Western Mount Lofty Ranges Prescribed Water Resources Area
2019–20 water resources assessment

Department for Environment and Water
October, 2021

DEW Technical Note 2021/11

Government of South Australia
Department for Environment and Water

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October 2021

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ISBN 978-1-922027-08-5

Preferred way to cite this publication

DEW (2021). *Western Mount Lofty Ranges Prescribed Water Resources Area 2019–20 water resources assessment*, DEW Technical Note 2021/11, Government of South Australia, Department for Environment and Water, Adelaide.

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1 Summary

WMLR PWRA	Fractured rock aquifers	
	Permian sand	
	Tertiary limestone	
	Surface water (Torrens and Onkaparinga)	
	Surface water (Fleurieu)	

LEGEND

- Highest on record
- Very much above average
- Above average
- Average
- Below average
- Very much below average
- Lowest on record

Rainfall

- Total annual rainfall across the Mount Lofty Ranges typically varies between 400 mm at lower elevations and greater than 1000 mm at higher elevations.
- Rainfall at Hindmarsh in 2019–20 was 907 mm, 4% above average, while rainfall at Mount Bold was 851 mm, 6% above average.

Surface water

- There are eight representative long-term streamflow gauging stations used for the analysis; four recorded 'Average' streamflow, three 'Below average' streamflow and one 'Very much below average' streamflow (Mount Pleasant) in 2019–20.
- Long-term data trends at the representative streamflow gauging stations show stable or increasing streamflow. These trends are defined using all years of data, but the very high rainfalls of 2016 greatly influence the current trend, whereas at least 12 of the past 20 years have been below average.
- The highest 2019–20 salinity was 891 mg/L in the Onkaparinga River and 466 mg/L in the River Torrens (Sixth Creek). These values remain within the historical ranges experienced at each site.

Groundwater

- Water levels in the Permian Sand and Tertiary limestone aquifers are generally commensurate with historical levels.
- Water levels in more than 50% of monitoring wells in fractured rock aquifers recorded below-average to lowest-on-record levels compared to respective historical levels.
- In the 10 years to 2020, greater than half of the fractured rock aquifer monitoring wells (52%) that have been sampled for salinity data show decreasing trends.
- In 2020, salinity data was not available for Permian Sand and Tertiary limestone aquifers; however, historical data shows that salinity within the Myponga and Hindmarsh Tiers basins is typically less than 1000 mg/L.

Water use

- Water for irrigation, commercial, stock and domestic purposes comes from a variety of sources. These include pumping and diversions from watercourses and aquifers, interception and storage by farm dams and imported water from the SA Water's reticulated distribution network.
- Water consumption in 2019–20 totalled 98 173 ML, comprising licensed surface water take (19 853 ML), licensed watercourse take (8073 ML), estimated non-licensed surface water demand (4956 ML), forestry (17 413 ML), SA Water extraction from reservoirs (33 745 ML) and groundwater extraction (14 169 ML).

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 Western Mount Lofty Ranges (WMLR) Prescribed Water Resources Area (PWRA) for 2019–20 and addresses surface water and water use data collected between July 2019 and September 2020, and groundwater data collected between July 2019 and December 2020.

1.2 Regional context

The WMLR PWRA is located 10 km east of Adelaide (Figure 1.1). It lies predominantly within the Hills and Fleurieu Landscape Region but has small areas also located within the Green Adelaide and Northern and Yorke Landscape Regions. The PWRA includes both groundwater and surface water resources and these are prescribed resources under the *Landscape South Australia Act 2019*. The Water Allocation Plan for the Western Mount Lofty Ranges Prescribed Water Resources Area, adopted in 2013, provides rules for their management.

Approximately 75% of the state's population has dependence on the water resources of the WMLR PWRA, which on average supplies around 60% of metropolitan Adelaide's water requirements. Effective management of these water resources are therefore vitally important socially, economically and ecologically.

The eastern regions of the PWRA include the highest elevations in the area and form the upland eastern extent of the Mount Lofty Ranges watershed. Several important watercourses drain the northern and central parts of the PWRA, including the South Para River, Little Para River and the River Torrens. The Onkaparinga River and Myponga River drain the southern parts of the PWRA and flow west before discharging to Gulf St Vincent.

The south-western part of the PWRA includes the Fleurieu Peninsula, which is characterised by smaller coastal catchments, draining a central plateau. The Fleurieu Peninsula contains numerous wetlands including the Fleurieu Swamps, listed under the *Environment Protection and Biodiversity Conservation Act 1999*. The most south-easterly parts of the PWRA comprise the Hindmarsh River and Inman River catchments which drain the Fleurieu Peninsula towards the south-east (Figure 1.1).

There are two types of aquifers in the WMRL PWRA: fractured rock aquifers and sedimentary aquifers. Fractured rock aquifers occur where groundwater is stored and moves through joints and fractures in the basement rocks. There are three main sedimentary groundwater systems within the WMLR PWRA: the Permian sand, Tertiary limestone and Quaternary aquifers (Figure 1.1). The McLaren Vale Prescribed Wells Area (PWA) located within the boundaries of the WMLR PWRA (Figure 1.1) is managed under a separate water allocation plan (AMLR NRM Board 2013) and consequently, a dedicated Water Resource Assessment Program report (DEW 2021) has been prepared for the aquifers in this PWA.

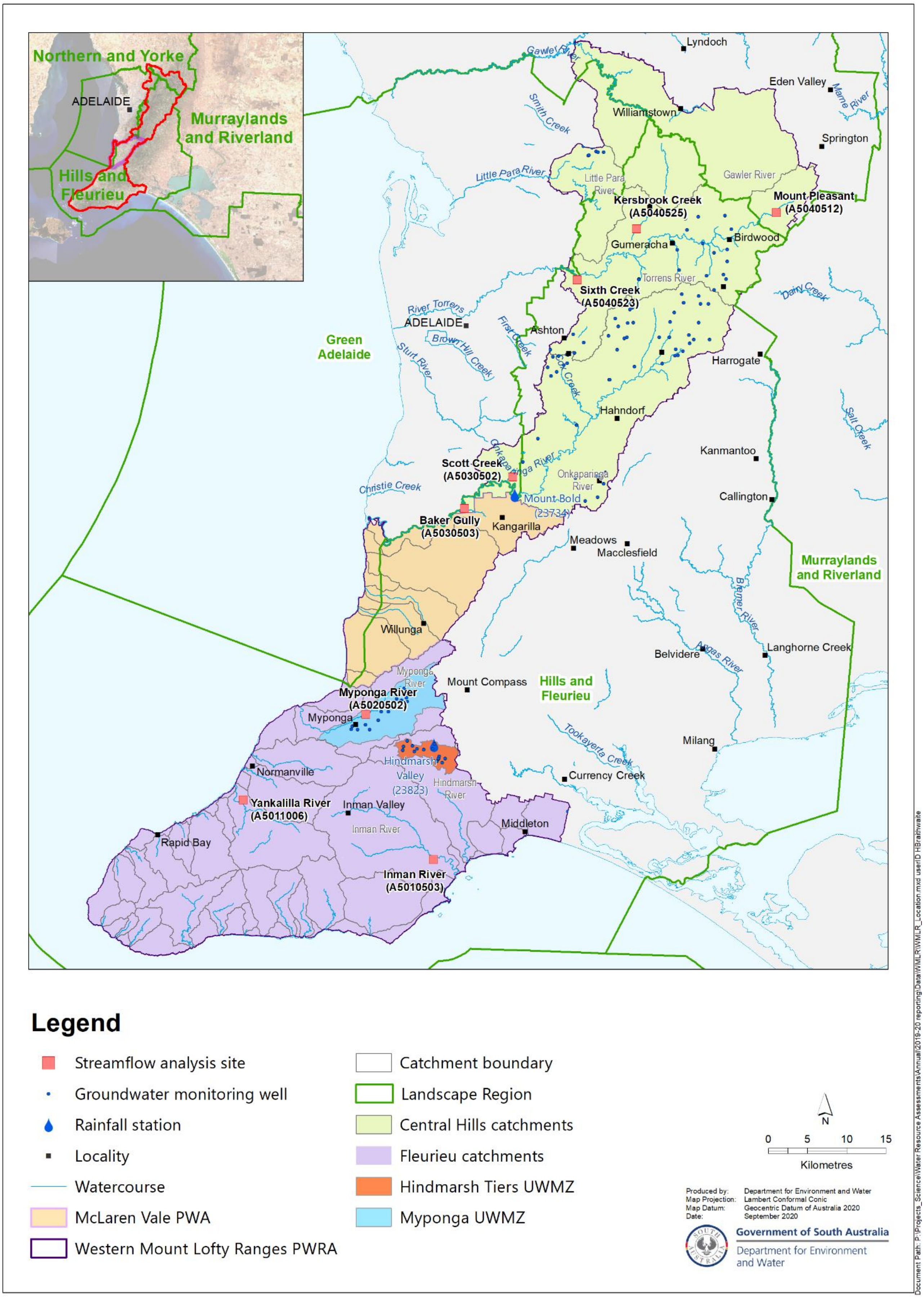

Figure 1.1. Location of prescribed areas of the WMLR

2 Methods and data

This section describes the source of rainfall, surface water, groundwater and water use data presented in this assessment and the methods used to analyse and present these 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[1] service provided by the Queensland Government, which provides interpolated values to fill gaps in observations (Figure 3.1 and Figure 3.2). Rainfall maps were compiled using gridded datasets obtained from the BoM (Figure 3.3). The long-term average annual rainfall map (1986–2015) was obtained from Climate Data Online[2]. The map of total rainfall in 2019–20 was compiled from monthly rainfall grids obtained for the months between July 2019 and June 2020 from the Australian Landscape Water Balance[3] website.

2.2 Surface water

2.2.1 Annual streamflow

The status of each of the streamflow gauging stations is determined by expressing the annual streamflow for the applicable year as a percentile[4] of the total period of data availability. The common streamflow data availability period for the WMLR streamflow gauging stations is 1973–20. Streamflow data were then given a description based on their percentile and decile[1] (Table 2.1 and Figure 4.1).

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[5]

[1]https://www.data.qld.gov.au/dataset/silo-patched-point-data

[2]http://www.bom.gov.au/jsp/ncc/climate_averages/rainfall/index.jsp

[3]http://www.bom.gov.au/water/landscape/#/rr/Actual/year/-28.4/130.4/3/Point////2020/12/31/

[4] 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.

[5] Bureau of Meteorology Annual climate statement at http://www.bom.gov.au/climate/current/annual/aus/

Annual streamflow data (Figure 4.2 and Figure 4.4) 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.

2.2.2 Monthly streamflow

Monthly streamflow for the applicable year is assessed alongside the long-term average monthly streamflow (Figure 4.3A and Figure 4.5A), for the period 1973–20 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 4.3B and Figure 4.5B).

2.2.4 Salinity

Box plots on a monthly basis are used to assess surface water salinity (Figure 2.1, Figure 4.6 and Figure 4.7). 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).

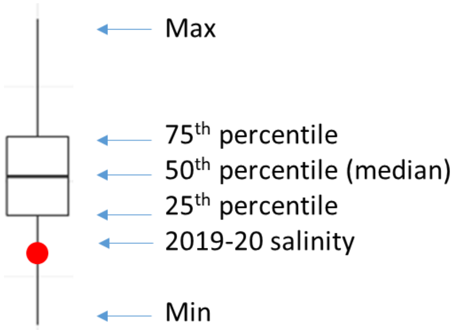

Figure 2.1 Box and whisker plot

2.3 Groundwater

2.3.1 Water level

Water level[6] data were obtained from wells in the monitoring network by both manual and continuous logger measurements. 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 aquifers in the WMLR PWRA return to a recovered maximum level between June and December.

For those wells that meet the selection criteria (see below), the annual recovered water levels are ranked from lowest to highest according to their decile range (Table 2.1) and given a description in a similar way as annual

[6] "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).

streamflow. The definition of a suitable long-term record varies depending on the history of monitoring activities in different areas; for the WMLR PWRA, in the Permian Sand and Tertiary limestone aquifers, any well with 10 years or more of recovered water level data is included, while in the fractured rock aquifers, any well with at least 7 years of data is included. The number of wells in each description class for the most recent year is then summarised for each aquifer (e.g. Figure 5.1). Hydrographs are shown for a selection of wells to illustrate common or important trends (e.g. Figure 5.3).

Five-year trends are 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 (e.g. Figure 5.2).

Moderately sized sedimentary confined and unconfined aquifers such as the Permian Sand aquifer and Tertiary limestone aquifer are given tolerance thresholds of 2 cm/y, while fractured rock aquifers with lower storages are given a tolerance threshold of 1 cm/y.

Twenty-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. 1989–91) and the average water level in 2020.

2.3.2 Salinity

Water samples from monitoring wells and irrigation wells are collected in the WMLR PWRA. 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. Groundwater salinity in the sedimentary aquifers of WMLR are not currently monitored, but salinity is typically less than 1000 mg/L in these aquifers within Myponga and Hindmarsh Tiers basins.

10-year salinity trends are calculated where there are at least seven 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:

$$\text{Percentage change in salinity (\%)} = \frac{\text{Slope of linear trend line (mg/L/y)} * 10}{\text{Value of trend line at start of period (mg/L)}} * 100$$

The percentage of change over the trend period is then summarised in categories depending on the range of change for each resource. The salinity measurements are based on the measurement of the electrical conductivity of a water sample and are often subject to small instrument errors (e.g. Figure 5.5).

Where available salinity graphs are shown for a selection of wells with long-term data to illustrate common or important trends (e.g. Figure 5.6).

2.4 Water use

Meter readings are used to collate licensed extraction volumes for both surface water and groundwater sources. Where meter readings are not available, licensed or allocated volumes are used to estimate extraction from surface water sources (Figure 6.1 and Figure 6.2).

Non-licensed water use (stock and domestic) from farm dams is not metered and is estimated at 30% of dam capacity (AMLR NRM Board, 2013). Futher information on the number, type and distribution of farm dams in the PWRA 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[7]. For additional information related to groundwater monitoring well nomenclature, please refer to the Well Details page on WaterConnect[8].

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

- Summary reports on the surface water (DEWNR, 2014) and groundwater resources of the WMLR PWRA (DEWNR, 2011), and annual surface water status reports such as DEW (2019a) and groundwater level and salinity status reports such as DEW (2019b);
- The Water Allocation Plan for the WMLR Prescribed Water Resources Area (AMLR NRM Board, 2013);
- Penney et al. (2020 draft) provides details regarding the construction and calibration of hydrological models for six water supply catchments across the Western Mount Lofty Ranges);
- Green et al. (2007) provides information on groundwater recharge and flow processes in the fractured rock aquifers of WMLR PWRA;
- Background information can be found on WMLR groundwater at Piccadilly Valley (Barnett and Zulfic, 1999), Upper Onkaparinga catchment (Zulfic et al., 2002), Torrens rural catchment (Barnett and Zulfic, 2000), Southern Fleurieu (Barnett and Rix, 2006) and South Para River catchment (Zulfic, 2006); these studies were completed to support water planning in WMLR PWRA.

[7] https://www.waterconnect.sa.gov.au/Systems/GD/Pages/default.aspx

[8] https://www.waterconnect.sa.gov.au/Systems/GD/Pages/Well-Details.aspx

3 Rainfall

The WMLR PWRA is characterised by warm summers and cold wet winters. Total annual rainfall across the Mount Lofty Ranges typically varies between 400 mm/y at the lower elevations and over 1000 mm/y at the higher elevations

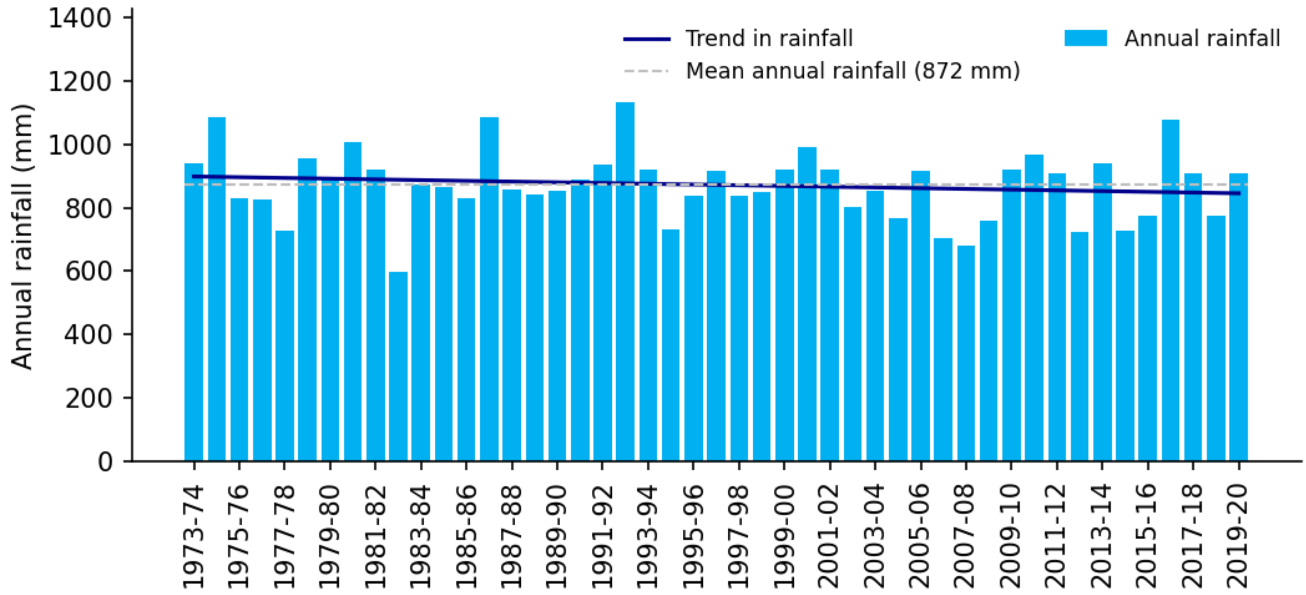

Figure 3.1 Annual rainfall for 1979–80 to 2019–20 at the Hindmarsh Valley rainfall station (23823)

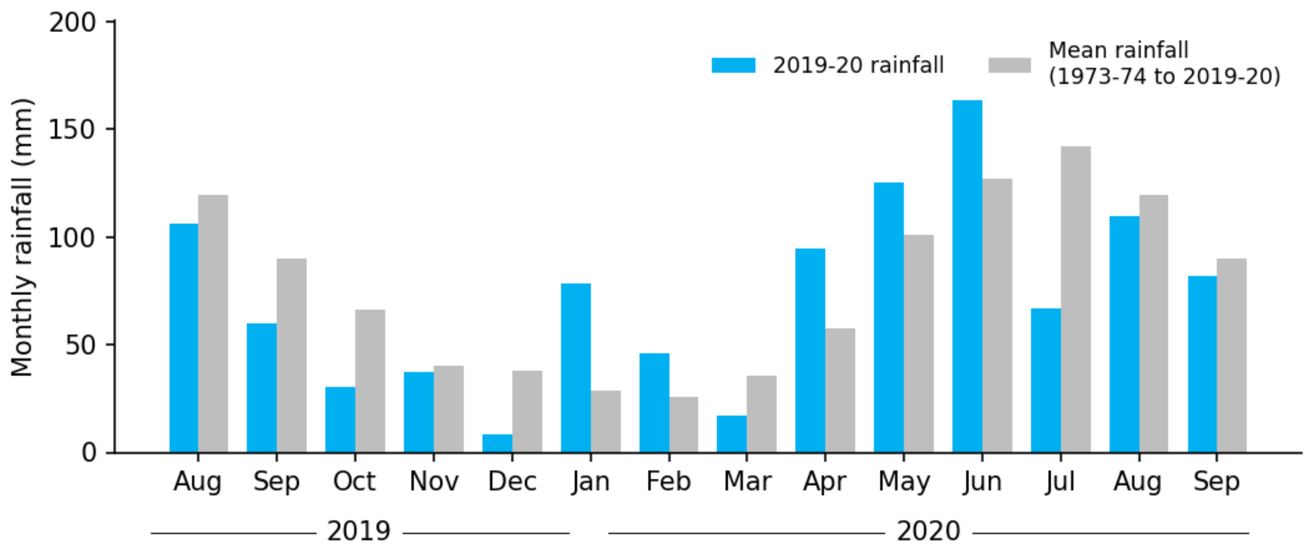

Figure 3.2 Monthly rainfall between July 2019 and September 2020 at the Hindmarsh Valley rainfall station (23823)

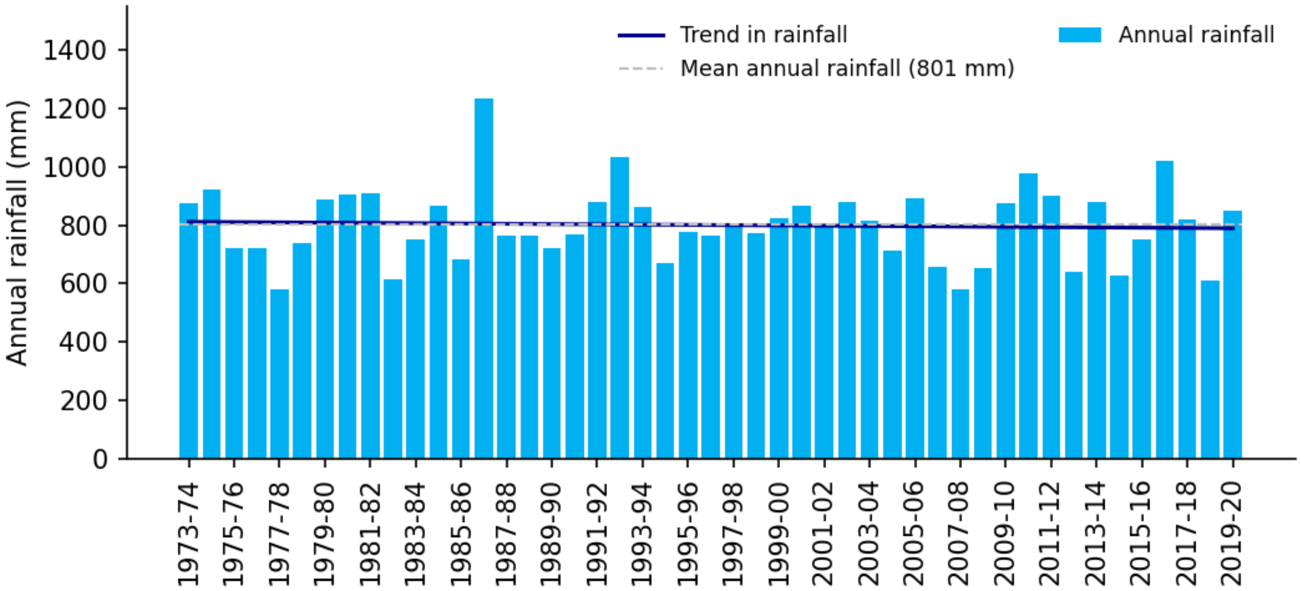

Figure 3.3 **Annual rainfall for 1973–74 to 2019–20 at the Mount Bold rainfall station (23734)**

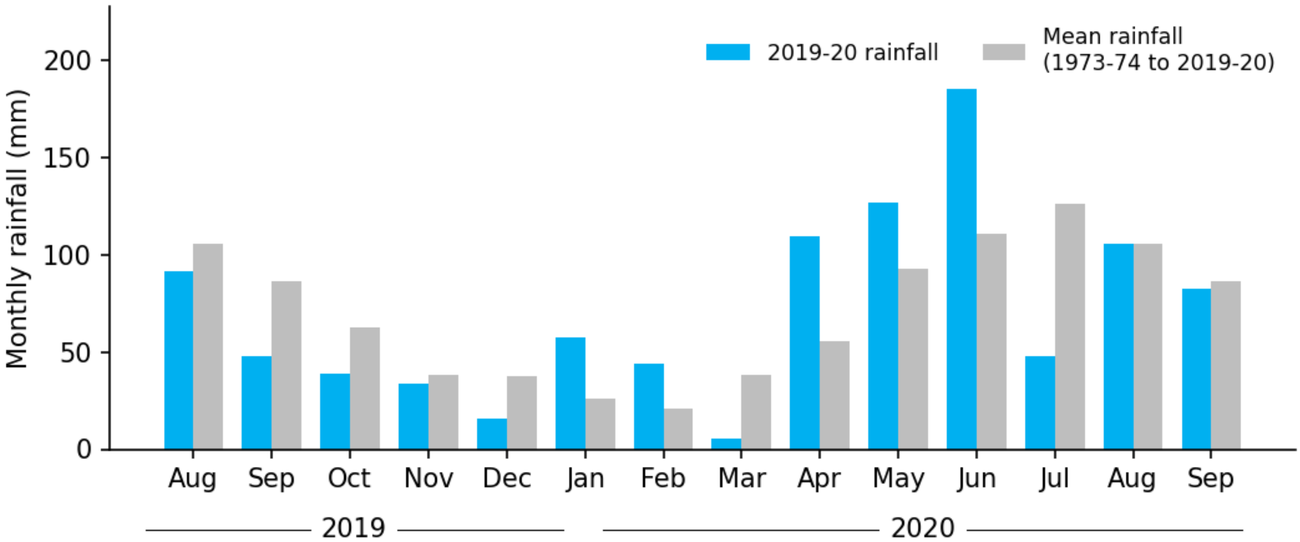

Figure 3.4 **Monthly rainfall between July 2019 and September 2020 at the Mount Bold rainfall station (23734)**

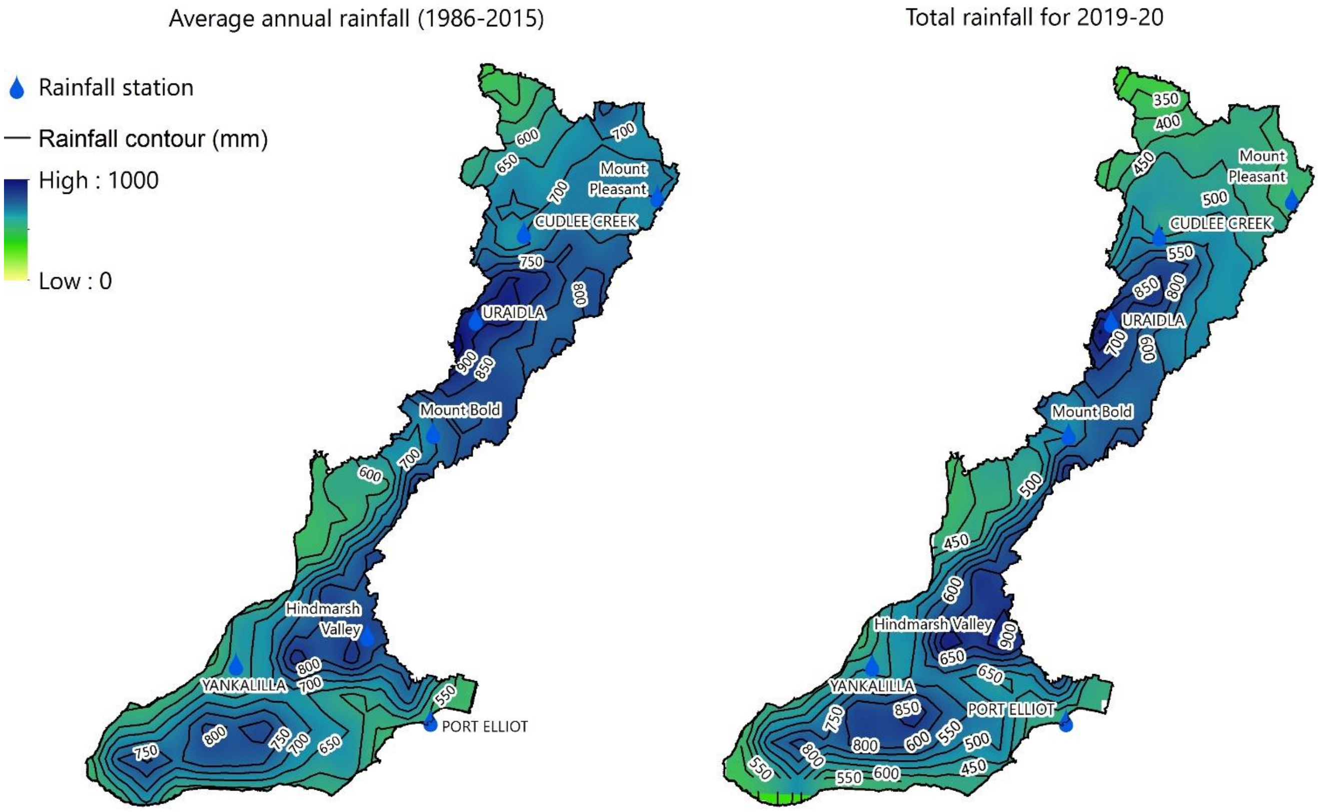

Figure 3.5 Rainfall in the prescribed areas of the WMLR for 2019–20 compared to the standard 30-year climatological average (1985–2015)

- The Hindmarsh Valley rainfall station (BoM station 23823) is used as a representative rainfall station for the Permian Sand and Tertiary limestone aquifers and the Fleurieu surface water catchments. The annual total recorded for 2019–20 was 907 mm. This was 35 mm higher than the average annual rainfall of 872 mm/y (1979–20). The long-term trend is declining across this period (Figure 3.1).
- Dry conditions were observed at the Hindmarsh Valley rainfall station during spring and early summer 2019 and again in spring 2020. The remainder of 2019–20 exhibited wetter conditions (Figure 3.2).
- The Mount Bold rainfall station (BoM station 23734) is used as a representative rainfall station for the Fractured Rock Aquifers and the Onkaparinga catchment. The annual total recorded for 2019–20 was 851 mm. This was 50 mm higher than the average annual rainfall of 801 mm/y (1973–20). The long-term trend is stable across this period (Figure 3.3).
- Predominantly below-average conditions were observed at the Mount Bold rainfall station during the spring and early summer 2019 as well as spring 2020. Similarly to the Hindmarsh Valley rainfall station, the remainder of 2019–20 recorded above-average rainfall (Figure 3.4).
- Rainfall in 2019–20 was slightly lower in the north and south of the WMLR PWRA when compared to the average annual rainfall patterns (Figure 3.5)[9]. The rainfall in 2019–20 in the central southern parts of the PWRA are more comparable to the average annual rainfall and in some instances were higher (for example, in the vicinity of the Hindmarsh Valley rainfall station).

[9] 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

Several significant watercourses drain the northern and central parts of the PWRA, flowing west through metropolitan Adelaide and its surrounding suburbs, before entering Gulf St Vincent, including: the South Para River, Little Para River, River Torrens, Onkaparinga River and Myponga River. The south-western part of the PWRA includes the Fleurieu Peninsula, which is characterised by smaller coastal catchments, draining a central plateau. The most south-easterly parts of the PWRA comprise the Hindmarsh River and Inman River which drain the Fleurieu Peninsula towards the south-east. Trends in streamflow and salinity are primarily rainfall driven, i.e. below-average winter rainfall will result in reduced annual streamflow volumes. Conversely, higher rainfall will result in increased surface water availability. The spatial variability in hydrological behaviour of the surface water catchments within the WMLR makes it challenging when assigning a single representative streamflow gauging station for the PWRA. Therefore eight streamflow gauging stations were chosen to be representative of the central, and southern portions of the WMLR PWRA. The River Torrens and Onkaparinga River catchments represent the central part, while the southern part of the region is represented by streamflow gauging stations located on the Fleurieu Peninsula. The common streamflow data availability period is 1973–20.

The representative sites for the River Torrens are the Mount Pleasant (A5040512), Sixth Creek (A5040523) and Kersbrook Creek (A5040525) streamflow gauging stations. For the Onkaparinga River catchment, the Scott Creek (A5030502) and Baker Gully (A5030503) streamflow gauging stations are used. The representative sites for the Fleurieu Peninsula are the Myponga River (A5020502), Inman River (A5010503) and the Yankalilla River (A5011006) streamflow gauging stations. In 2019–20, three stations recorded 'below-average' streamflow, 1 'very much below average' and 4 average streamflow (Figure 4.1) Further detail on the methodology used for analysis can be found in Section 2.

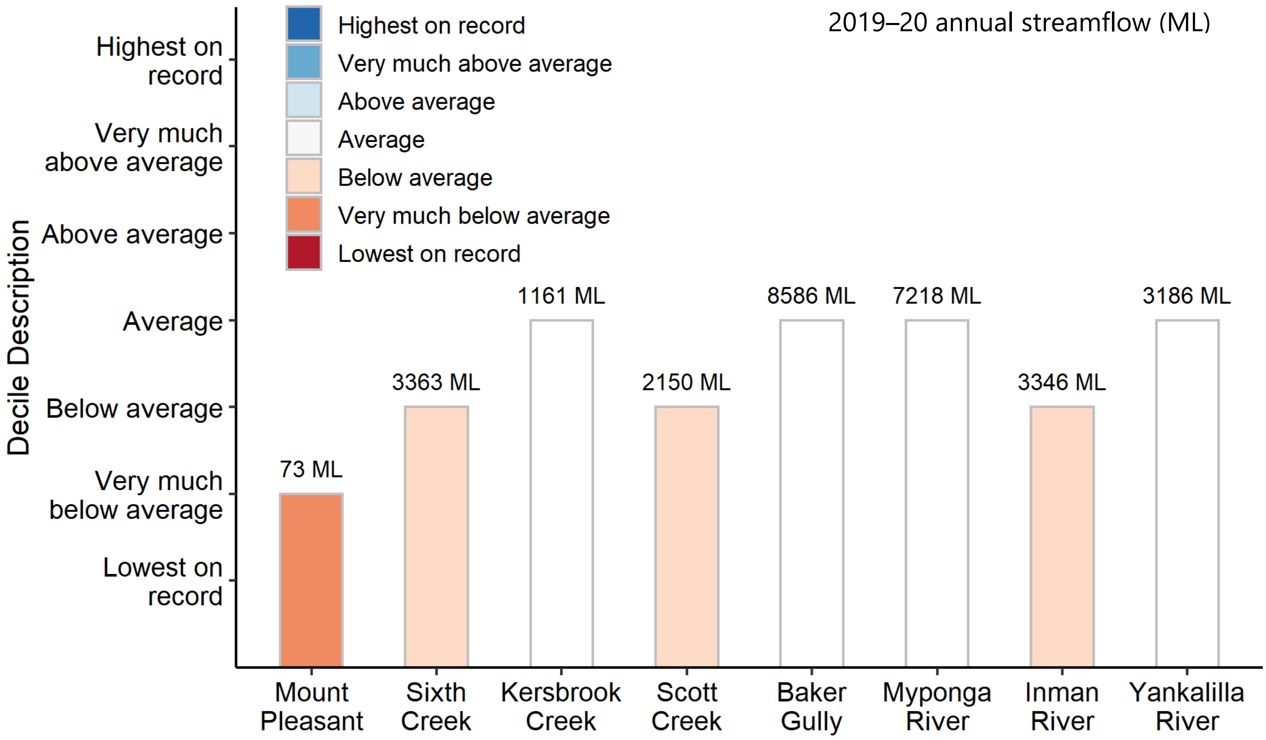

Figure 4.1. WMLR PWRA annual streamflow summary 2019–20

4.1.1 River Torrens: Mount Pleasant (A5040512)

One of the principal long-term streamflow gauging stations for the central part of the WMLR PWRA is at Mount Pleasant. This site is located in the headwaters of the River Torrens and captures a catchment area of 26 km^2. It is upstream of the Mount Pleasant dissipator where River Murray water is discharged to the River Torrens.

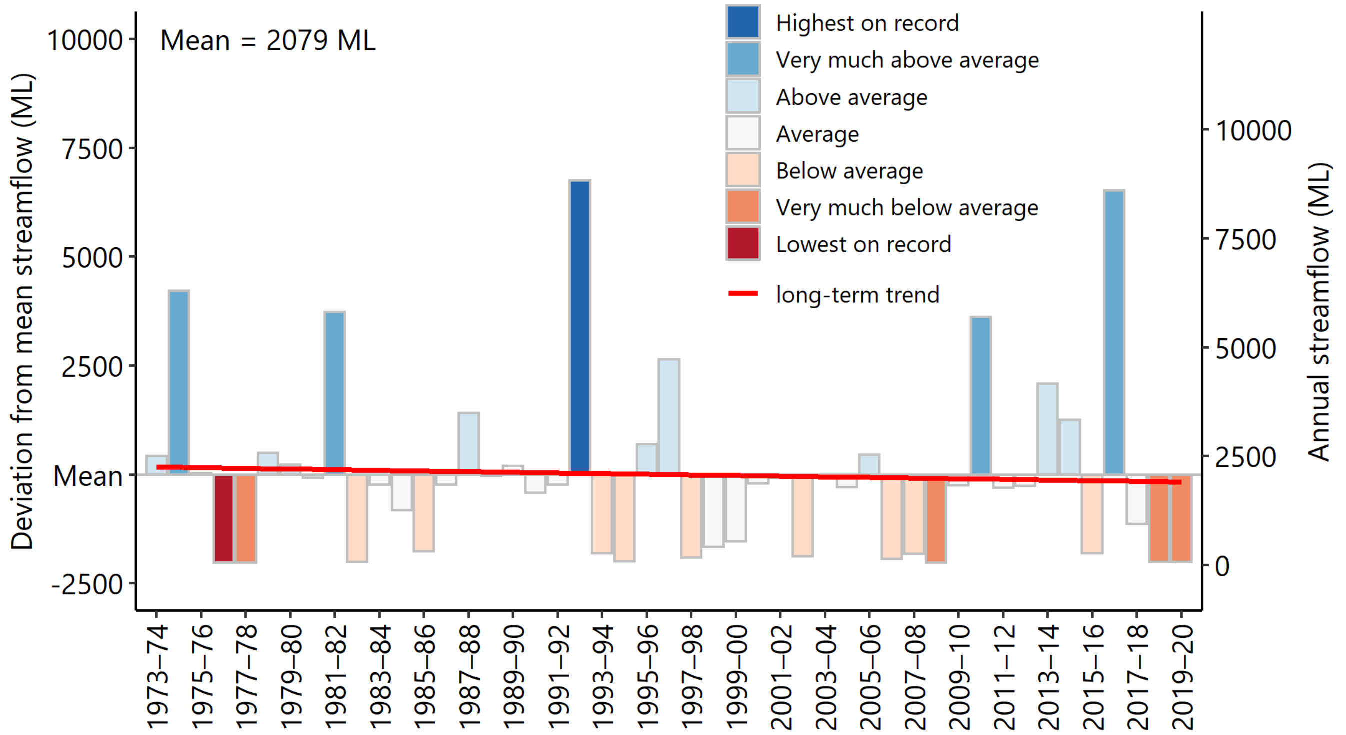

Figure 4.2. Annual deviation from mean streamflow at Mount Pleasant (1973–74 to 2019–20)

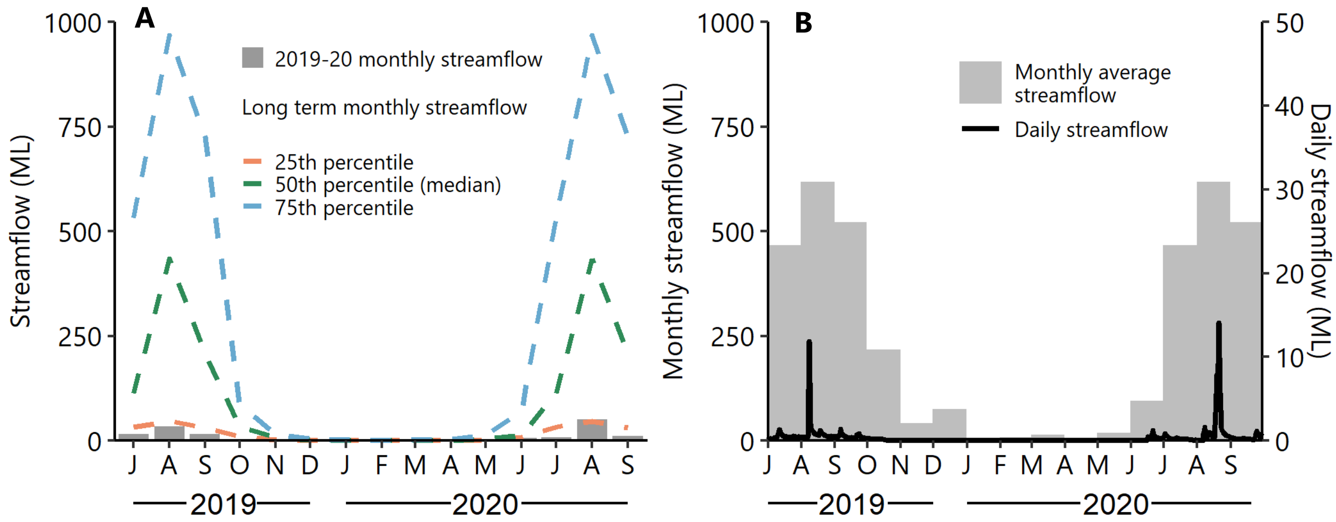

Figure 4.3. (A) Long-term monthly statistics and 2019–20 monthly streamflow at Mount Pleasant; (B) Long-term average monthly streamflow and 2019–20 daily streamflow at Mount Pleasant

The deviation of each individual year's streamflow from the long-term average is shown in Figure 4.2. The annual streamflow at Mount Pleasant in 2019–20 was 73 ML, which is 2006 ML below the average annual streamflow of 2079 ML (1973–20). Runoff lower than neighbouring sub-catchments appears to be a general trend at the Mount Pleasant streamflow gauging station despite the above-average rainfall experienced in 2019-20 in the area.

The annual streamflow for 2019–20 is ranked as 'Very much below average' assessed for the period 1973–20. Annual streamflow in the River Torrens at Mount Pleasant indicates a long-term stable trend but 4 out of the last 5 years have been below the average annual streamflow (Figure 4.2).

Figure 4.3A shows the monthly streamflow for 2019–20 (grey bars) relative to the long-term monthly streamflow (1973–20) for (a) low flows (25th percentile), (b) median flows (50th percentile) and high flows (75th percentile). All months in 2019–20 had low streamflow, mostly below the 25th percentile.

The headwaters of the River Torrens at Mount Pleasant are ephemeral and zero or low flows are typically recorded between January and April. The majority of the flow occurs between July and October and normally accounts for almost 90% of the total annual flow in any given year. In 2019–20, streamflow occurred from July to October 2019 and again between June and September 2020.

Figure 4.3B presents the long-term average monthly streamflow (1973–20) and the daily flows for 2019–20. Maximum daily flows were recorded in August 2020 and in the period from July to September 2019.

4.1.2 Inman River (A5010503)

One of the principal long-term streamflow gauging stations in the Fleurieu Peninsula is located at the outlet of the River Inman catchment, and covers a catchment area of 164 km^2. The station is upstream of the Victor Harbor sewage treatment works, north of Victor Harbor.

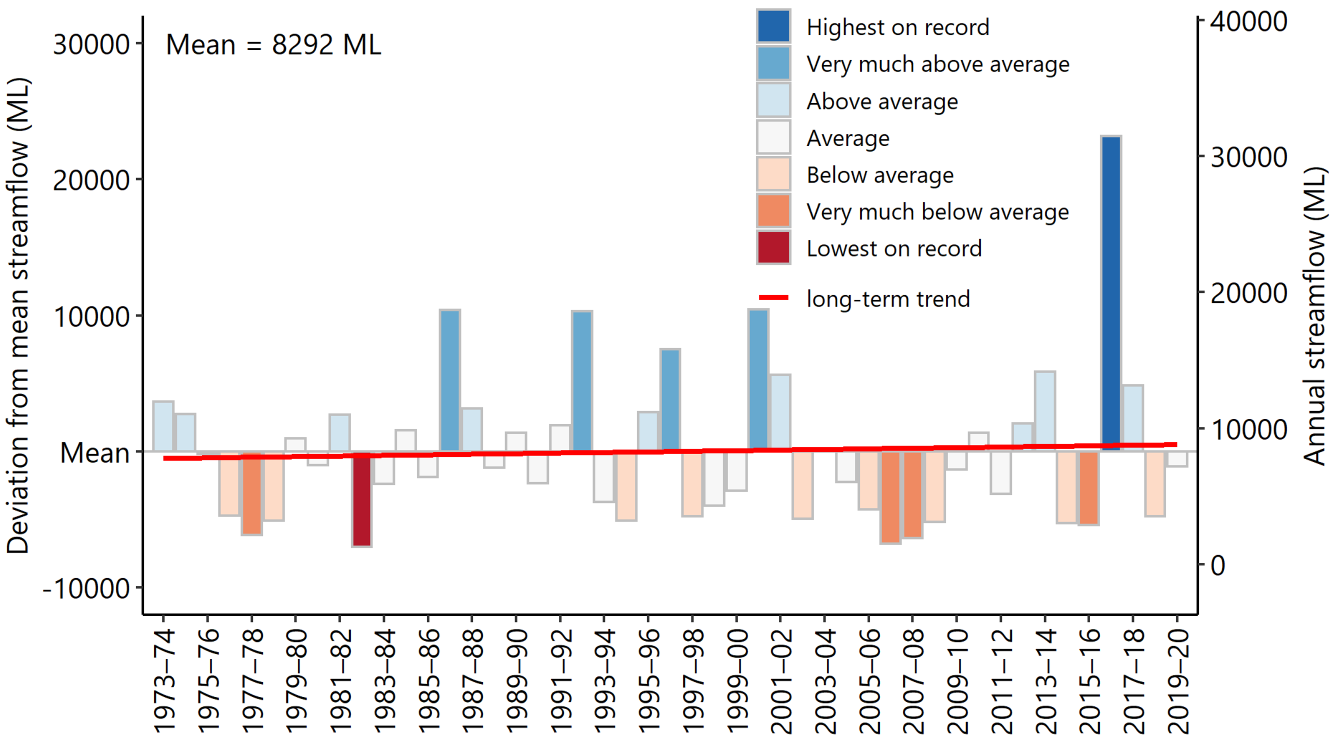

Figure 4.4. Annual deviation from mean streamflow on the River Inman (1973–74 to 2019–20)

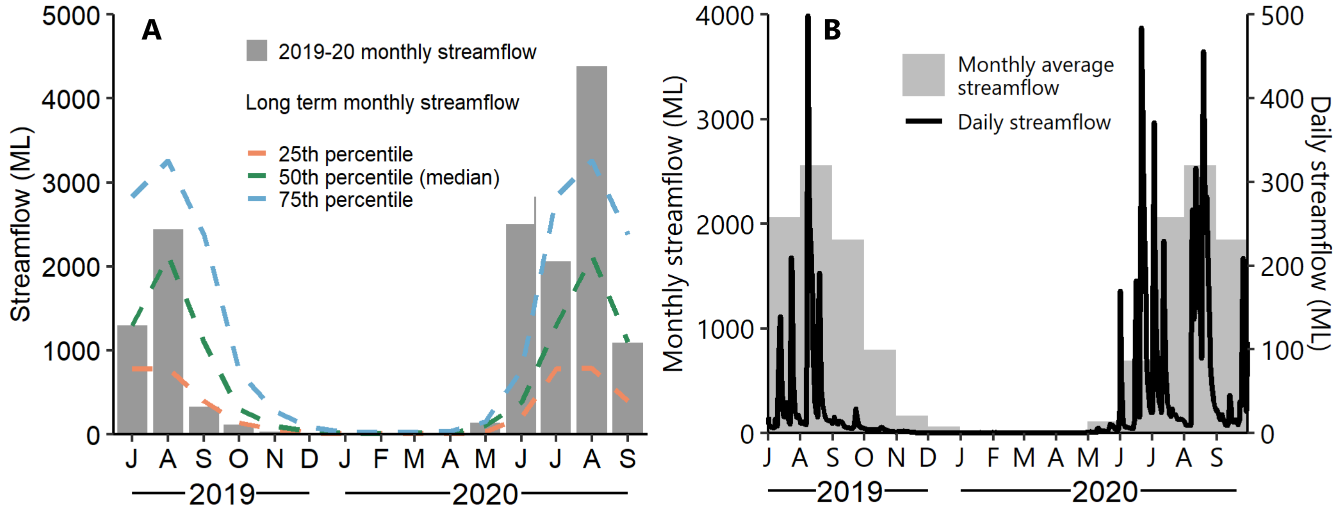

Figure 4.5 (A) Long-term monthly statistics and 2019–20 monthly streamflow on the River Inman; (B) Long-term average monthly streamflow and 2019–20 daily streamflow on the River Inman

The deviation of each individual year's streamflow from the long-term average streamflow is shown in Figure 4.4 for the period 1973–20. The River Inman streamflow gauging station recorded an annual flow of 7218 ML in 2019–20, which is 1074 ML below the average annual streamflow of 8292 ML (1973–20).

The annual total for 2019–20 is ranked as 'Average' for the assessment period 1973–20. Annual streamflow in the Inman River indicates a long-term slight increasing trend which is particularly influenced by the high rainfall recorded in 2016–17. However, 3 out of the last 5 years were below the average annual streamflow (Figure 4.4).

Figure 4.5A shows the monthly streamflow for 2019–20 (grey bars) relative to the long-term monthly streamflow (1973–20) for (a) low flows (25th percentile), (b) median flows (50th percentile) and high flows (75th percentile). In 2019–20, streamflow occurred throughout the year with July 2019, August 2019 and between May and September 2020 all recording higher-than average monthly flows. The remaining months were below the 50th (or median) monthly streamflow. The Inman River streamflow gauging station is at the outlet of the catchment and flows are typically recorded all year round but the lowest flows are experienced from January to April. The majority of the flows occur between June and October and normally account for 95% of the total annual flow in any given year.

Figure 4.5B presents the long-term average monthly streamflow (1973–20) and the daily flows for 2019–20. Maximum daily flows were recorded in August 2019 and in the period from July to September 2020.

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 mobilised 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 at many locations across the WMLR PWRA and two of these stations are used as representative sites for this assessment, one in the Onkaparinga River catchment (upstream of the Hahndorf dissipator A5031001), and the other in the River Torrens catchment (Sixth Creek A5040523). The Sixth Creek station (A5040523) has been used as a representative site for the Torrens catchment as there are no imports of water into this sub-catchment that could affect the dilution of salts.

Figure 4.6 and Figure 4.7 show the long term monthly salinity statistics (from the early 2000's) and median monthly values for 2019–20 (red dots) at the Onkaparinga River and River Torrens (Sixth Creek) streamflow gauging stations.

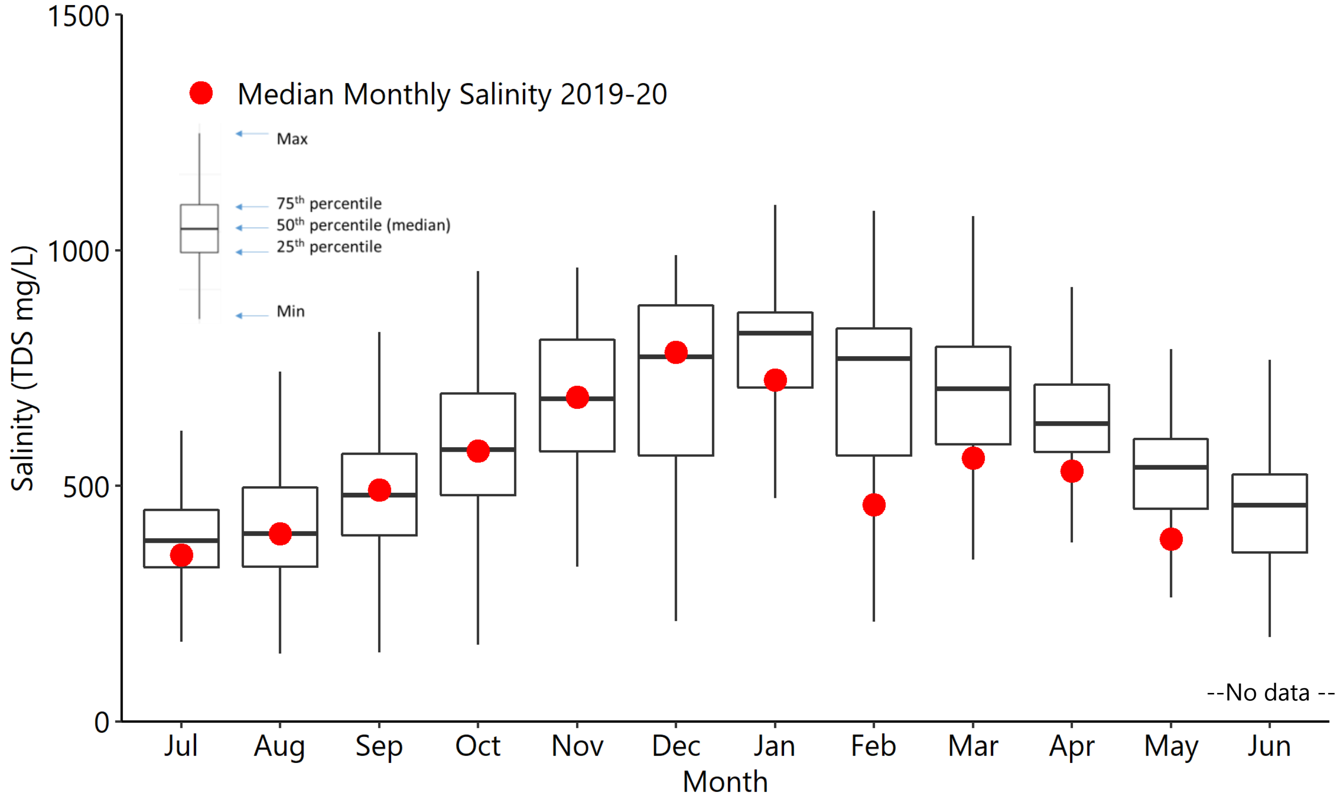

Figure 4.6. Long-term and 2019–20 monthly salinity at the Onkaparinga River streamflow gauging station (A5031001)

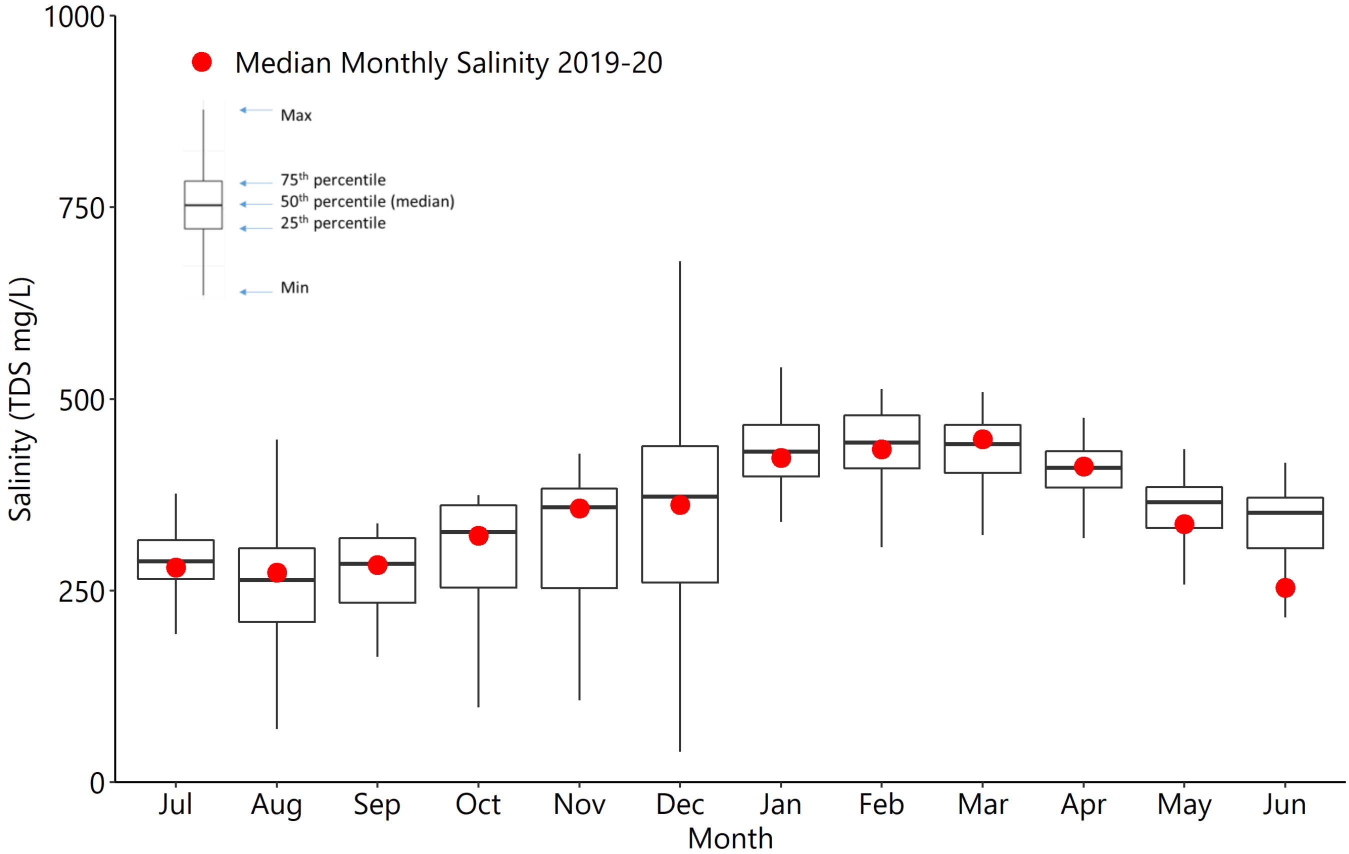

Figure 4.7. Long-term and 2019–20 monthly salinity at the River Torrens (Sixth Creek) streamflow gauging station (A5040523)

The majority of salinity levels are below 1000 mg/L at the stations presented in Figure 4.6 and Figure 4.7 for the period of data availability (early 2000's to 2019–20).

The median salinity observed in the Onkaparinga River is 574 mg/L and the highest salinity recorded in 2019–20 was 819 mg/L. There is a period of missing data in June 2020 at this station (Figure 4.6).

In comparison, Sixth Creek has slightly less saline conditions with a median salinity of approximately 366 mg/L. The highest salinity observed in 2019–20 was 466 mg/L.

The 2019–20 salinity levels remained within the historical ranges experienced each month for both stations. The long-term data indicates a lower variability in monthly salinity for the Sixth Creek site, as indicated by the generally smaller range between the minimum and maximum monthly values.

5 Groundwater

5.1 Hydrogeology

There are two different types of aquifers in the WMLR PWRA. Fractured rock aquifers occur where groundwater is stored and moves through joints and fractures in basement rocks. Sedimentary aquifers occur in the valleys where groundwater flows through the pore spaces within the sediments. Recharge to both of these aquifers occurs directly from the portion of rainfall that percolates down to the water table through the soil profile or, in the case of the sedimentary aquifers, indirectly by throughflow from adjacent aquifers. The majority of groundwater extraction across the PWRA occurs from the fractured rock aquifers in the Central Hills region and sedimentary aquifers (i.e. Permian Sand aquifer and Tertiary limestone aquifer) in the Myponga and Hindmarsh Tiers basins (Figure 1.1). As a result, the groundwater monitoring network and this report is focussed on these areas of higher groundwater demand.

5.1.1 Fractured rock aquifers

The fractured rock aquifers comprise three geological units: the Barossa Complex, the Adelaidean sediments and the Kanmantoo Group. Generally, the Adelaidean sedimentary rocks are more favourable in terms of recharge, salinity and yields, while the Barossa Complex and Kanmantoo Group rocks provide groundwater of poorer quality at low yields.

The Adelaidean sedimentary rocks are the main source of groundwater extractions in the area. As these rocks have not been subjected to the heat and pressure of metamorphism, they are considered reasonably good aquifers because the joints and fractures are open and permeable, resulting in relatively high yields. In addition, these sediments occur in the west of the region where the rainfall is higher, resulting in higher recharge and lower salinities. Groundwater extraction and monitoring from the fractured rock aquifers mainly occurs in the Central Hills region as defined in the WAP and as such is the main focus of this report.

5.1.2 Sedimentary aquifers

There are three types of sedimentary aquifers in the area: Permian sand, Tertiary limestone and Quaternary sediments. Tertiary limestone aquifers provide good quality water and high yields, while the Permian sand aquifers display a wide variation in characteristics. Quaternary sediments are found at the lowest points in the catchments adjacent to drainage lines and consist of dark grey silts and clays but these are not discussed in this report.

5.1.2.1 Permian Sand aquifer

The Permian sediments consist of unconsolidated sands, silts and clays with occasional gravel beds that are known as the Cape Jervis Formation. This aquifer is generally low-yielding, except in the northern Myponga Basin where the Tertiary limestone aquifer, which otherwise overlies the Permian Sand aquifer, is absent. Here, the aquifer shows generally good yields and low salinity; however, high clay content in some areas can lead to lower yields and higher salinities.

5.1.2.2 Tertiary limestone aquifer

The Tertiary limestone aquifer is restricted in extent to isolated basins, such as Myponga and Hindmarsh Tiers. The Tertiary limestone aquifer is an important source of water where it contains good quality groundwater and is confined by the overlying Quaternary clays, which may cause seasonal artesian conditions. This aquifer is widely developed for irrigation, primarily of dairy pasture in the Myponga and Hindmarsh Tiers Basins in the south of the PWRA on the Fleurieu Peninsula.

5.2 Fractured rock aquifers - water level

During 2019–20, the majority (54%) of fractured rock aquifer monitoring wells show levels below-average to lowest-on-record (Section 2.3.1). These wells are distributed widely across the aquifer with clusters near Lobethal, Woodside and Mount Bold Reservoir (Figure 5.1).

The change in water level over the past 20 years ranged from a decline of 26.19 m to a rise of 34.12 m (the median change is a decline of 1.32 m).

Five-year trends in water levels (2015–2019) are declining in 91% of wells, with rates ranging from a decline of 2.68 m/y to a rise of 1.33 m/y (the median rate is 0.37 m decline per year) (Figure 5.2).

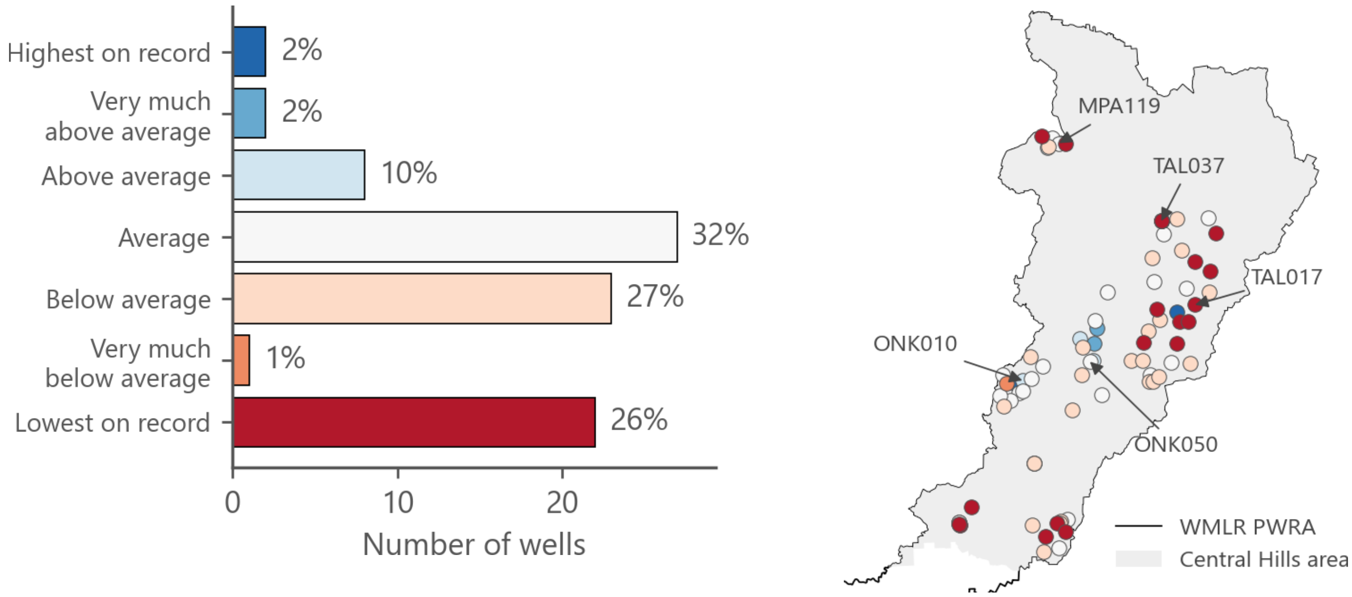

Figure 5.1. 2020 recovered water levels for wells in the fractured rock aquifers

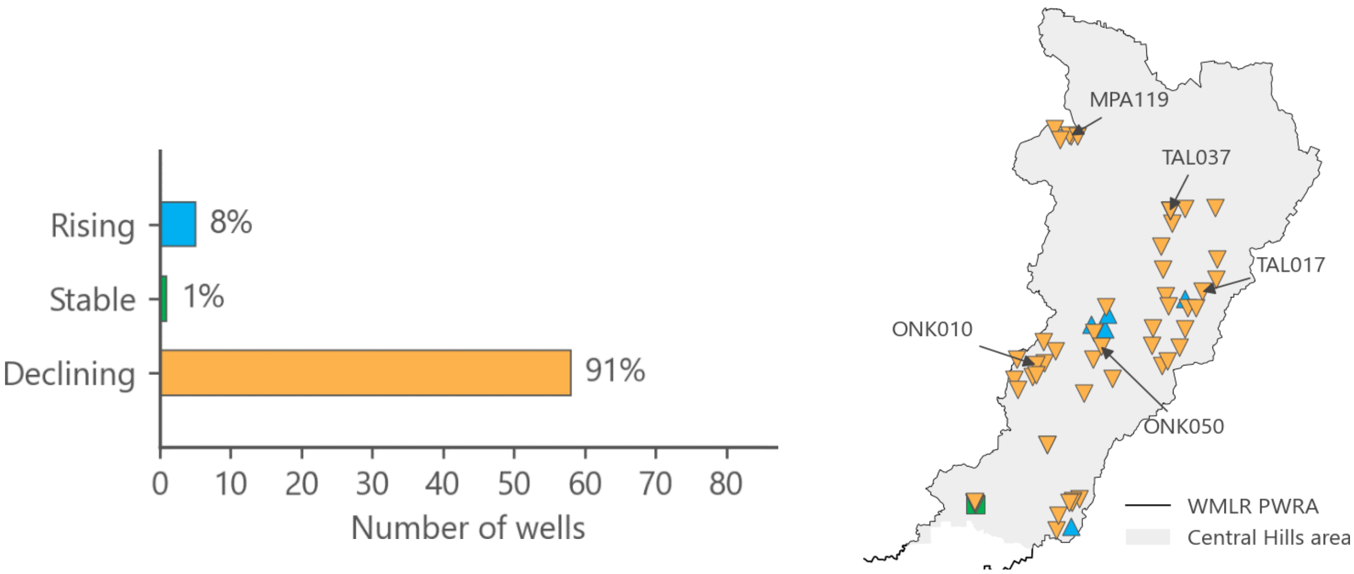

Figure 5.2. 2016–20 trend in recovered water levels for wells in the fractured rock aquifers

Hydrographs from a selection of fractured rock aquifer monitoring wells illustrate common or important trends (Figure 5.3). Monitoring well ONK010 is located at Uraidla and displays large seasonal variations. Groundwater levels were generally stable from the start of monitoring until 2000 when levels gradually rose up to the highest levels on record in 2016, in response to rainfall events. In 2020, the water level is above-average at this site. Monitoring well ONK050, located south of Lenswood, shows stable water levels since monitoring began in 2002.

TAL017 and TAL037 are located at Mount Torrens and north of Gumeracha and show a gradual decline since monitoring began. These wells show their lowest levels in 2020 but, the length of record is relatively short (around 10–20 years) for these wells.

At MPA119, located at One Tree Hill, water levels show a steady rate of decline from 1985 to 1999, followed by recovery up until 2005. Groundwater levels declined from 2005 to 2009 but have remained relatively stable since recovery.

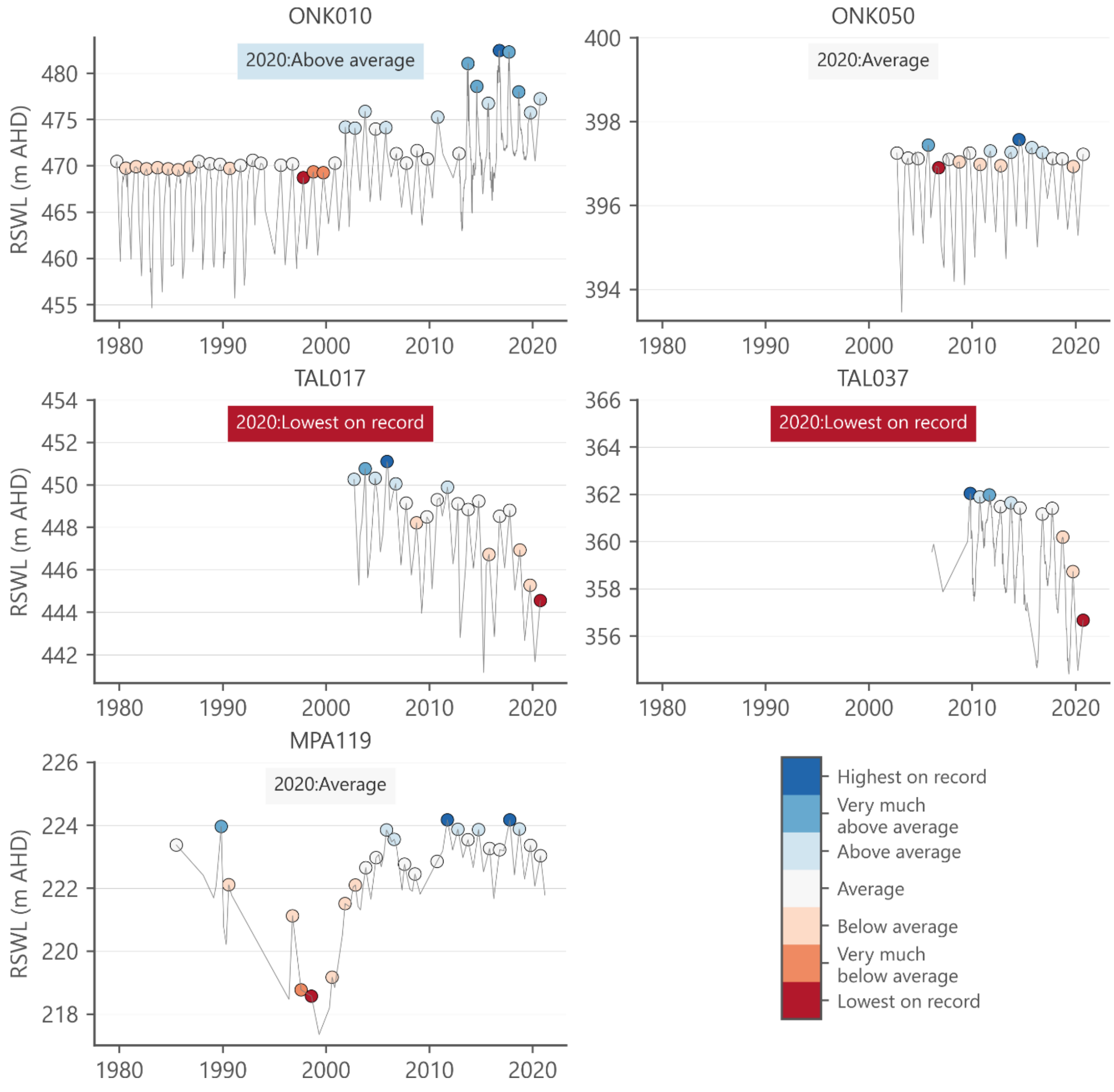

Figure 5.3. Selected fractured rock aquifer hydrographs

5.3 Fractured rock aquifers - salinity

Groundwater salinity is highly variable in the fractured rock aquifers of the WMLR PWRA and is influenced by the type of rock in which fractures occur and complex systems of preferential flow paths that affect groundwater recharge, transport and mixing through the aquifer. In 2020, results from 30 monitoring wells ranged between 110 mg/L and 3030 mg/L with a median of 805 mg/L (Figure 5.4).

In the 10 years to 2020, more than half of wells (52%) show a decrease in salinity levels (Section 2.3.2). Trends in salinity over the 10-year period vary from a decrease of 2.65% per year to an increase of 4.48% per year, with a median rate of 0.04% decrease per year (Figure 5.5).

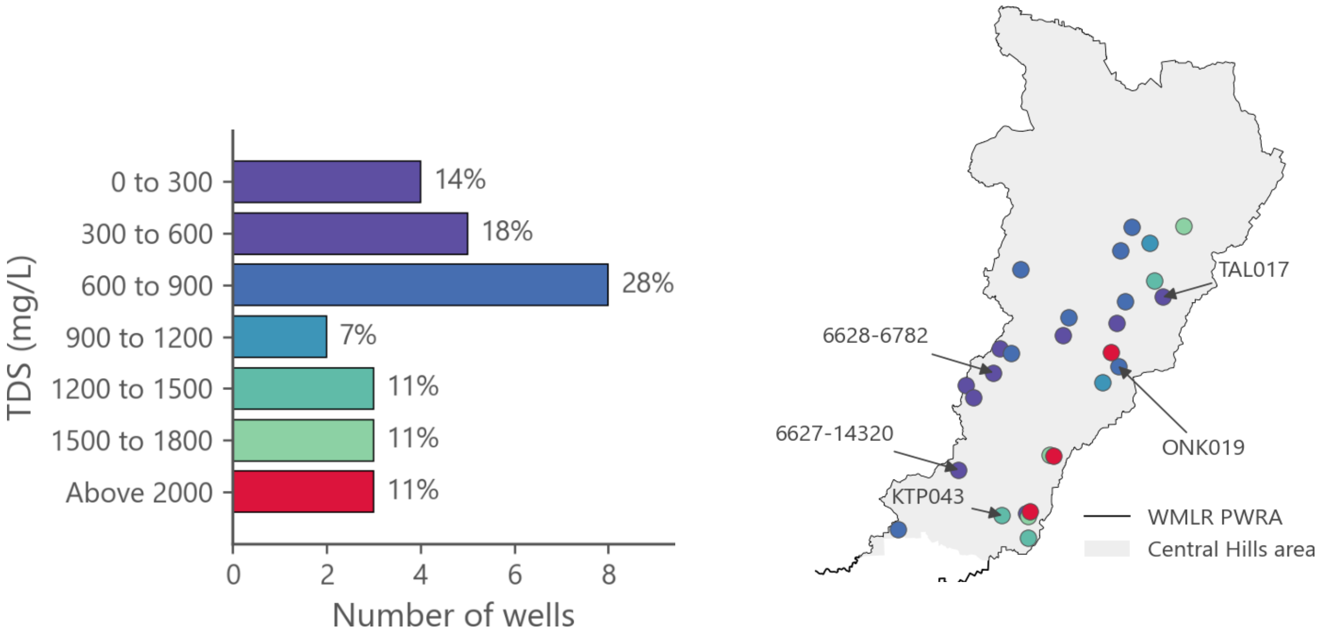

Figure 5.4. 2020 salinity observations from wells in the fractured rock aquifers

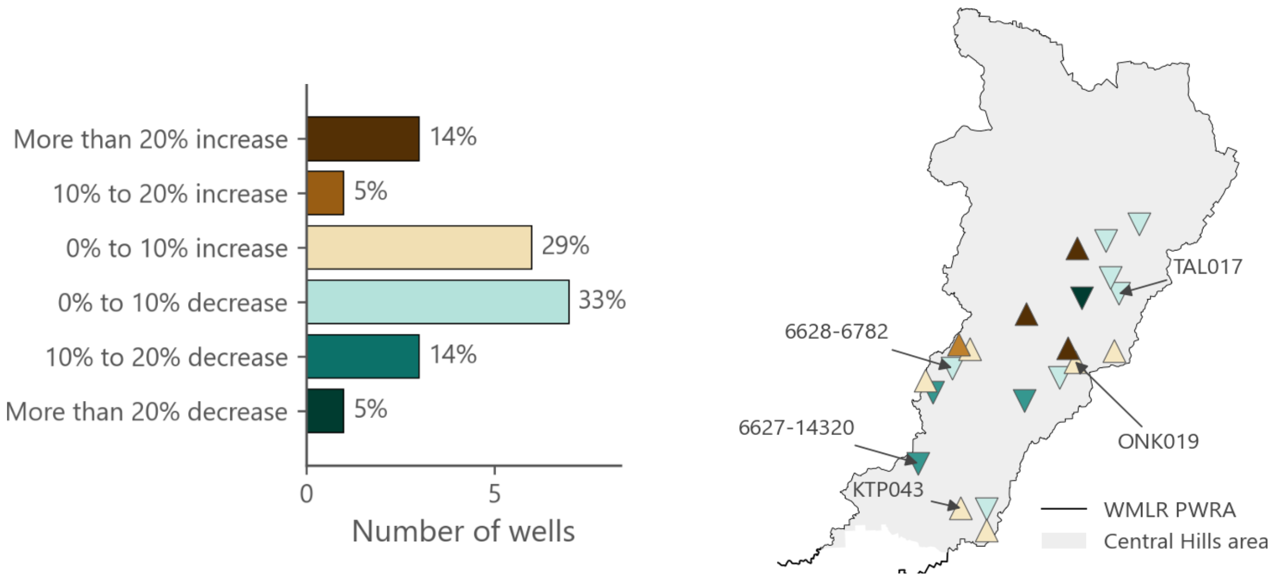

Figure 5.5. Salinity trends in the 10 years to 2020 for wells in the fractured rock aquifers

Groundwater salinities within the Adelaidean fractured rock aquifers of the Central Hills region have been largely stable over the period of record, as shown by representative salinity graphs from a selection of fractured rock aquifer monitoring wells (Figure 5.6).

Observation well 6628-6782 is located at Uraidla and from 1960, salinity is relatively stable. ONK019 at Woodside shows a gradual increase of salinity from early 2000, while TAL017 at Mount Torrens and 6627-14320 at Bradbury show gradual decreases of salinity over the same period. KTP043 is located to the west of Echunga and shows seasonal fluctuations in salinity with a gradual increasing trend over the past 20 years.

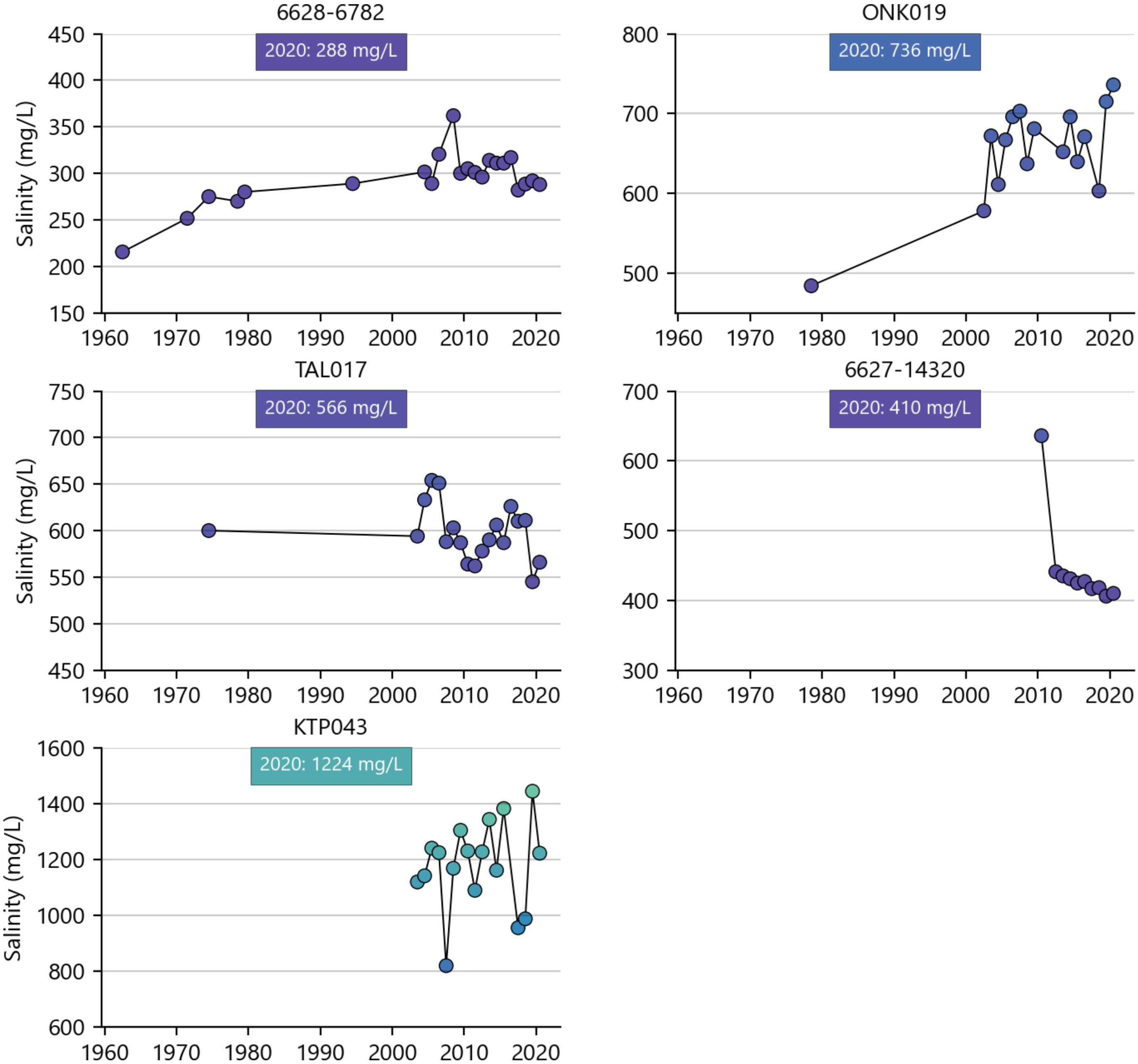

Figure 5.6. Selected fractured rock aquifer salinity graphs

5.4 Permian Sand aquifer – water level

During 2019–20, water levels observed in the majority (87%) of Permian Sand monitoring wells shows levels average or above-average when compared to their respective historical record (Section 2.3.1) (Figure 5.7). One monitoring well (13%) that is located in Myponga Basin showed a level that is below-average.

The change in water level over the past 20 years ranged from a decline of 0.67 m to a rise of 0.41 m (Section 2.3.1) (the median change is a decline of 0.47 m).

Five-year trends in water levels in the majority of wells are either rising (33%) or stable (22%), while a declining trend was observed in 45% of wells. Rates of change in water levels range from a decline of 0.27 m/y to a rise of 0.32 m/y (the median rate is 0.02 m decline per year (Figure 5.8).

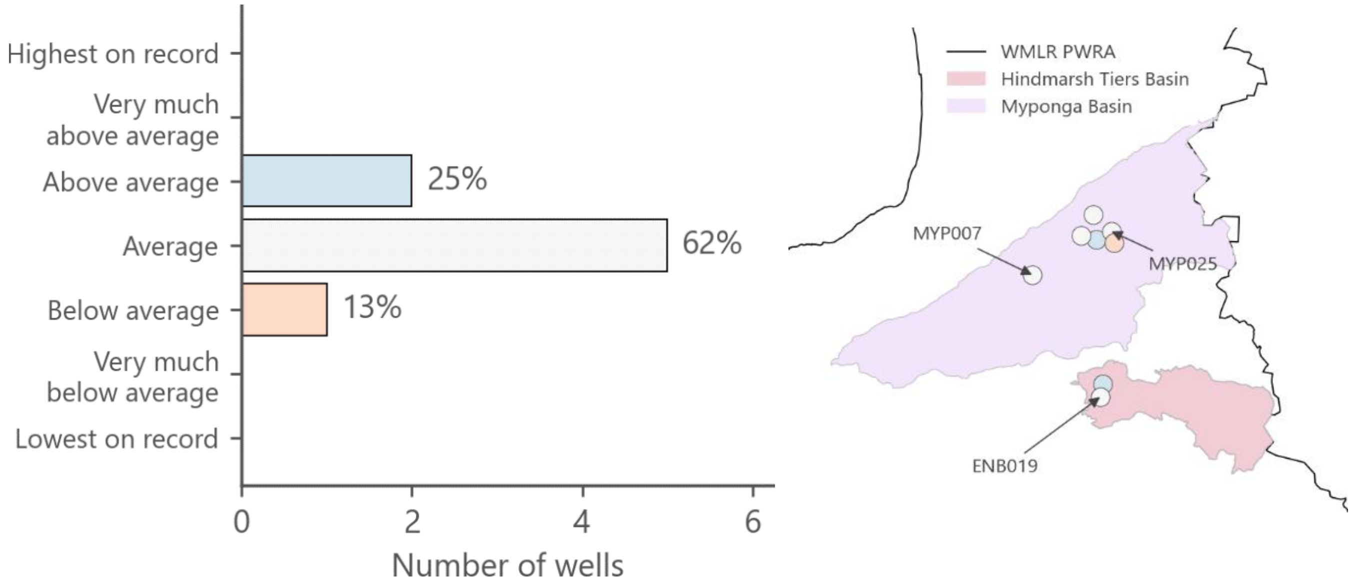

Figure 5.7. 2020 recovered water levels for wells in the Permian Sand aquifer

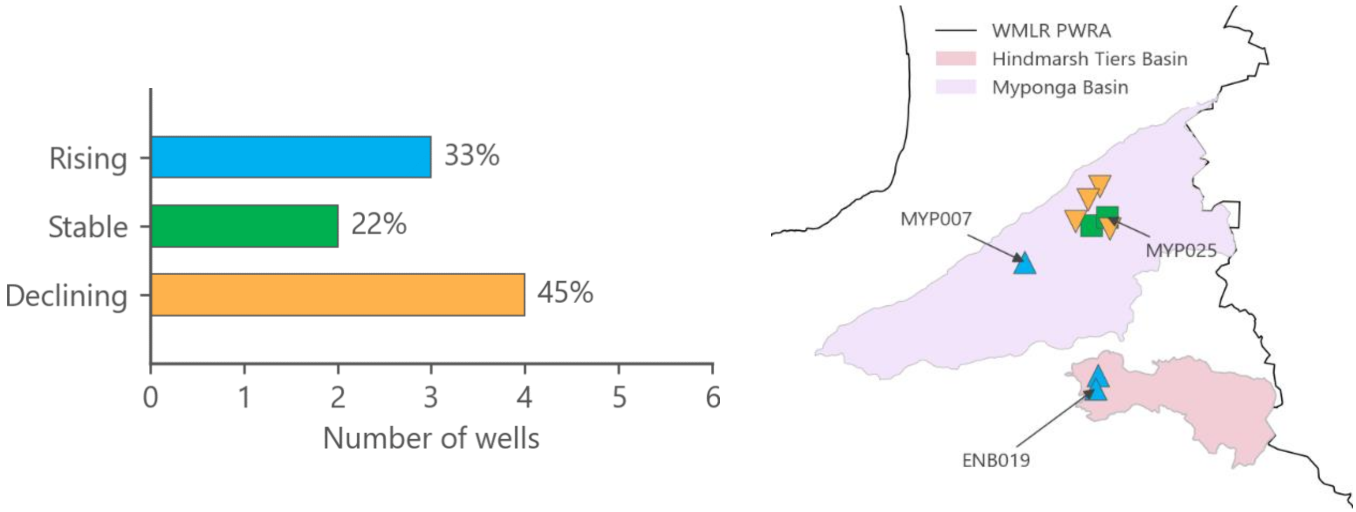

Figure 5.8. 2016–20 trend in recovered water levels for wells in the Permian Sand aquifer

Hydrographs from a selection of Permian Sand aquifer monitoring wells illustrate common or important trends (Figure 5.9). The Permian sand aquifer displays large seasonal variations in groundwater levels in both the Myponga and Hindmarsh Tiers Basins. Groundwater levels in the Myponga Basin were relatively stable between 1975 and 1995 (e.g. MYP007). Since 2001, groundwater levels have declined by up to two metres (e.g. MYP007 and MYP025). These declines correlate with below-average rainfall recorded over this period, which is likely to have reduced recharge to the aquifer and increased the demand for groundwater. Groundwater levels have been relatively stable since 2010.

In the Hindmarsh Tiers Basin, groundwater levels rose slightly between 1983 and 1993 (e.g. ENB019). Between 1993 and 1999, levels declined by around two metres. Levels were relatively stable between 1999 and 2004, after which they have declined slightly, with a gradual recovery from 2009 to 2016. In 2020, water levels were average when compared to their respective long term record (Section 3.2.1).

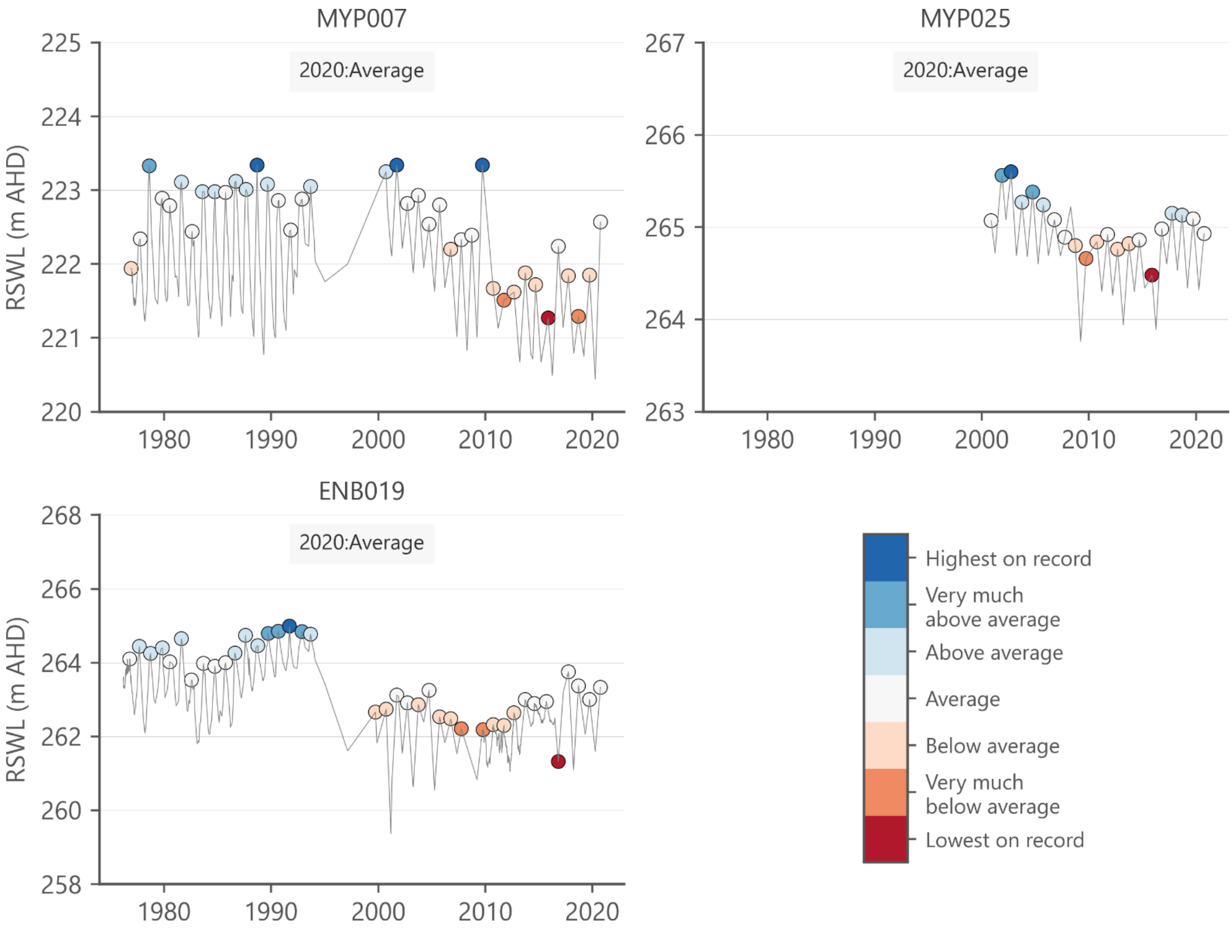

Figure 5.9. Selected hydrographs for the Permian Sand aquifer

5.5 Tertiary limestone aquifer – water level

During 2019–20, the majority (63%) of Tertiary limestone aquifer monitoring wells showed water levels that were average when compared to their respective historical record (Section 3.2.1) (Figure 5.10).

The change in water level over the past 20 years ranged from a decline of 1.68 m to a rise of 2.72 m (the median change is a decline of 0.41 m).

Five-year trends show declining water levels in all wells. Rates of decline in water levels range from 0.08 m/y to 1.70 m/y (the median rate of decline is 0.23 m/y (Figure 5.11).

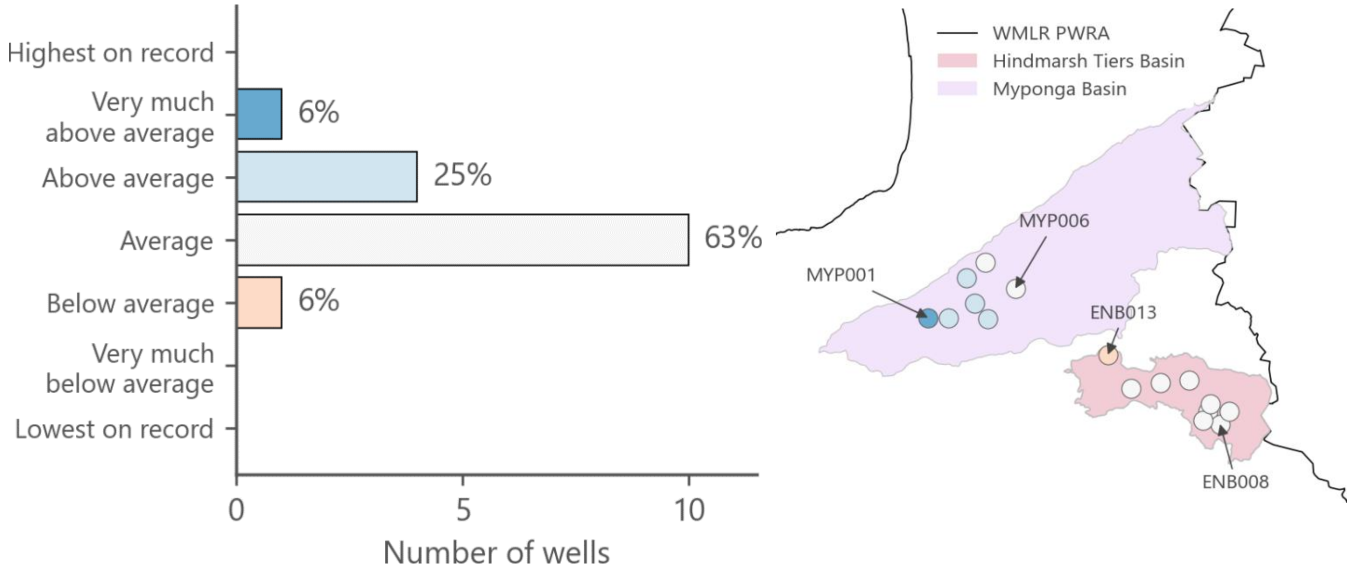

Figure 5.10. 2020 recovered water levels for wells in the Tertiary limestone aquifer

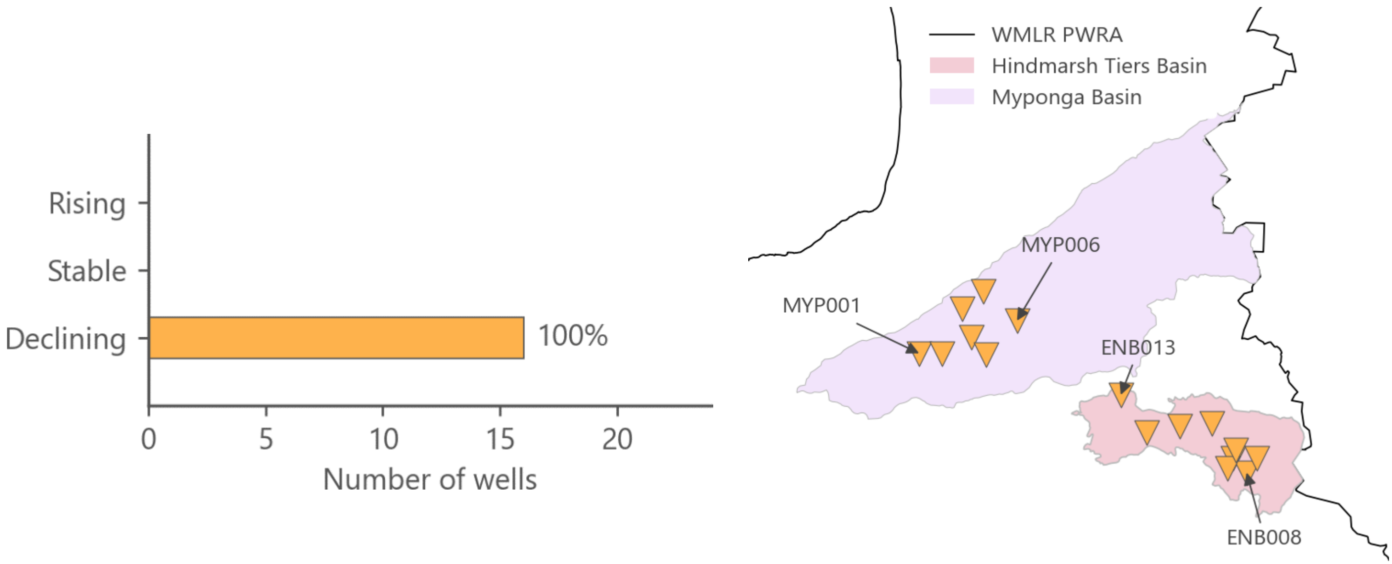

Figure 5.11. 2016–20 trend in recovered water levels for wells in the Tertiary limestone aquifer

Hydrographs from a selection of Tertiary limestone aquifer monitoring wells illustrate common or important trends (Figure 5.12). Groundwater levels display large seasonal fluctuations from annual extractions due to the confined nature of the Tertiary limestone aquifer where it occurs within the Myponga and Hindmarsh Tiers Basins. Winter-recovered groundwater levels in the Myponga Basin have remained stable since monitoring began in 1975, with a period of lower-than-average levels (Section 2.3.1) between 2005 and 2009 (e.g. MYP001 and MYP006).

Towards the eastern margin of the Hindmarsh Tiers Basin, groundwater levels have steadily declined since 1975 (e.g. ENB008), followed by a recovery in levels between 2008–16. The increase in groundwater levels may be attributed to the wetter conditions during 2009–11, particularly the unusually wet summer of 2010–11. The groundwater level in 2020 was classified as average when compared with the historical record (Section 2.3.1). Towards the western side of the basin, ENB013 indicates that winter-recovered water levels have remained relatively stable since monitoring began in 1975.

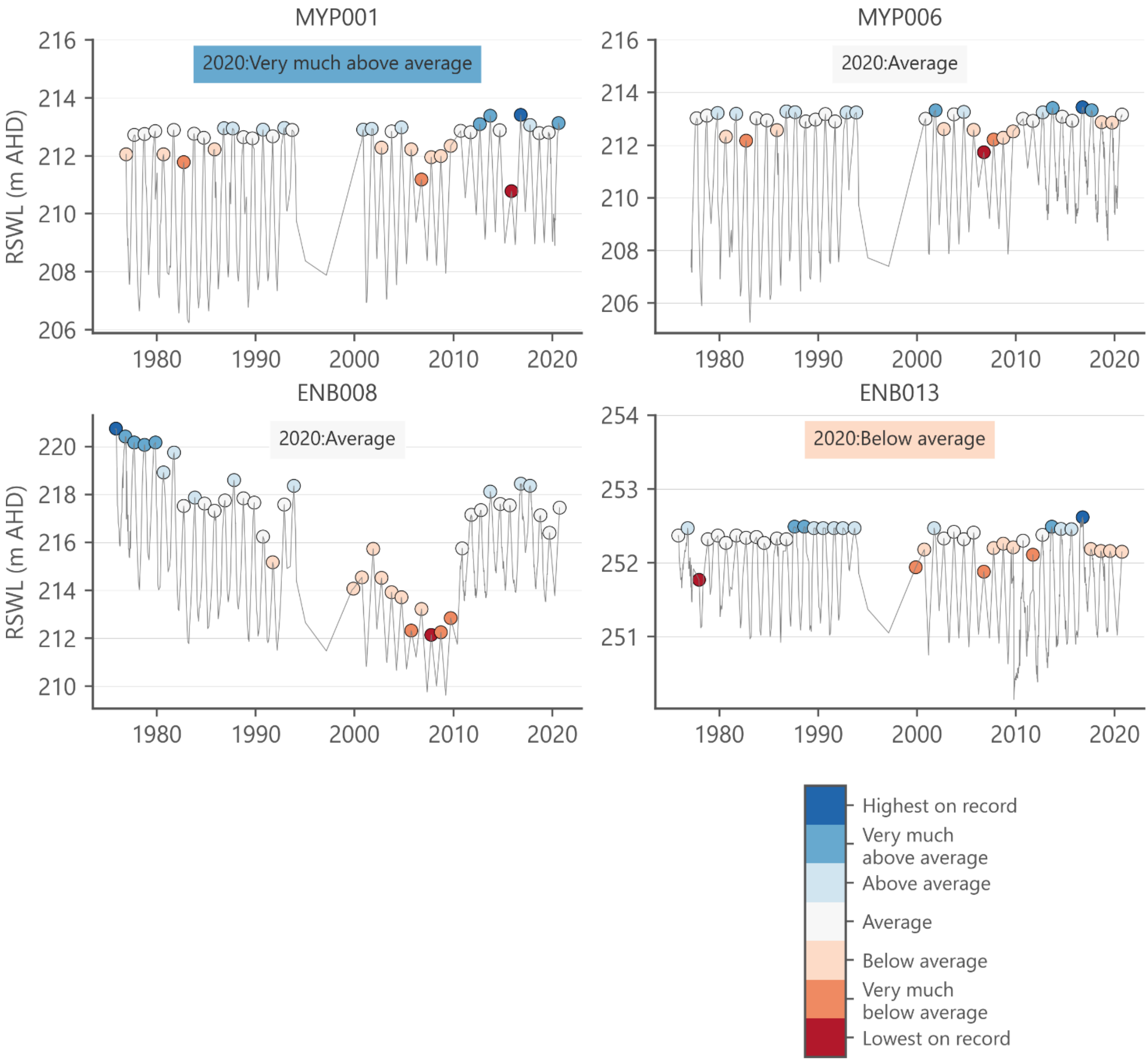

Figure 5.12. Selected hydrographs for wells in the Tertiary limestone aquifer

6 Water use

The WMLR PWRA contains approximately 11 500 wells (2860 are recorded as stock and domestic wells), 13 000 dams and 250 watercourse extraction points (AMLR NRM Board 2013). The PWRA contains eight water supply reservoirs distributed throughout the Little Para River, South Para River, River Torrens, Onkaparinga River and Myponga River catchments.

Demand for water across the PWRA includes crop irrigation (particularly viticulture), intensive animal farming, mining, forestry, aboriginal water needs, commercial, industrial, town water supply and recreational uses. There is high demand for consumptive uses of the water resources and as such, the needs of water-dependent ecosystems are accounted by determining environmental water requirements and provisions, as outlined in the WMLR WAP (AMLR NRM Board 2013). The watercourses, wetlands and swamps (including the Fleurieu Peninsula swamps) are often of high conservation value.

The total volume of licensed water use in 2019–20 was 98 173 ML. This includes surface water volumes (Figure 6.1 and Section 6.1) and metered groundwater extraction (Figure 6.2 and Section 6.2).

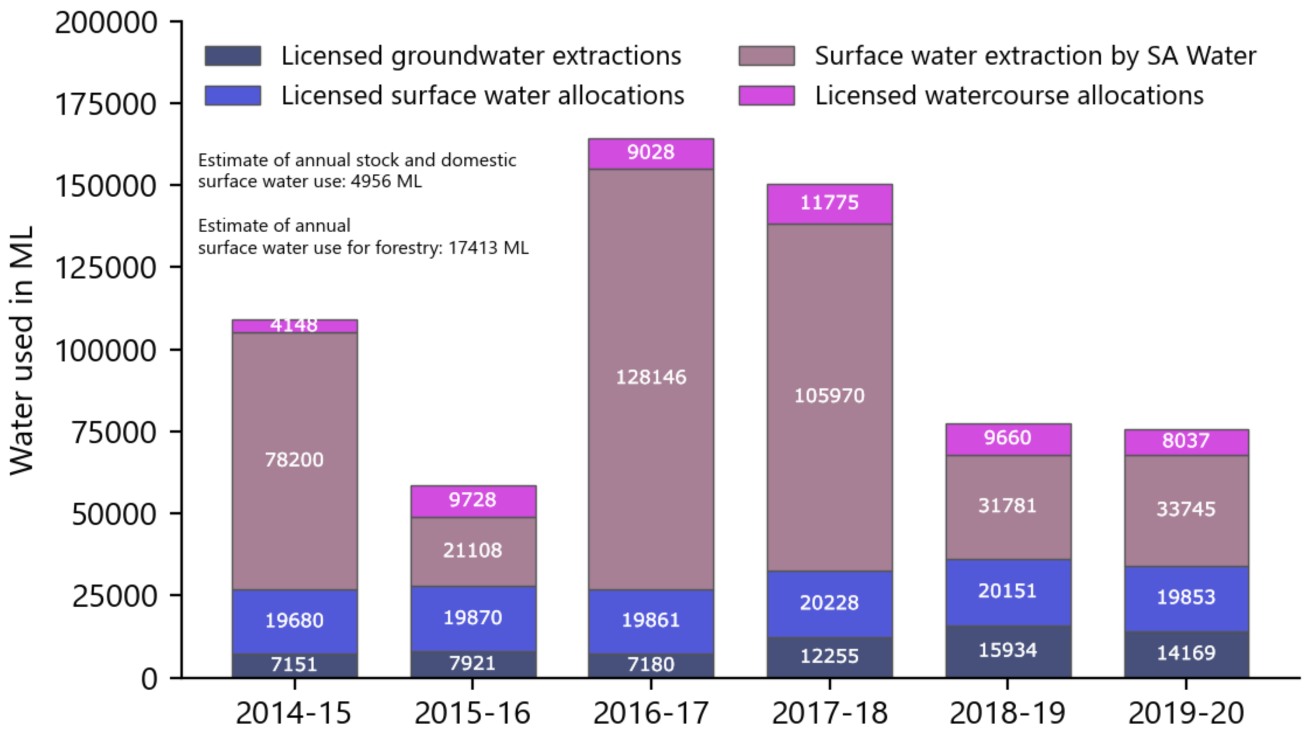

Figure 6.1. Licensed water use from 2014–15 to 2019–20 for the WMLR PWRA

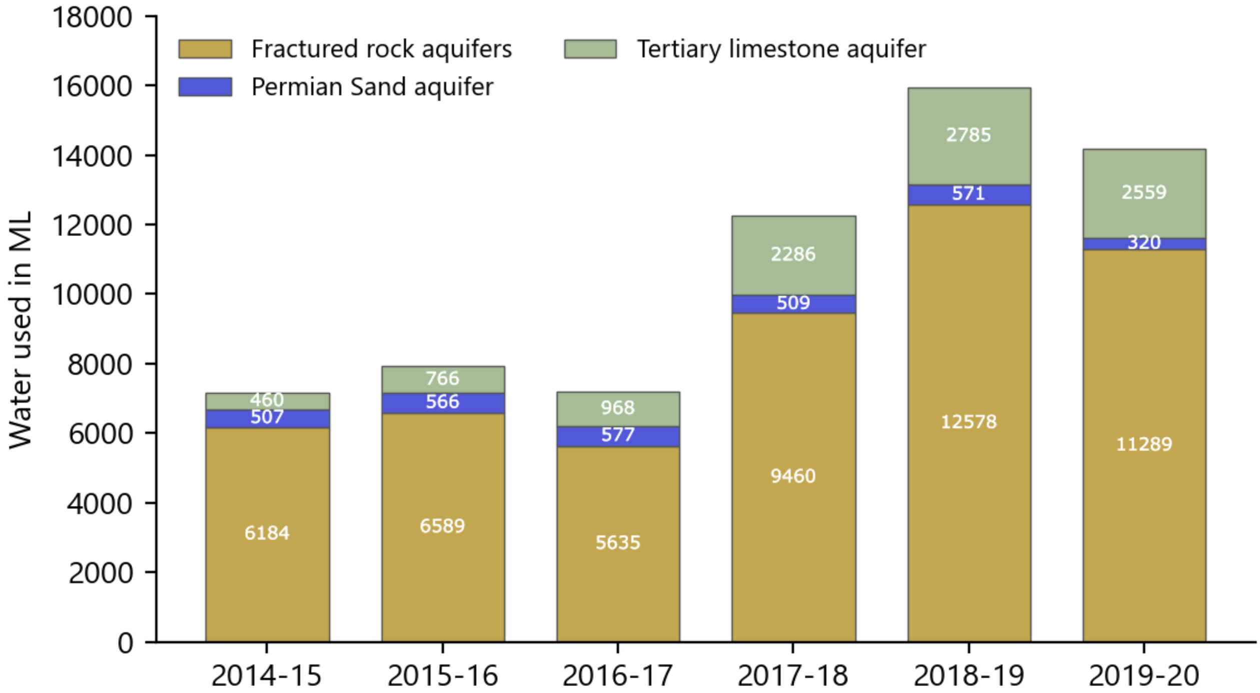

Figure 6.2. Metered groundwater extraction for the WMLR PWRA

6.1 Groundwater use

Groundwater is extracted for a range of purposes, such as irrigation of crops, town water supply and stock and domestic use. Licensed water take for irrigation and town water supply is metered, while water take for stock and domestic purposes is generally exempt from this requirement.

In 2019–20, a total volume of 14 169 ML was extracted from all groundwater sources across the PWRA (Figure 6.2), namely:

- 80% from fractured rock aquifers.
- 2% from the Permian Sand aquifer in the Myponga and Hindmarsh Tiers Basins.
- 18% from the Tertiary limestone aquifer in the Myponga and Hindmarsh Tiers Basins.

6.2 Surface water use

Surface water use in the WMLR PWRA is not comprehensively metered and therefore this report uses licenced allocations to provide an indication of the volumes of water being used where metered data is not available.

In 2019–20, the total surface water allocation for the WMLR PWRA was estimated to be 84 004 ML (compared to 83 961 ML in 2018–19). This consists of:

- 19 853 ML licensed surface water take from dams.
- 8037 ML licensed surface water take from watercourses.
- 4956 ML water demand for stock and domestic, which is not required to be licensed. This is approximated at 30% of dam capacity and is based on analysis in the water allocation plan (AMLR NRM Board, 2013).

- 17 413 ML from plantation forestry. This is based on analysis in the water allocation plan (AMLR NRM, 2013).
- 33 745 ML from SA Water extraction (compared to 31 781 ML in 2018–19). SA Water's extraction is related to rainfall. In high rainfall years, SA Water extracts the majority of its public water supply from the WMLR, while in dry years the River Murray provides a larger percentage of SA Water's total extraction. This data is based on metered values. These values are shown in Figure 6.1.

6.2.1 Farm dams

Based on the information contained in the WMLR WAP (AMLR NRM Board 2013), there are approximately 13 000 farm dams in the PWRA. 1700 of these are used for licensed purposes and the remainder are for stock and domestic or other non-licensed purposes. The total capacity of non-licensed dams is 16 516 ML, and the estimated total surface water demand for stock and domestic use is approximately 4956 ML.

The Onkaparinga River catchment is one of the main water supply catchments in the WMLR. Detailed analysis of the farm dams in the catchment (Figure 6.3) shows that there are 3476 farm dams (764 licensed) in the Onkaparinga with a total storage capacity of 14 605 ML. Approximately 84% of dams in the Onkaparinga have a storage capacity of less than 5 ML, while contributing to only 24% of the total storage capacity. Larger dams (5 ML or greater capacity) make up only 16% of the total dam count but account for 76% of total storage capacity.

Farm dam density in the WMLR PWRA is shown in Figure 6.3. Average farm dam density for the Onkaparinga upstream of Mount Bold is 35 ML/km^2. This is high compared to some of the other catchments across the WMLR: River Torrens upstream of the Gumeracha weir (26 ML/km^2), Little Para upstream of the gauging station A5040503 (13 ML/km^2) and South Para (10 ML/km^2). Dam density varies greatly across the catchment, with headwater zones and high rainfall areas such as Lenswood Creek and the Western Branch sub-catchment having much higher farm dam density (>58 ML/km^2) in comparison to some downstream receiving zones like Cox Creek (6 ML/km^2).

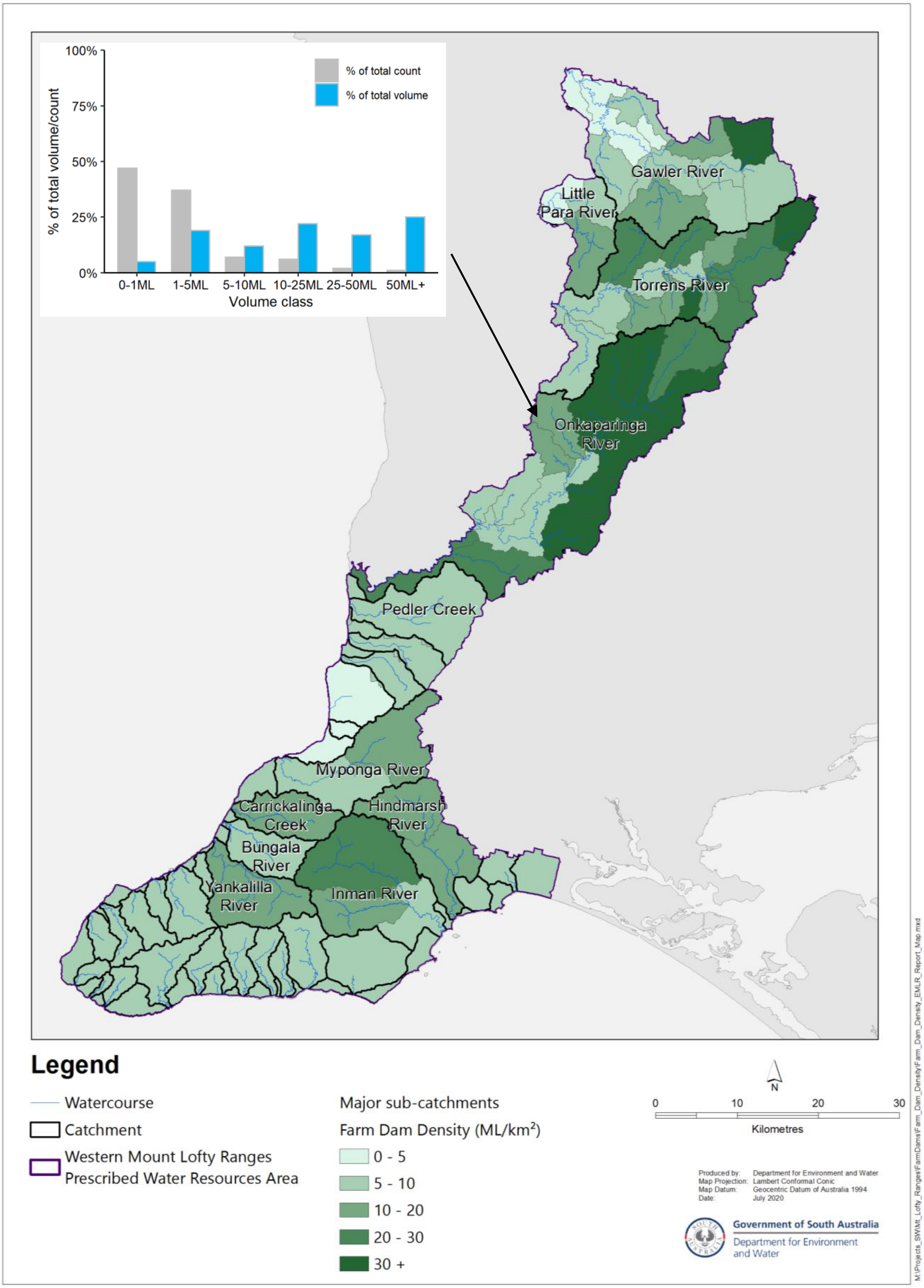

Figure 6.3. Farm dam density in the WMLR PWRA (Inset: farm dam volume and count in the Onkaparinga River catchment)

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