (median 2177 mg/L; Figure 5.37).

Five-year trends in water salinity were stable in the two wells with suitable records (Figure 5.38).



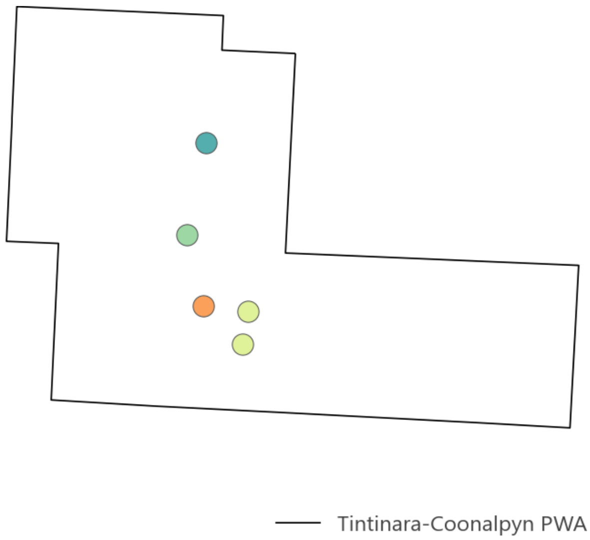
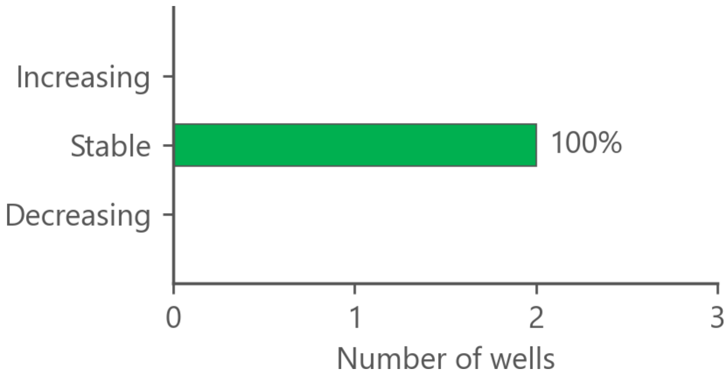


Figure 5.37. 2019 salinity observations from wells in the unconfined aquifer in the Tintinara-Coonalpyn PWA



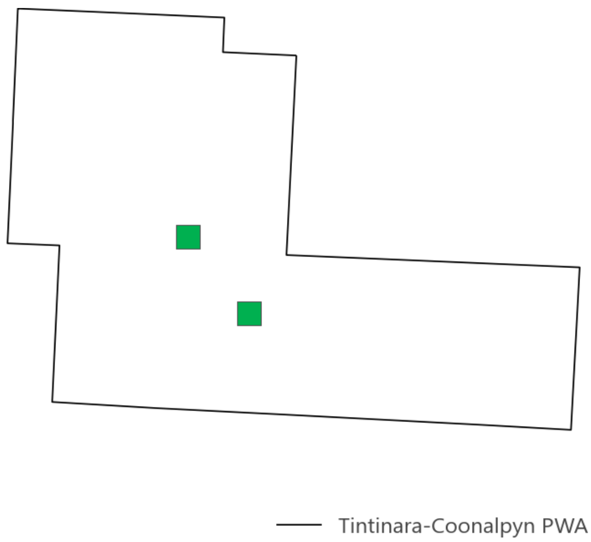


Figure 5.38. 2015–2019 trend in water salinity for wells in the unconfined aquifer in the Tintinara-Coonalpyn PWA

5.3 Confined aquifer

5.3.1 Lower Limestone Coast PWA – confined aquifer – water level

Following the 2018–19 irrigation season, 40 monitoring wells (46% of those with long-term records) were observed to have average recovered water levels compared to historic levels, with 25% of wells having above-average recovered water levels and 15% of wells having below-average recovered water levels (Figure 5.39). In general, most wells with above-average levels are in the north-western part of the PWA around Kingston SE and Robe, where the confined aquifer is artesian and more water is taken from the aquifer for irrigation. Wells with recovered water levels which are below average and lowest on record are generally near the eastern and northern margins of the PWA, where the confined aquifer is less frequently used.

Changes in water level over the past 30 years are varied, with 65% of wells declining over that period (overall median change was a decline of 0.40 m). Five-year water level trends (2015–2019) are rising for 69 wells (76%), with rates of rise ranging from 0.02 to 0.30 m/y (median rise of 0.06 m/y) and declining for 14 wells (15%), at rates of decline ranging from 0.02 to 0.49 m/y (median decline of 0.05 m/y; Figure 5.40).

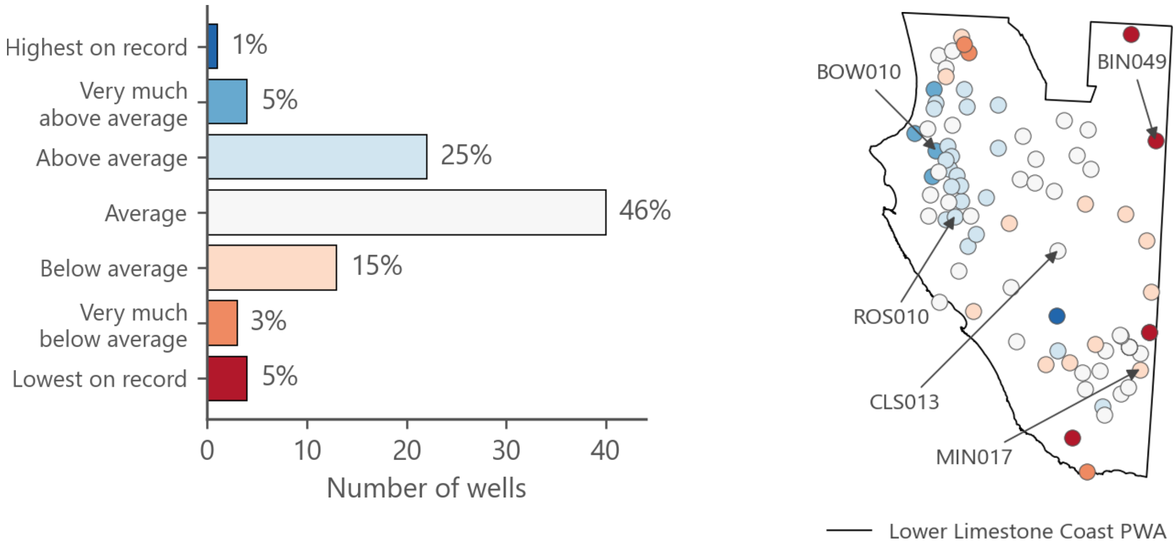


Figure 5.39. 2019 recovered water levels for wells in the confined aquifer in the Lower Limestone Coast PWA

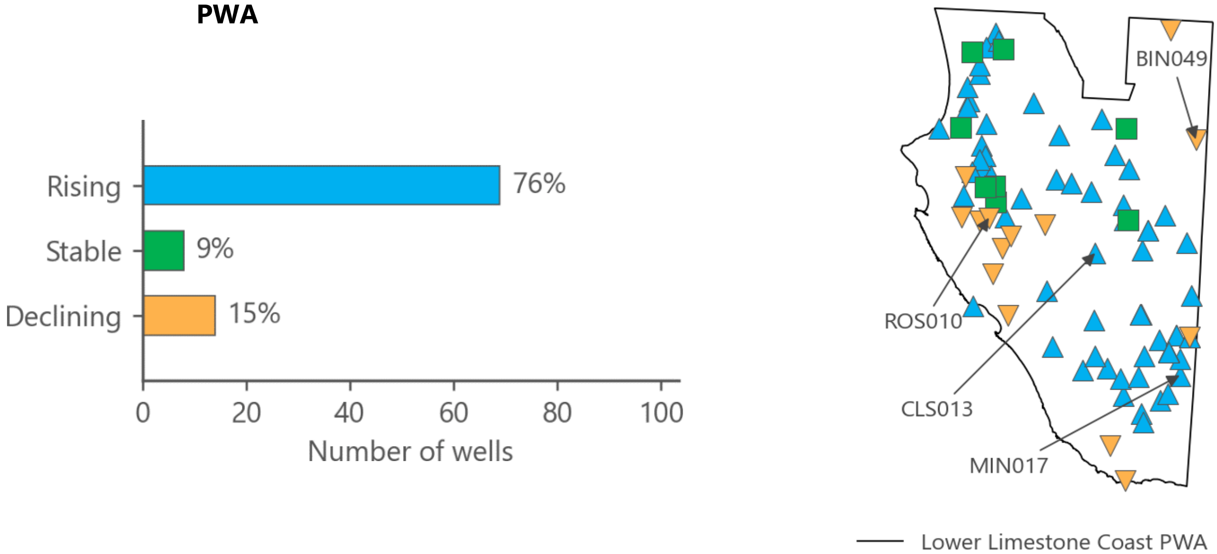


Figure 5.40. 2015–2019 trend in recovered water levels for wells in the confined aquifer in the Lower Limestone Coast PWA

The major area of extraction from the confined aquifer in the Lower Limestone Coast PWA is in the central artesian area, inland between Kingston SE and Beachport (BOW010 and ROS010; Figure 5.41). Outside of this area there is generally limited extraction, except for some town water supplies and some irrigation south of Mount Gambier. Seasonal changes in water level can be seen in monitoring wells located near areas of extraction, such as BOW010 and ROS010, and in CLS013 (Figure 5.41). In these areas water levels have generally risen slightly since 2010.

Outside the areas of irrigation extraction, there is no direct recharge from rainfall, with trends in confined aquifer water levels generally stable prior to 1993 and generally declining since then. These trends are likely to be caused by the process of hydrostatic loading, where a declining amount of water in storage in the overlying unconfined aquifer causes less weight on the confining layer and in turn this reduces the hydrostatic pressure in the underlying confined aquifer. An example is MIN017 (Figure 5.41), which shows similar overall trends to the nearby NAN009 in the unconfined aquifer (Figure 5.3).

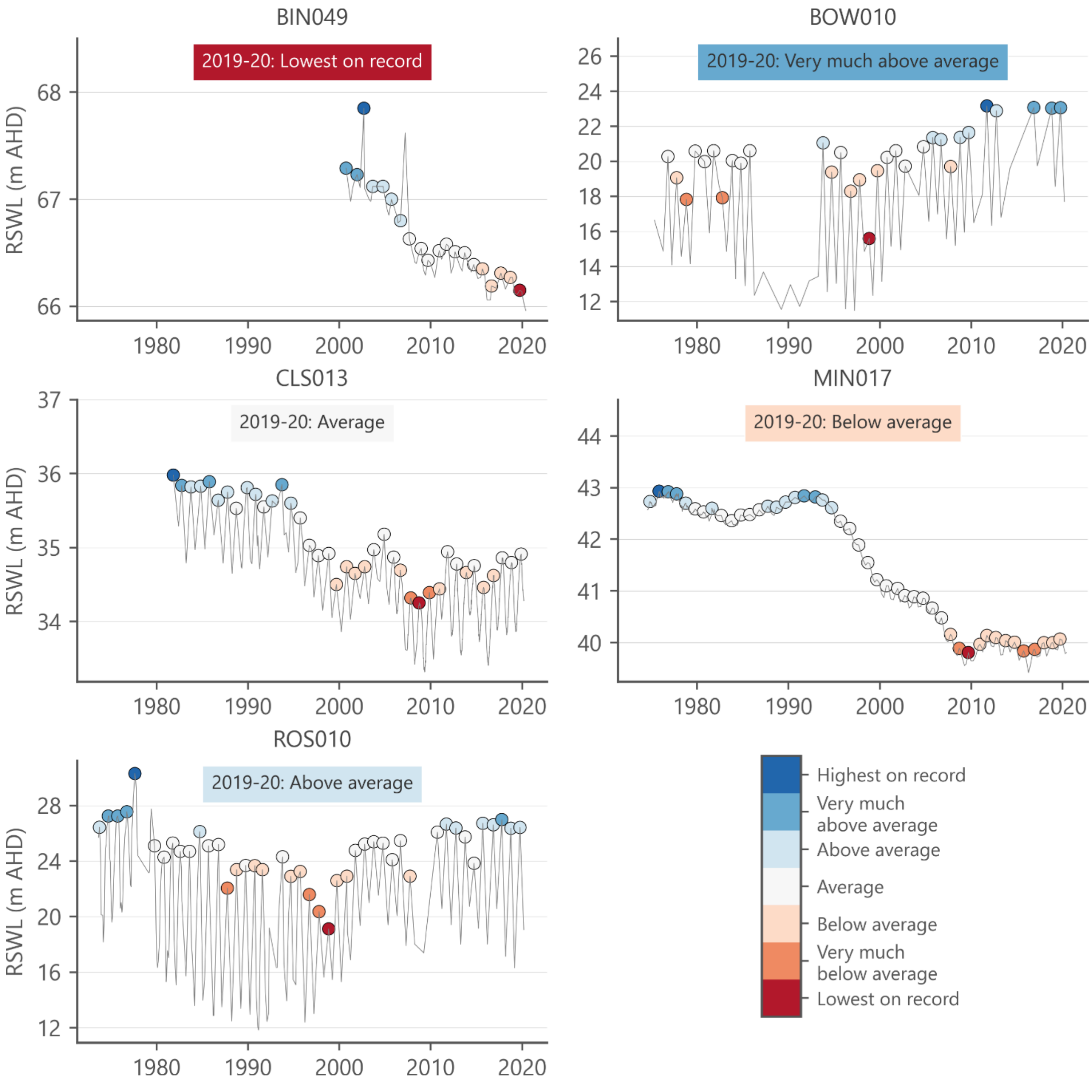


Figure 5.41. Selected hydrographs for wells in the confined aquifer in the Lower Limestone Coast PWA

5.3.2 Padthaway PWA – confined aquifer – water level

The confined aquifer is generally absent or thin over much of the Padthaway PWA and is not utilised as a water resource. Limited data are available, as there are only three confined aquifer monitoring wells in the area. In 2019 two of these wells were below their average water level compared to their historic record (Figure 5.42). Over the past 30 years, water levels have declined in all three wells, with declines ranging from 1.63 to 2.14 m.

Five-year trends (2015–2019) in water levels are showing rising trends for all three wells, ranging from 0.26 to 0.29 m/y (median 0.28 m/y; Figure 5.43).

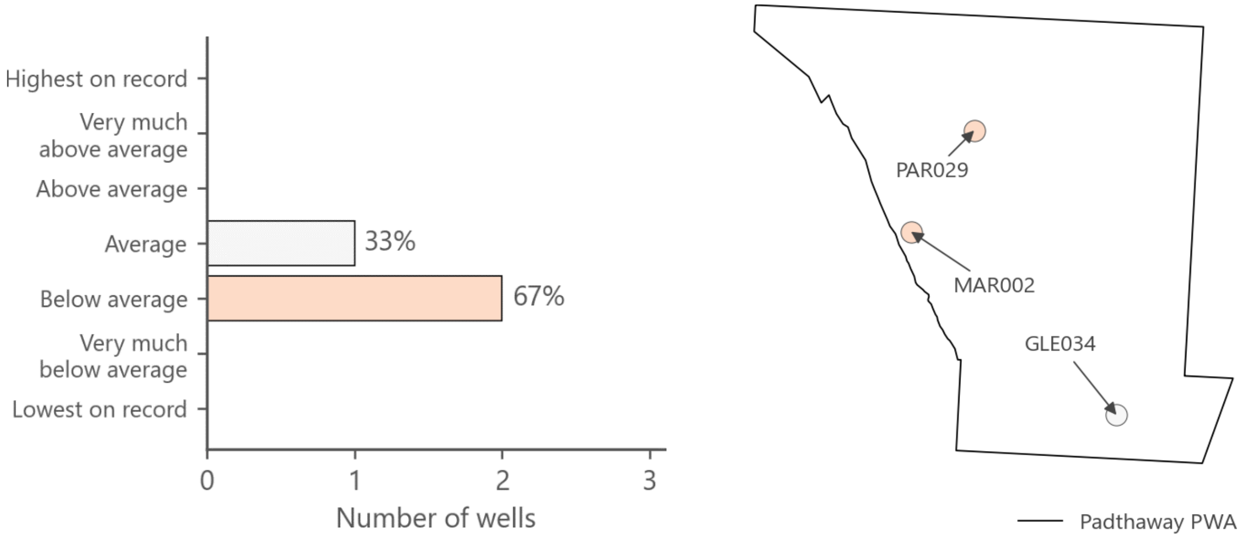


Figure 5.42. 2019 recovered water levels for wells in the confined aquifer in the Padthaway PWA

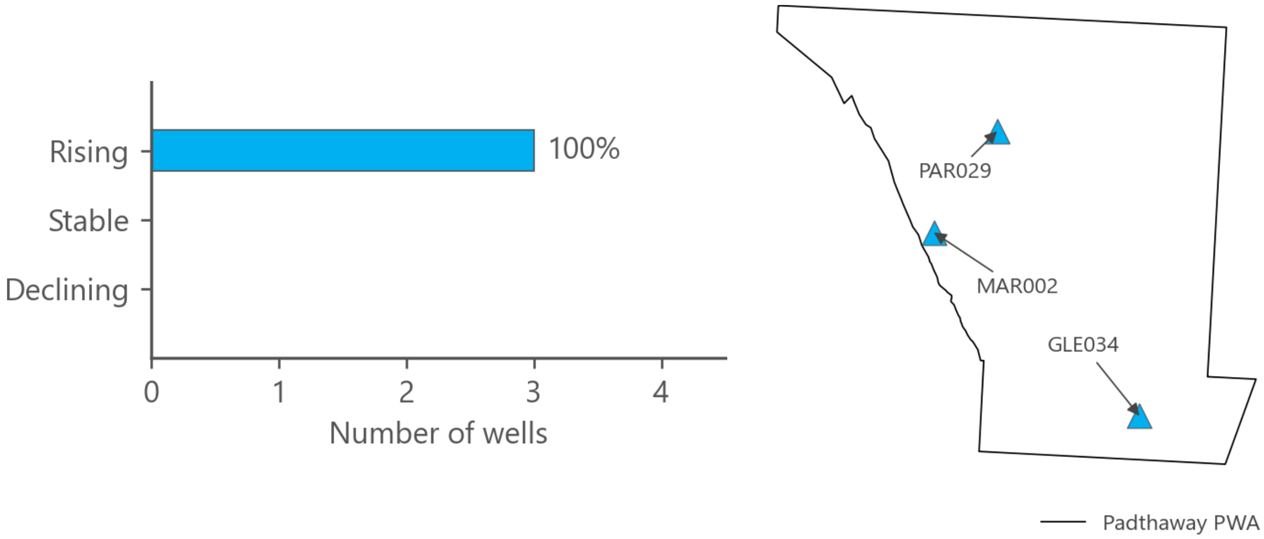


Figure 5.43. 2015–2019 trend in recovered water levels for wells in the confined aquifer in the Padthaway PWA

Long-term observations of the confined aquifer indicate that the groundwater elevation is declining at variable rates. All three monitoring wells in the Padthaway PWA are showing signs of recovery since 2009 (Figure 5.44). The trends in the confined water level are similar to the trends in the Padthaway Flats unconfined aquifer (Figure 5.13), which could be due to the hydrostatic loading effect, where water level trends in the underlying confined aquifer are affected by changes in the watertable in the overlying, unconfined aquifer.

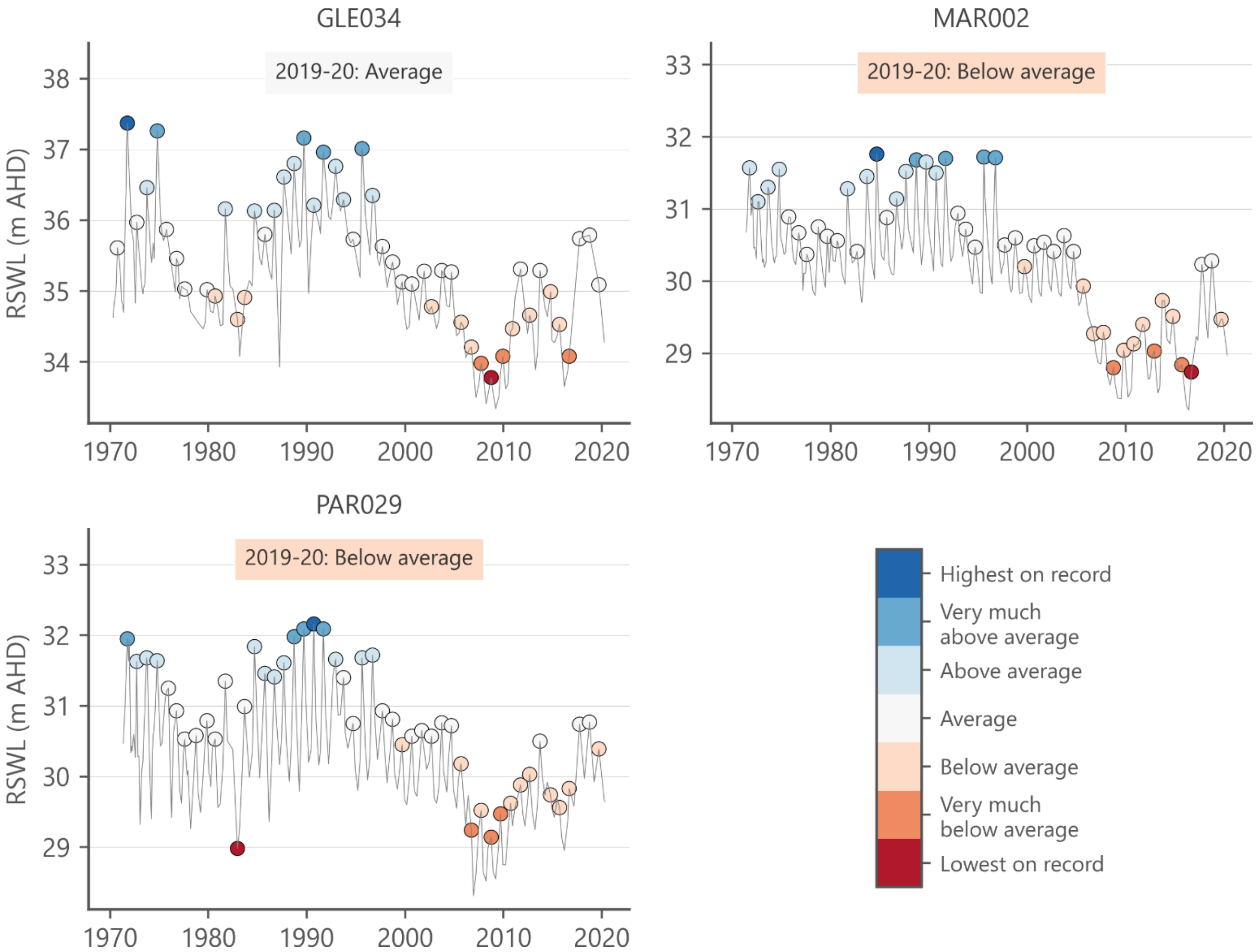


Figure 5.44. **Selected hydrographs for wells in the confined aquifer in the Padthaway PWA**

5.3.3 Lower Limestone Coast and Padthaway PWAs – confined aquifer salinity

In 2019, the groundwater salinity ranged from 614 mg/L to 1166 mg/L in the Lower Limestone Coast PWA (median 687 mg/L; Figure 5.45). The majority of wells (81%) have a salinity of less than 800 mg/L. These are primarily around the area of intensive irrigation inland from Beachport and Kingston SE.

Five-year trends are stable, with no wells recording a change of greater than 10% over a five year period (Figure 5.46).

There is one confined aquifer monitoring well in the Padthaway PWA (MAR002) which has been sampled in 2019 at 4326 mg/L and the five-year trend shows that salinity is increasing at a rate of 33% over the past five years.

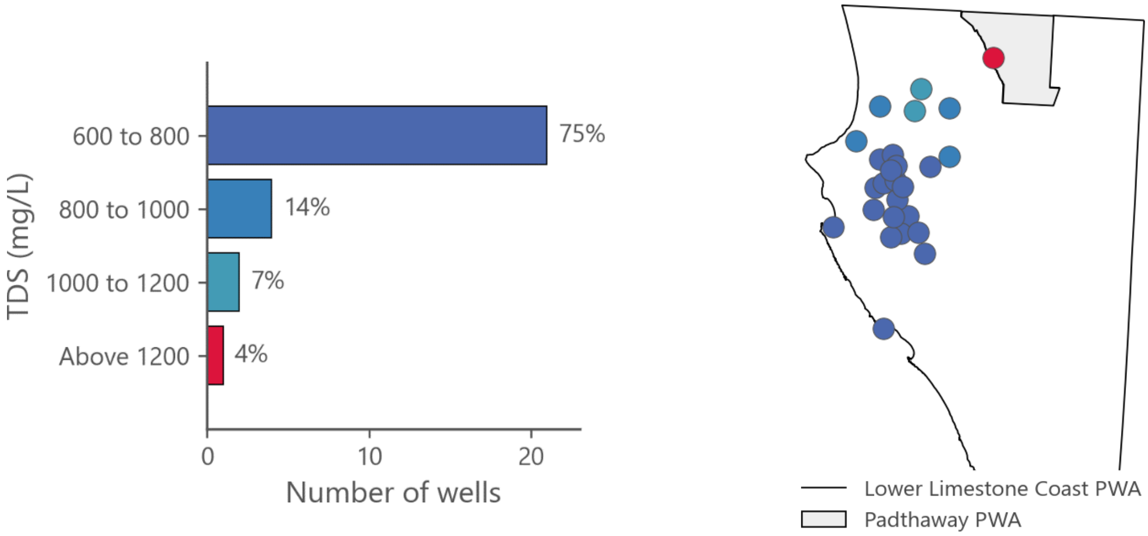


Figure 5.45. 2019 salinity observations from wells in the confined aquifer in the Lower Limestone Coast and Padthaway PWAs

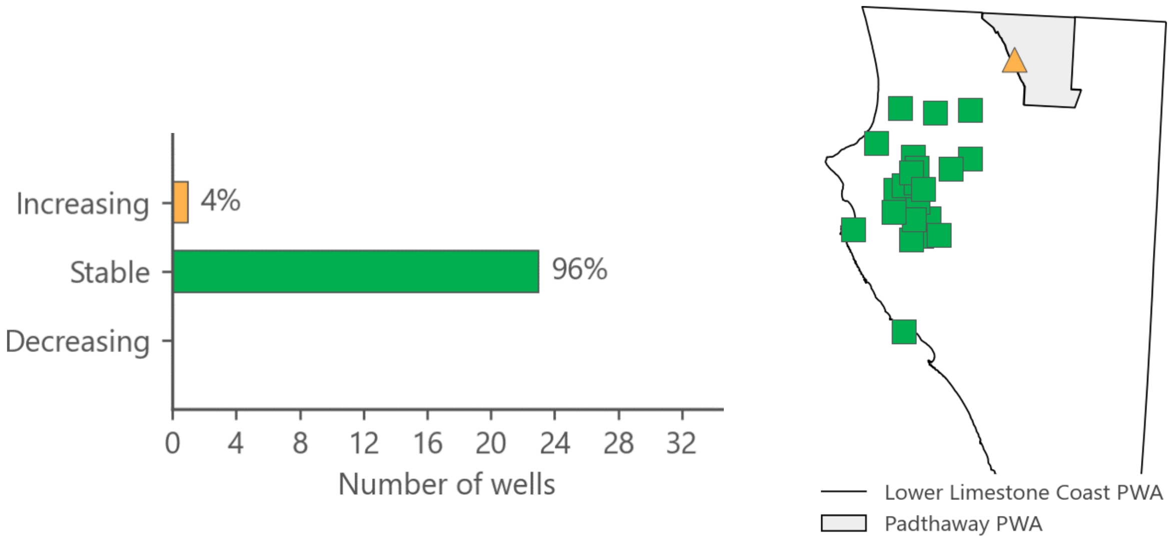


Figure 5.46. 2015–2019 trend in water salinity for wells in the confined aquifer in the Lower Limestone Coast and Padthaway PWAs

5.3.4 Tatiara PWA – confined aquifer – water level

In 2019, recovered water levels in all five monitoring wells in the confined aquifer with long-term records were below their historical average, with two wells (40%) at their lowest recovered water level on record (Figure 5.47). Those wells which are lowest on record are on the eastern margin of the PWA. All wells have declined over the past 20 years, with changes ranging from declines of 0.76 to 2.74 m (median change is a decline of 2.66 m).

Five-year trends (2015–2019) in water levels are more variable, with two wells in the western part of the PWA showing rising trends (0.03 to 0.07 m/y) and the two lowest on record wells in the north-eastern and south-eastern parts of the PWA showing declining trends (0.05 to 0.06 m/y; Figure 5.48).

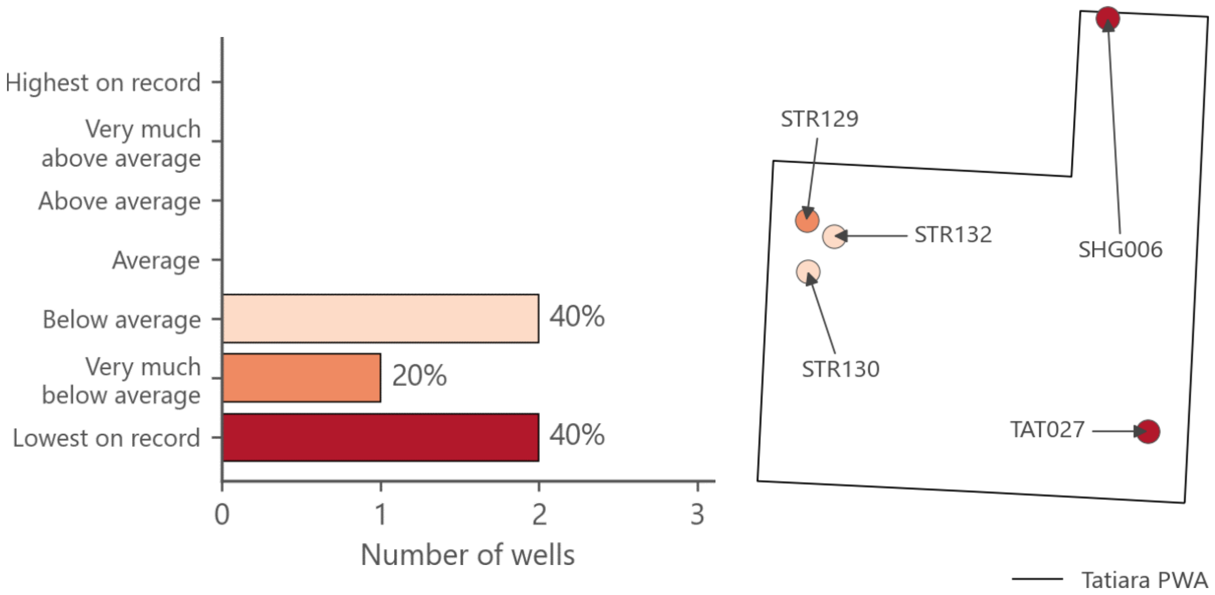


Figure 5.47. 2019 recovered water levels for wells in the confined aquifer in the Tatiara PWA

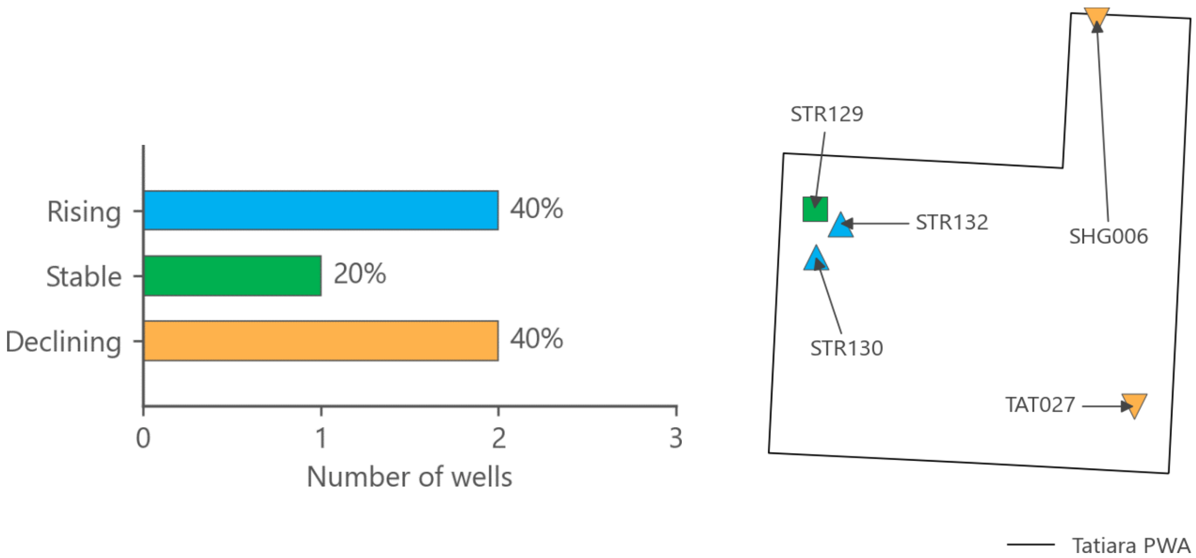


Figure 5.48. 2015–2019 trend in recovered water levels for wells in the confined aquifer in the Tatiara PWA

The groundwater level trends observed in the confined aquifer (Figure 5.49) are very similar to those observed in the overlying unconfined aquifer in both the plains (STR129, STR130, and STR132; Figure 5.23) and highlands areas (SHG006 and TAT027; Figure 5.28).

There is only a small amount of extraction from the confined aquifer in the Tatiara PWA, and no direct recharge from rainfall. The similarity of confined aquifer trends to those observed in the overlying unconfined aquifer in the plains area (Figure 5.23) could be due to the hydrostatic loading effect, where water level trends in the underlying confined aquifer are affected by changes in the watertable in the overlying unconfined aquifer,

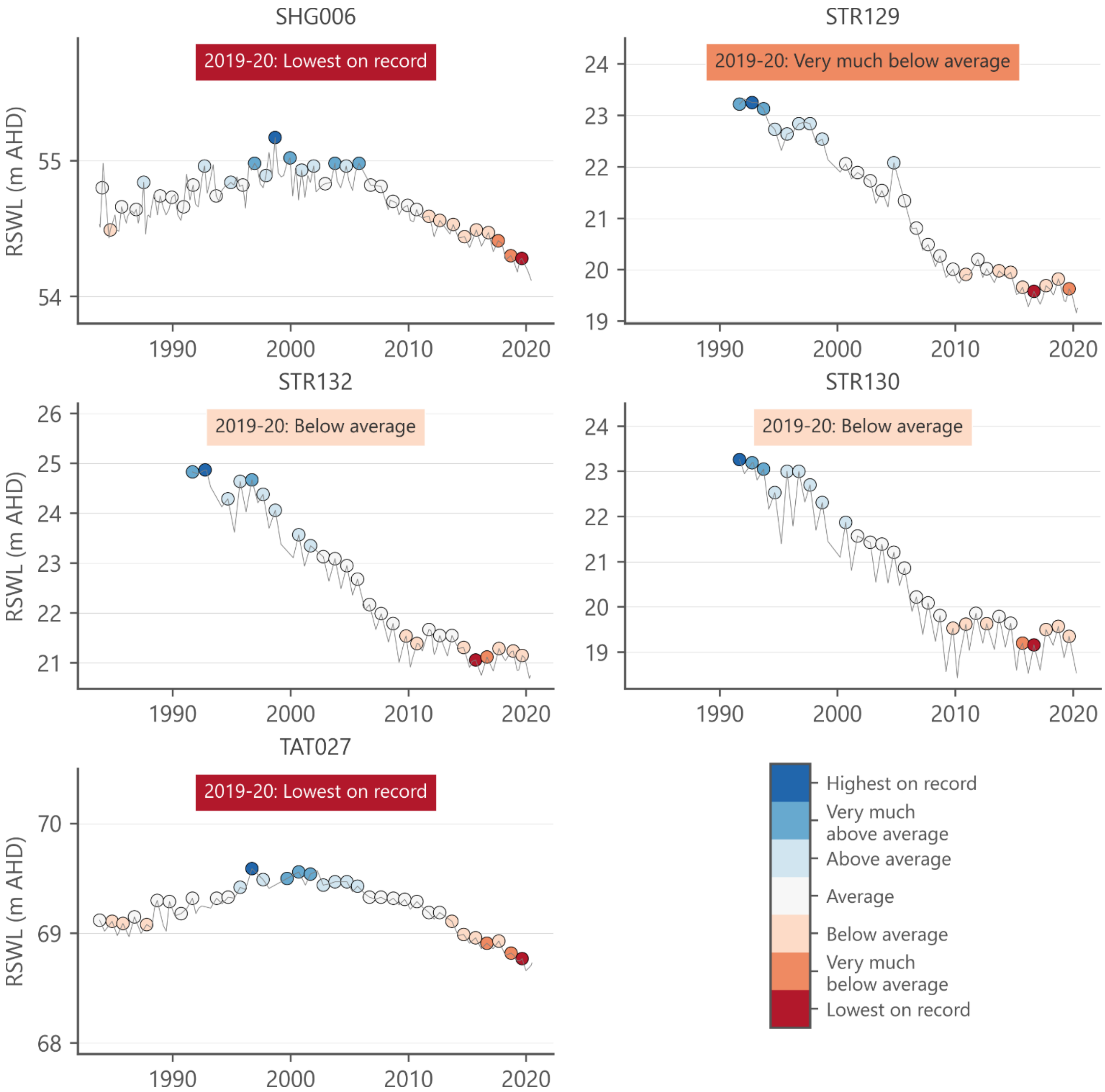


Figure 5.49. Selected hydrographs for wells in the confined aquifer in the Tatiara PWA

5.3.5 Tintinara-Coonalpyn PWA – confined aquifer – water level

Following the 2018–19 irrigation season, 25 monitoring wells (83% of those with long-term records) were observed to have recovered water levels below their historic average, with 9 wells (31%) at their lowest water level on record (Figure 5.50). All wells with 20 years of data have declined over that period, with changes ranging from declines of 0.52 m to 17.97 m (the median change is a decline of 4.93 m).

Five-year trends (2015–2019) in water levels show similar changes, with declining trends seen in 22 out of 27 wells (81%) with rates of decline in those wells ranging from 0.03 m/y to 1.08 m/y (median 0.29 m/y; Figure 5.51).

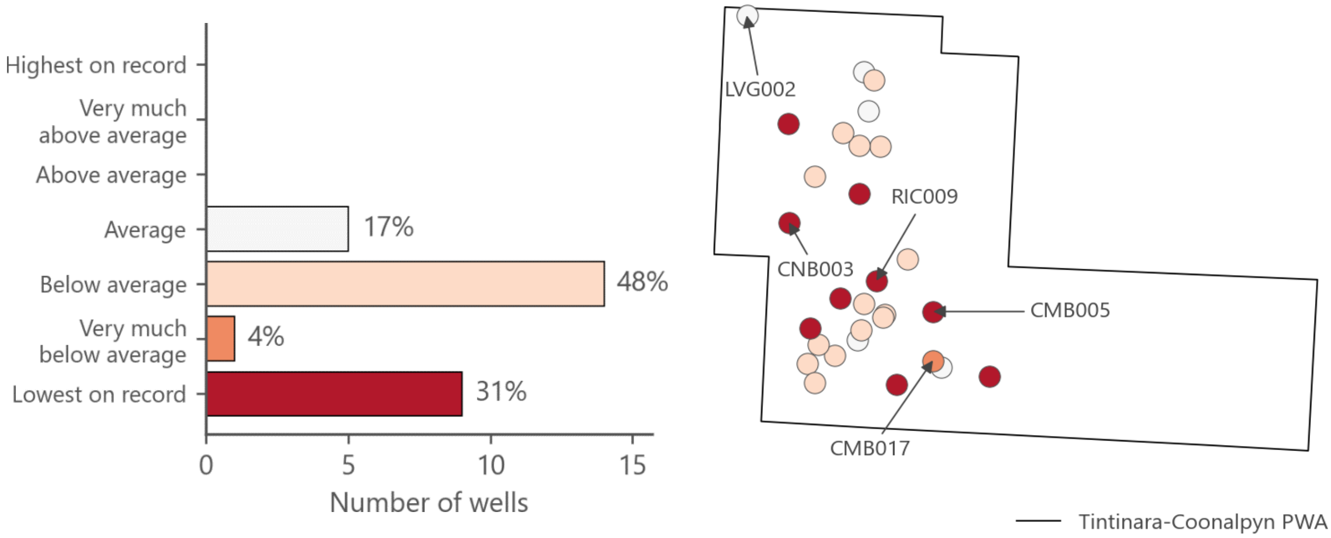


Figure 5.50. 2019 recovered water levels for wells in the confined aquifer in the Tintinara-Coonalpyn PWA

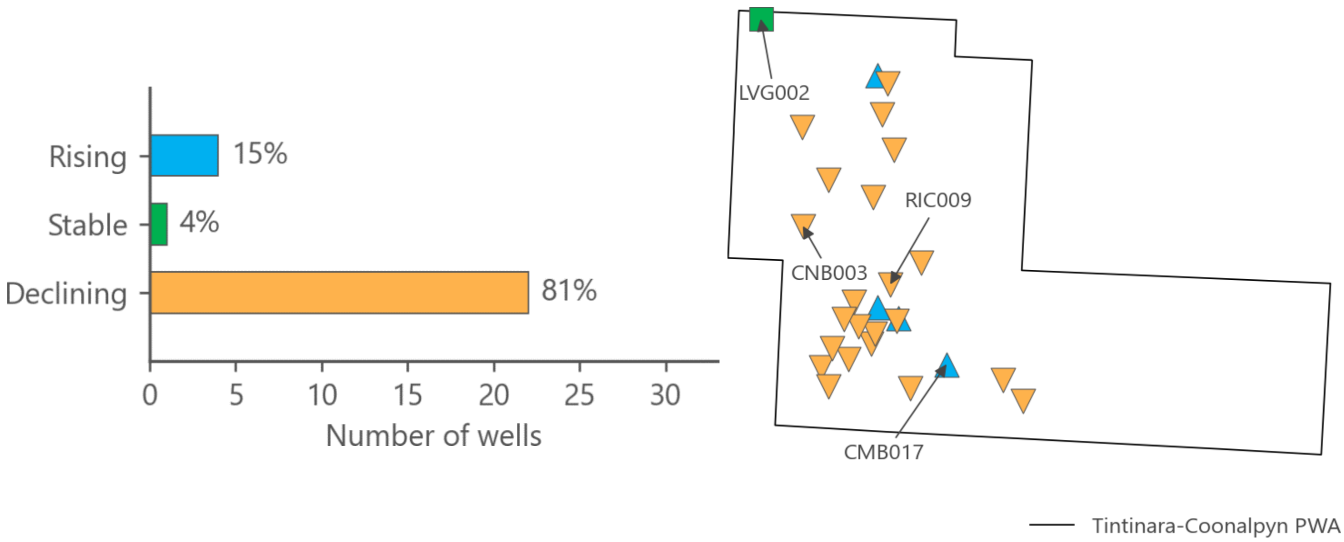


Figure 5.51. 2015–2019 trend in recovered water levels for wells in the confined aquifer in the Tintinara-Coonalpyn PWA

Figure 5.52 presents long-term hydrographs from a number of representative monitoring wells in the confined aquifer in the Tintinara-Coonalpyn PWA. The majority of wells show a declining trend beginning in the mid to late 1990s, with the rate of decline slowing or becoming stable following the end of the Millenium drought in 2009-10. The monitoring well LVG002 is located farther north on the boundary of the PWA and has seen a recovery in water level since 2010 to average levels (Figure 5.52).

The confined aquifer trends seen below mirror those seen in the unconfined aquifer (Figure 5.33), which is likely due to hydrostatic loading rather than reflecting large-scale effects of water extraction from the confined aquifer. The impacts of groundwater extractions are seen as seasonal fluctuations in water level, with are most pronounced in wells near Tintinara (e.g. RIC009, Figure 5.52).

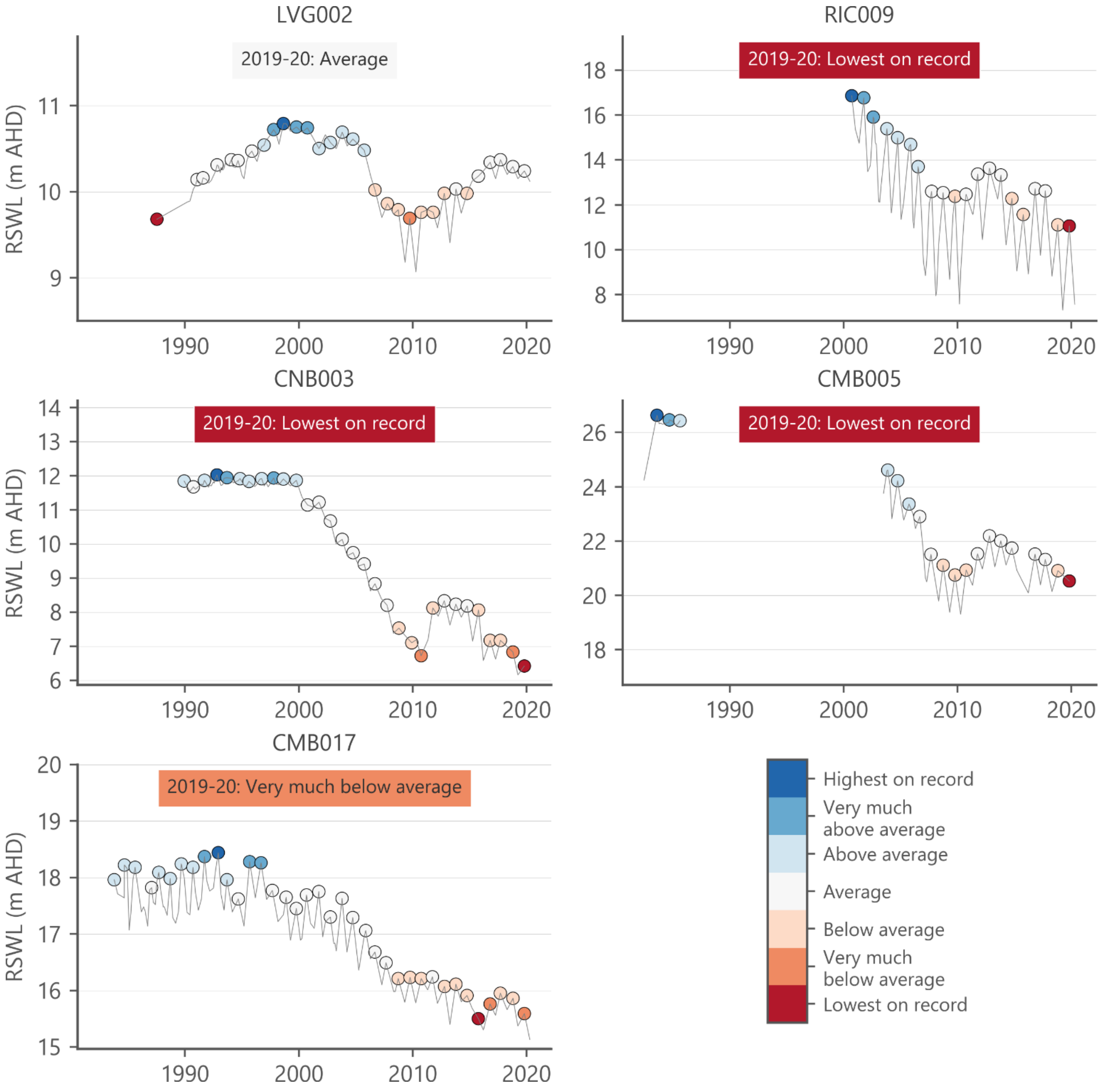


Figure 5.52. Selected hydrographs for wells in the confined aquifer in the Tintinara-Coonalpyn PWA

5.3.6 Tintinara-Coonalpyn and Tatiara PWAs – confined aquifer salinity

In 2019, the groundwater salinity ranged from 950 mg/L to 3996 mg/L in the Tintinara-Coonalpyn and Tatiara PWAs (median 1622 mg/L; Figure 5.53). Generally the higher salinities are found in the south-western part of the Tintinara-Coonalpyn PWA.

Five-year trends in salinity are stable for all four wells with suitable data, in the southern part of the Tintinara-Coonalpyn PWA (Figure 5.54).

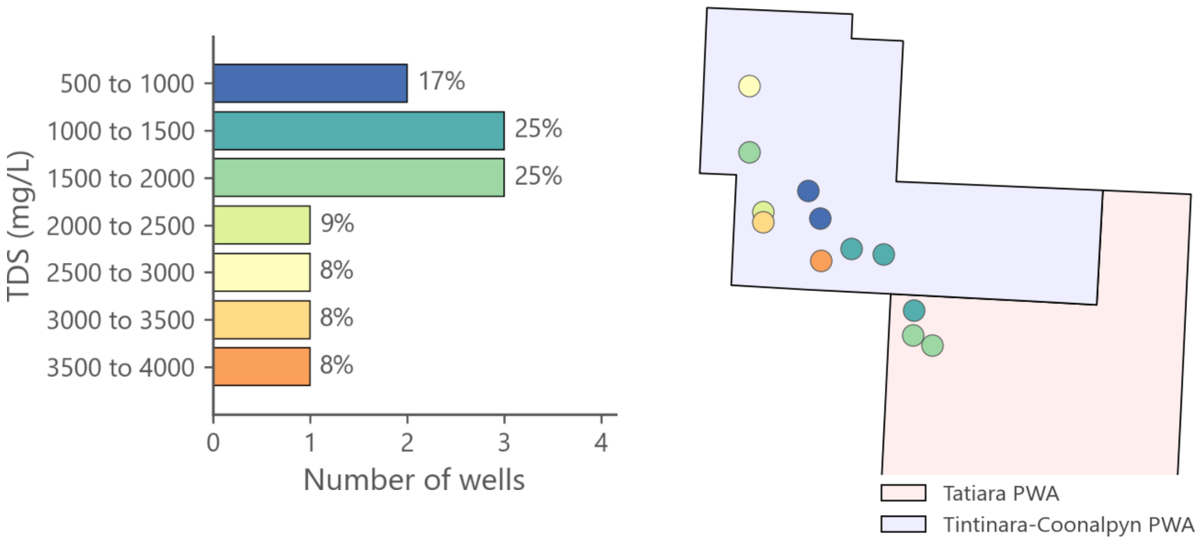


Figure 5.53. 2019 salinity observations from wells in the confined aquifer in the Tintinara-Coonalpyn and Tatiara PWAs

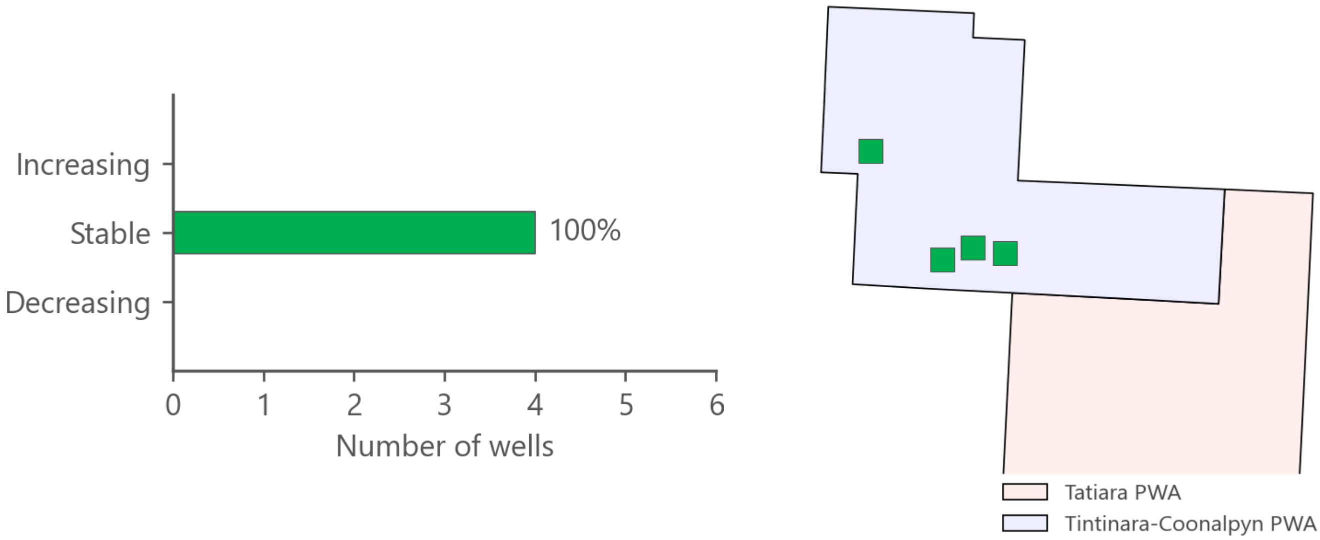


Figure 5.54. 2015–2019 trend in water salinity for wells in the confined aquifer in the Tintinara-Coonalpyn and Tatiara PWAs

6 Water use

Given the general absence of reliable surface water, there is a large reliance on groundwater resources for town water supply, stock and domestic use, irrigation and industrial use. Large volumes of water are extracted from the unconfined aquifer across the four PWAs of the South East, mainly for irrigation. Extraction from the confined aquifer contributes between 5% and 10% of total licensed water use and a comparatively small volume of surface water is also used in the Morambro Creek area (Figure 6.1). The majority of water extracted is from the Lower Limestone Coast PWA, which is also the largest region by area (Figure 6.2).

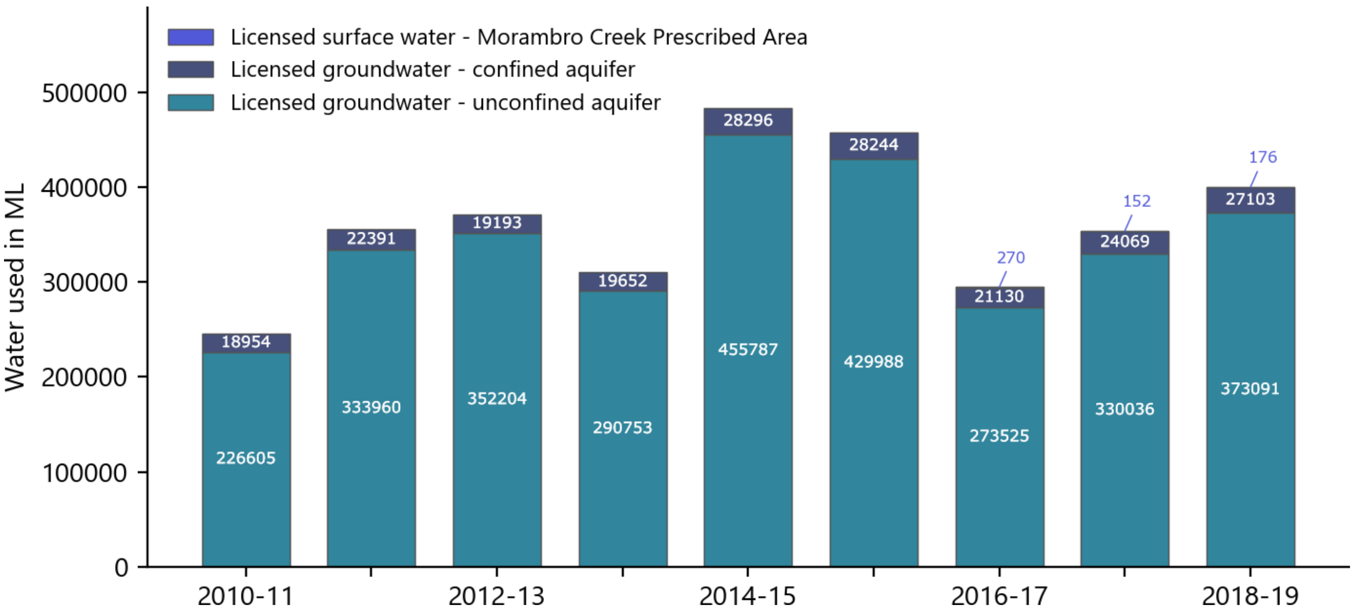


Figure 6.1. Licensed water extraction from 2010–11 to 2018–19 by water resource type

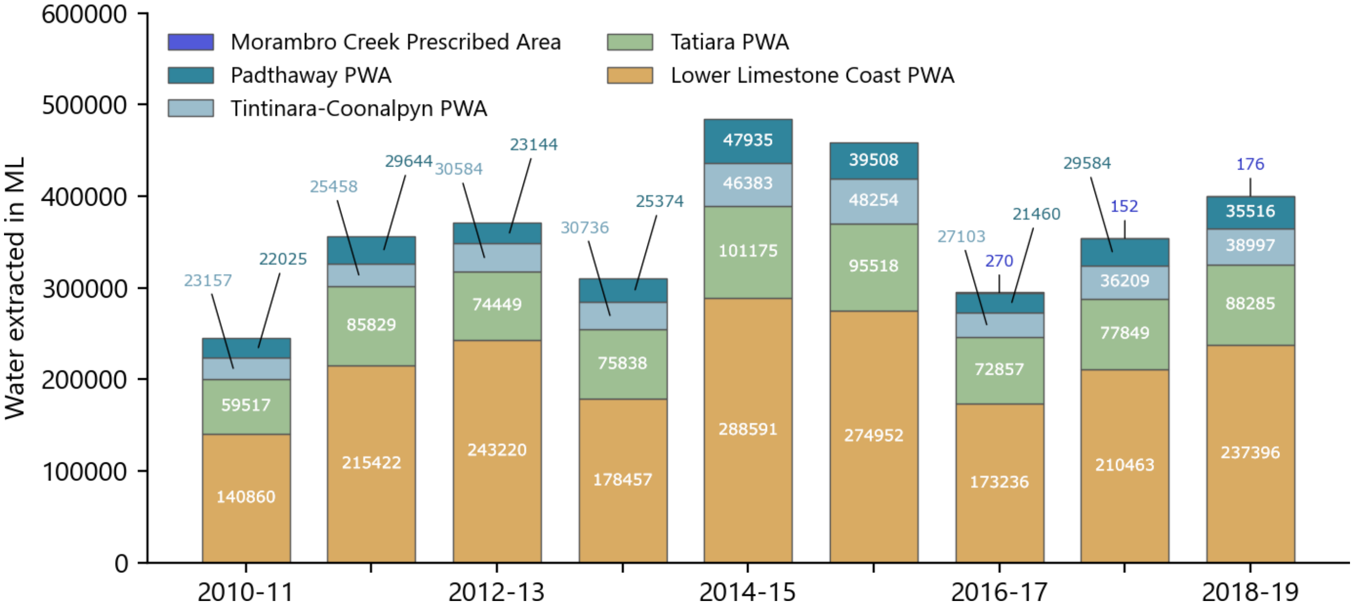


Figure 6.2. Licensed water extraction from 2010–11 to 2018–19 by prescribed area

The total amount of water used in 2018–19 was 400 370 ML (Figure 6.1). This includes only licensed groundwater extraction and licensed surface water extraction. Other supplies of water such as from the River Murray via the Tailem Bend to Keith pipeline are not included in this total amount.

6.1 Surface water use

The Morambro Creek and Nyroca Channel PWC and Morambro Creek PSWA were prescribed in response to an increase in demand for water for aquifer recharge schemes to address the increasing salinity of the adjacent groundwater resource in the Padthaway PWA. The majority of existing users divert water from the Morambro Creek or the Nyroca Channel. Others divert water via dams or drainage wells. The diverted water is used for aquifer recharge, stock, domestic, irrigation and recreation purposes. There is no commercial, industrial or town use of water in the PWC or PSWA.

Low reliability of streamflow in Morambro Creek has meant there has been no systematic development of the surface water resource. Licensees are limited to a rate of take once specific flow thresholds are reached. Currently there are four licences to take or divert water within the prescribed area. Flow was recorded in 2018–19 and this enabled extraction for irrigation. Extraction from licensed surface water sources was 176 ML (50% of the allocated volume of 354 ML).

6.2 Groundwater use

More than 90% of groundwater extraction occurs from the unconfined aquifer in all the PWAs of the South East. Most of that extraction occurs in the Lower Limestone Coast and Tatiara PWAs, with a large amount also occurring in Padthaway PWA given its relatively small size (Figure 6.3). The primary uses of water pumped from the unconfined aquifer water are irrigation, industry and stock and domestic supplies, including reticulated town water supplies. Extraction from the confined aquifer occurs mainly across the Lower Limestone Coast and Tintinara-Coonalpyn PWAs, with similar end uses as the unconfined aquifer (Figure 6.4).

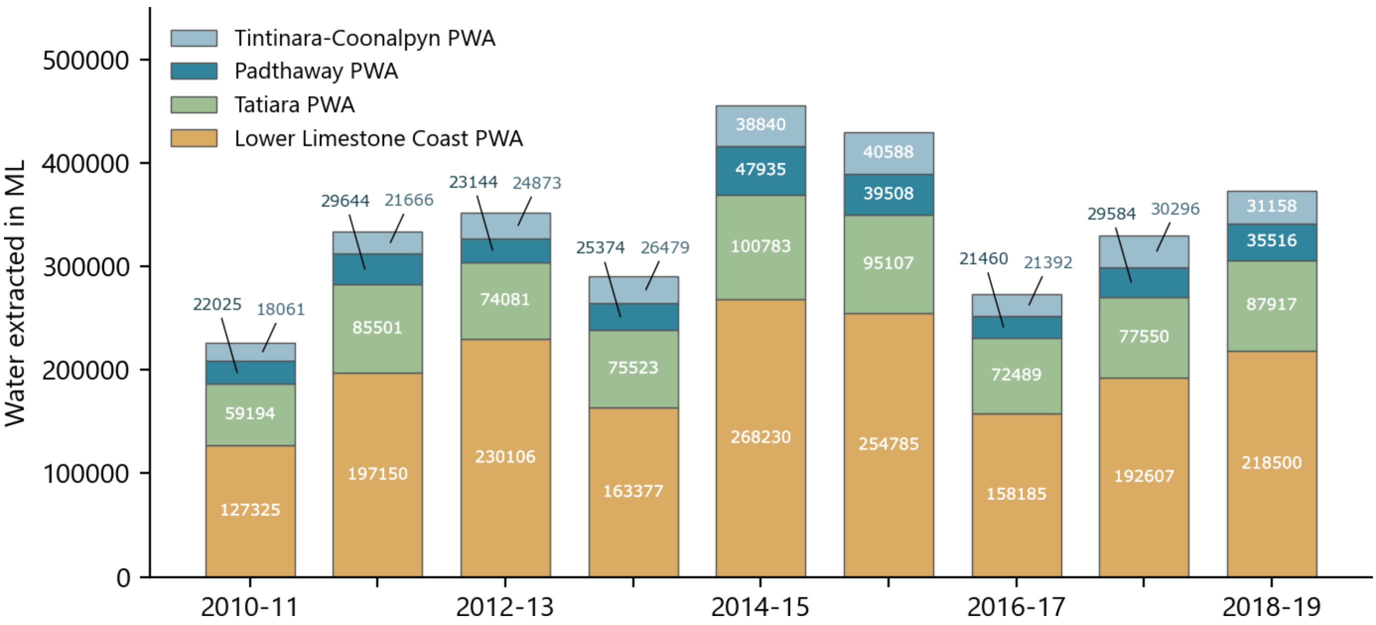


Figure 6.3. Licensed water extraction from the unconfined aquifer between 2010–11 and 2018–19

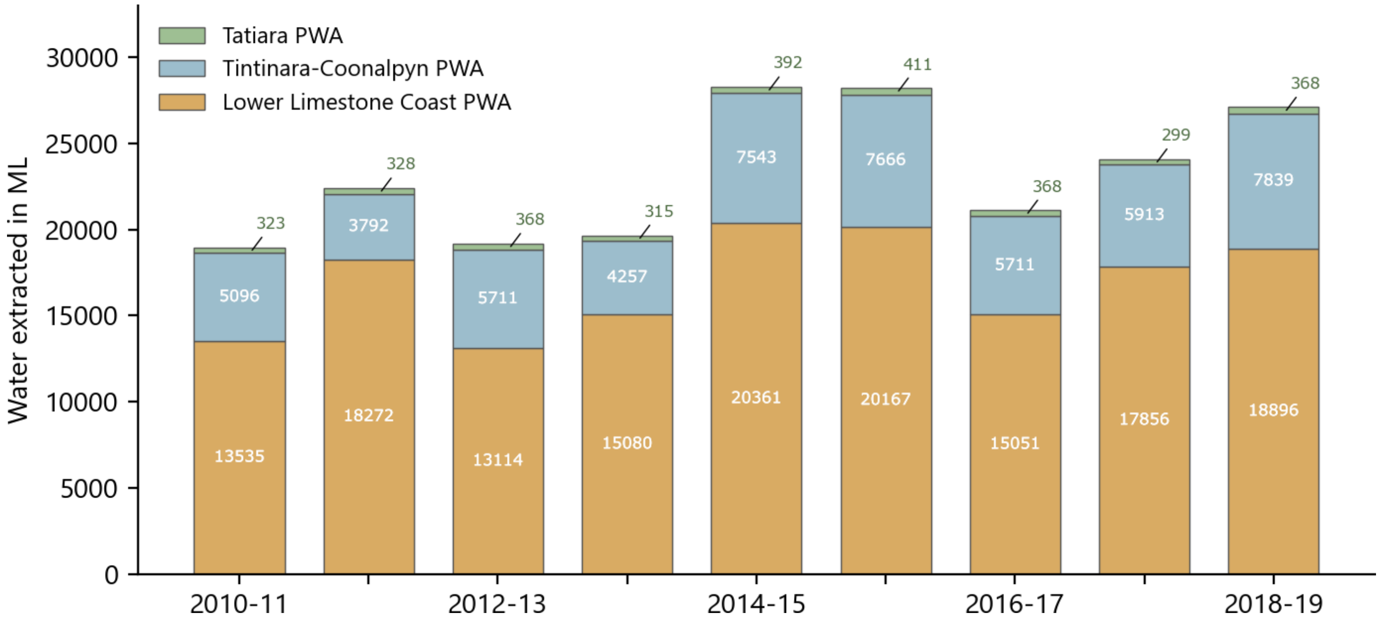


Figure 6.4. Licensed water extraction from the confined aquifer between 2010–11 and 2018–19

6.2.1 Lower Limestone Coast PWA

In 2018–19, licensed groundwater extractions from the unconfined aquifer were 218499 ML. This is an increase of 13% compared to 2017–18, which is likely caused by a reduction in rainfall. The volume of extraction tends to be driven by whether the rainfall was low or high; relatively low volumes were extracted in 2016–17, 2013–14, and 2010–11, which were all years of significantly above-average rainfall at the Mount Gambier rainfall station (Figure 3.1).

A similar but less pronounced trend occurs with licensed extractions from the confined aquifer, which were 18 895 ML in 2018–19, a 6% increase from 2017–18. In general the variation is less closely correlated to rainfall, with some years showing an increase in extraction despite also having an increase in rainfall (e.g. 2013–14).

6.2.2 Padthaway PWA

In 2018–19, licensed groundwater extractions from the unconfined aquifer were 35516 ML; this is an increase of 20% from 2017-18. The volume of extraction tends to be driven by whether the rainfall was low or high, although this is a significant increase compared to a 5% drop in annual rainfall over the same period at Marcollat rainfall station (Figure 3.5). Generally the trend holds, with the smallest volumes extracted in 2016–17 and 2010–11, which were both years of significantly above-average rainfall at Marcollat rainfall station (Figure 3.5).

There were no licensed extractions from the confined aquifer in 2018–19 in the Padthaway PWA.

6.2.3 Tatiara PWA

In 2018–19, licensed groundwater extractions from the unconfined aquifer were 87197 ML, which is an increase of 12% from 2017-18, which corresponds to a reduction in rainfall of 14% over the same period at Keith rainfall station (Figure 3.7). The volume of extraction tends to be driven by whether the rainfall was low or high; the lowest volumes extracted over the last nine years have been in 2016–17, 2013–14, and 2010–11, which were all years of significantly above-average rainfall at Keith rainfall station (Figure 3.7).

There was a small increase in extraction from the confined aquifer in the Tatiara PWA in 2018–19 (368 ML compared to 299 ML in the previous year).

6.2.4 Tintinara-Coonalpyn PWA

In 2018–19, licensed groundwater extractions from the unconfined aquifer were 31157 ML, which is an increase of 3% compared to 2017–18. This is despite a large reduction in rainfall of 17% over the same period at the Tintinara rainfall station (Figure 3.9).

In 2018–19, licensed extractions from the confined aquifer were 7839 ML, which is an increase of 33% from 2017–18. This corresponds to a decrease of 17% in rainfall over the same period at the Tintinara rainfall station (Figure 3.9).

6.3 Farm dams

Farm dam development in the PSWA has the potential to significantly reduce the low flow component of streamflow of the Morambro Creek and Nyroca Channel prescribed watercourses and the Marcollat watercourse downstream. There are approximately 290 farm dams in the PWSA, and some of these divert water from the PWC and PSWA for stock and domestic purposes. Any recreational use is primarily for amenity dams. Total farm dam storage is estimated from an aerial survey in 2013 to be 250 ML. Across the Morambro PSWA, smaller dams (capacity less than 5 ML) account for the majority of the number of dams (99%), and represent 62% of the total storage capacity of dams. Larger dams (5 ML or greater capacity) make up 1% of the total dam count but contribute 38% of the total storage capacity (Figure 6.5).

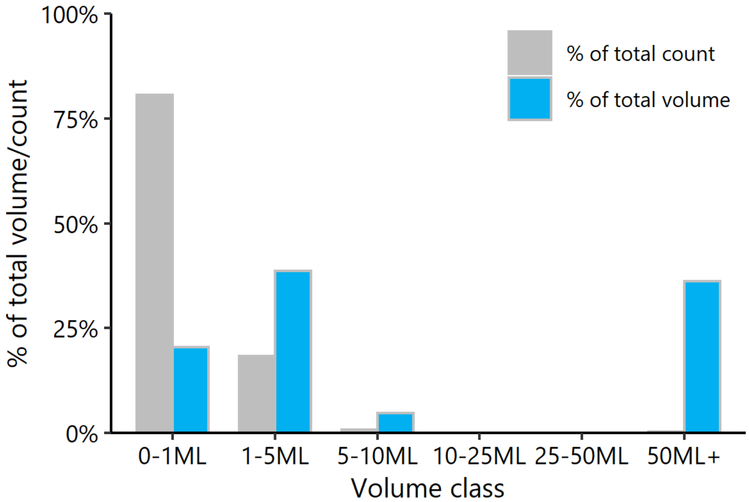


Figure 6.5. Count and volume of farm dam classes in the Morambro PSWA

7 References

Cranswick RH (2018) Groundwater resource condition assessment of the eastern Lower Limestone Coast PWA, DEW Technical report 2018/07, Government of South Australia, through Department for Environment and Water, Adelaide.

Cranswick RH & Barnett S (2017) Development of Groundwater Resource Condition Limits: Upper South East PWAs, DEW Technical report 2017/16, Government of South Australia, through Department for Environment and Water, Adelaide.

Cranswick RH & Herpich (2018) Groundwater–surface water exchange in the South East: 30 years of change, DEW Technical report 2018/09, Government of South Australia, through Department for Environment and Water, Adelaide.

Cranswick RH & Li C (2018) Science support for the Tatiara PWA WAP review: 2017–18, DEW Technical report 2018/06, Government of South Australia, through Department for Environment and Water, Adelaide.

DEW (2019a). Lower Limestone Coast Prescribed Wells Area Unconfined aquifer 2018 Groundwater level and salinity status report, Government of South Australia, through Department for Environment and Water, Adelaide.

DEW (2019b). Padthaway Prescribed Wells Area Unconfined aquifer 2018 Groundwater level and salinity status report, Government of South Australia, through Department for Environment and Water, Adelaide.

DEW (2019c). Tatiara Prescribed Wells Area Unconfined aquifer 2018 Groundwater level and salinity status report, Government of South Australia, through Department for Environment and Water, Adelaide.

DEW (2019d). Tintinara-Coonalpyn Prescribed Wells Area Unconfined aquifer 2018 Groundwater level and salinity status report, Government of South Australia, through Department for Environment and Water, Adelaide.

DEW (2019e). Prescribed Wells Areas of the South East Confined aquifer 2018 Groundwater level and salinity status report, Government of South Australia, through Department for Environment and Water, Adelaide.

DEW (2019f). Morambro Creek and Nyroca Channel Prescribed Watercourses and Morambro Creek Prescribed Surface Water Area 2018 Surface water status report, Government of South Australia, through Department for Environment and Water, Adelaide.

DEWNR (2012a). Lower Limestone Coast PWA Groundwater level and salinity status report 2009-10, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide.

DEWNR (2012b). Padthaway PWA Groundwater level and salinity status report 2009-10, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide.

DEWNR (2012c). Tatiara PWA Groundwater level and salinity status report 2009-10, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide.

DEWNR (2012d). Tintinara-Coonalpyn PWA Groundwater level and salinity status report 2009-10, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide.

DEWNR (2014) Morambro Creek and Nyroca Channel PWCs and Morambro Creek PSWA Surface Water Status Report 2010-11, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide.

Harding C, Herpich D & Cranswick RH (2018) Examining temporal and spatial changes in surface water hydrology of groundwater dependent wetlands using WOfS (Water Observations from Space), Southern Border Groundwaters Agreement area, South East South Australia, DEW Technical report 2018/08, Government of South Australia, through Department for Environment and Water, Adelaide.

Li C & Cranswick RH (2017) Tatiara PWA numerical groundwater flow model and projected scenarios, DEW Technical report 2017/17, Government of South Australia, through Department for Environment and Water, Adelaide.

SE NRM Board (2006). Water Allocation Plan for the Morambro Creek and Nyroca Channel Prescribed Watercourses including Cockatoo Lake and the Prescribed Surface Water Area, Government of South Australia, South East Natural Resources Management Board, Adelaide.

SE NRM Board (2009). Water Allocation Plan for the Padthaway Prescribed Wells Area, Government of South Australia, South East Natural Resources Management Board, Adelaide.

SE NRM Board (2010). Water Allocation Plan for the Tatiara Prescribed Wells Area, Government of South Australia, South East Natural Resources Management Board, Adelaide.

SE NRM Board (2012). Water Allocation Plan for the Tintinara Coonalpyn Prescribed Wells Area, Government of South Australia, South East Natural Resources Management Board, Adelaide.

SE NRM Board (2013). Water Allocation Plan for the Lower Limestone Coast Prescribed Wells Area, amended 29 June 2019, Government of South Australia, South East Natural Resources Management Board, Adelaide.

Simmons C, Cook P, Boulton A & Zhang L (2019). Independent review of science underpinning reductions to licensed water allocation volumes in the Lower Limestone Coast water allocation plan, Technical Report Series No. 19/01, Goyder Institute for Water Research.

Whiting JP and Savadamuthu K (2018). South East NRM Plan Water Affecting Activity Policy—Surface Water & Dams Technical Review, DEW Technical report 2018/10, Government of South Australia, Department for Environment and Water, Adelaide.

Wood C (2017) Lower Limestone Coast forest water accounting groundwater model, DEW Technical report 2017/14, Government of South Australia, through Department for Environment and Water, Adelaide.

Government
of South Australia

Department for
Environment and Water