Clare Valley Prescribed Water Resources Area 2018-19 water resources assessment

Department for Environment and Water
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Contents

1 Summary

Rainfall

- Rainfall typically ranges from 500 to 620 mm with the higher rainfall in the central and elevated areas.
- Rainfall at Calcannia was lower than average in 2018–19. This pattern was consistently observed across the PWRA and long-term data trends indicate a decline in rainfall.
- Rainfall in early winter and spring of 2018 was below average and very dry conditions occurred in summer 2018–19.

Surface water

- Three streamflow gauging stations are used, one of which (Hill River) recorded the 'lowest on record' and the other two (Hutt and Wakefield River) recorded 'very much below average' streamflow during 2018–19.
- There is an overall declining trend with 17 of the past 20 years recording a below-average annual streamflow. No flow was recorded on the Wakefield River between July and September 2019.
- The highest salinity in the Wakefield River in 2018–19 was 5683 mg/L and 2146 mg/L in the Skillogalee Creek. These values remain within the historical ranges experienced at each site.

Groundwater

- Water levels in the fractured rock aquifer range from average to lowest on record when compared to their historic range, with a median level of 'below average'.
- For 40% of the 34 monitoring wells in the area, the observed recovered water levels were lowest on record. Five-year trends in water level showed declining trends in 80% of the wells at a median rate of decline of 0.37 m/y.
- Groundwater salinity varies widely across the area. 60% of the wells showed stable five-year trends.

Water use

- Water use 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 River Murray water via the Clare Valley Water Supply Scheme and the SA Water network.
- Water use for consumptive purposes was 4320 ML in 2018–19, which includes 2228 ML imported from the River Murray. Water sourced from within the Clare Valley included 200 ML from licensed surface water sources and 1217 ML from licensed groundwater.
- Water use was higher due to irrigation demand; this is likely to be due to the 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 Clare Valley Prescribed Water Resources Area (PWRA) 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 Clare Valley PWRA is located approximately 100 km north of Adelaide (Figure 1.1) and lies within the Northern and Yorke Landscape Region. It includes both groundwater and surface water resources. These resources are prescribed under South Australia's Landscape SA Act 2019 and a water allocation plan, adopted in 2009, provides rules for their management.

Surface water resources in the PWRA are the Broughton, Hill and Hutt River catchments in the north and the Wakefield River catchment drains to the south. The main watercourses are ephemeral, with permanent pools primarily sustained by groundwater occurring in many places.

There are two groundwater systems within the Clare Valley region: a Quaternary alluvial aquifer which occurs at shallow depths of less than 15 m in valley floors and extensive fractured rock aquifers which occur throughout the area. The fractured rock aquifers are the main groundwater system in the Clare Valley and their status is described in this report. The Quaternary alluvial aquifer provides only a small portion of the groundwater resource, mainly in the vicinity of Stanley Flat.

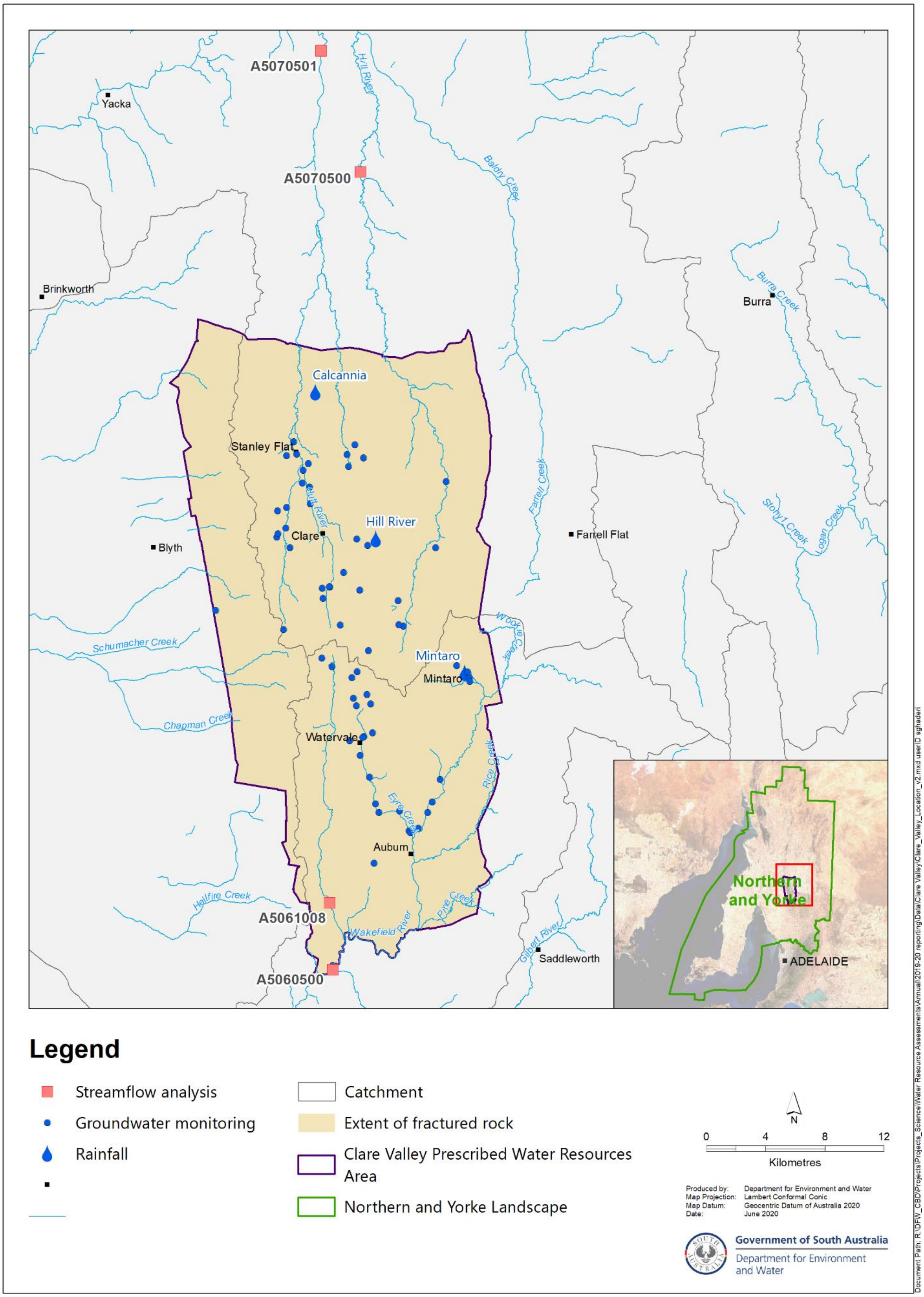

Figure 1.1. Location of Clare PWRA

2 Methods and data

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

2.1 Rainfall

Daily rainfall observations were used from selected Bureau of Meteorology (BoM) stations in order to calculate monthly and annual totals. The data were obtained from the SILO Patched Point Dataset service provided by the Queensland Government, which provides interpolated values to fill gaps in observations (Figure 3.1 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. 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

The status of each of the streamflow gauging stations is determined by expressing the annual streamflow for the applicable year as a percentile[1] of the total period of data availability. The period of data availability for the Wakefield River streamflow gauging station is 1970–71 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] Bureau of Meteorology Annual climate statement 2019

2.2.2 Monthly streamflow

Monthly streamflow for the applicable year is assessed alongside the long-term average monthly streamflow (Figure 4.3A), for the period 1970–71 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 4.3B).

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).

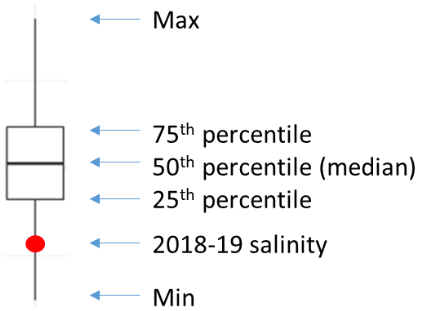

Figure 2.1 Box and whisker plot

2.3 Groundwater

2.3.1 Water level

Water level data[3] 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 observation 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 wells in the Clare Valley PWRA return to a recovered maximum level between September and December.

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 Clare Valley PWRA, any well with 8 years or more of recovered water level data is included. The number of wells in each description class for the most recent year is then summarised for each aquifer (for

[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).

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 (Figure 5.2). Fractured rock aquifers such as those in the Clare Valley have lower storages than sedimentary aquifers and 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 twenty years ago (i.e. 1998–2000) and the average water level in 2019.

2.3.2 Salinity

Water samples are collected annually from pumping irrigation wells in the Clare Valley 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. The results are shown in 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 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 (Figure 6.1).

Non-licensed water use (stock and domestic) from farm dams is not metered and is estimated at 30% of dam capacity (AMLR NRM Board, 2019). 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. 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 Clare Valley PWRA are:

- Summary reports on the surface water (DEWNR, 2011) and groundwater resources (DFW, 2010) of the Clare Valley PWRA.
- Annual surface water status reports such as (DEW, 2019a) and groundwater level and salinity status reports such as (DEW, 2019b).
- Favier et al. (2000, 2004) provide detailed river management plans for the Wakefield and Broughton River catchments.
- The Water Allocation Plan for the Clare Valley Prescribed Water Resources Area (NY NRM Board, 2009).

3 Rainfall

The Clare Valley PWRA has mild, wet winters and hot, dry summers which are typical of a Mediterranean climate. Rainfall in the Clare Valley is generally higher in more elevated areas (annual total of 600 to 620 mm) decreasing to annual totals of between 500 and 600 mm in other parts of the PWRA.

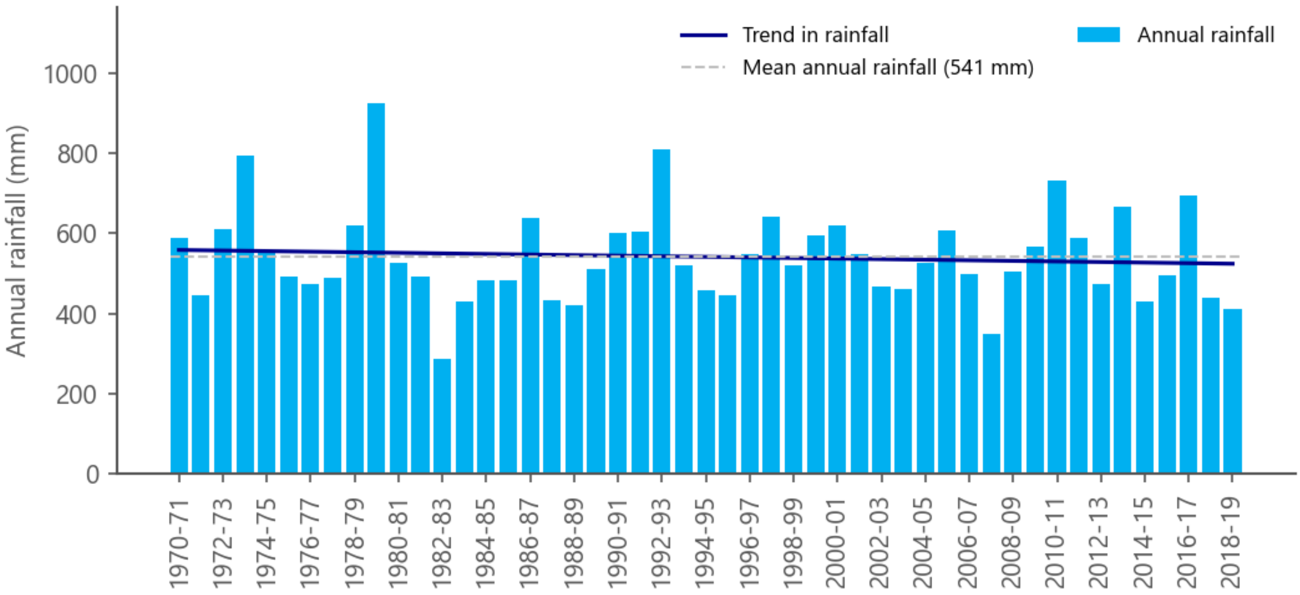

Figure 3.1 Annual rainfall for 1970–71 to 2018–19 at the Calcannia rainfall station (21075)

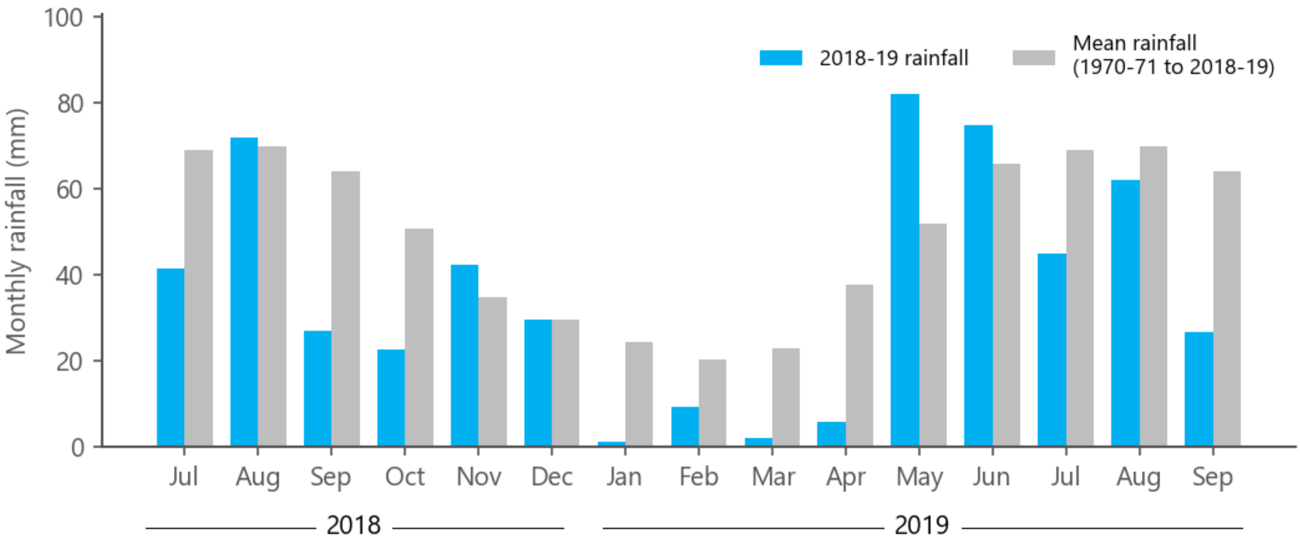

Figure 3.2 Monthly rainfall between July 2018 and September 2019 at the Calcannia rainfall station (21075)

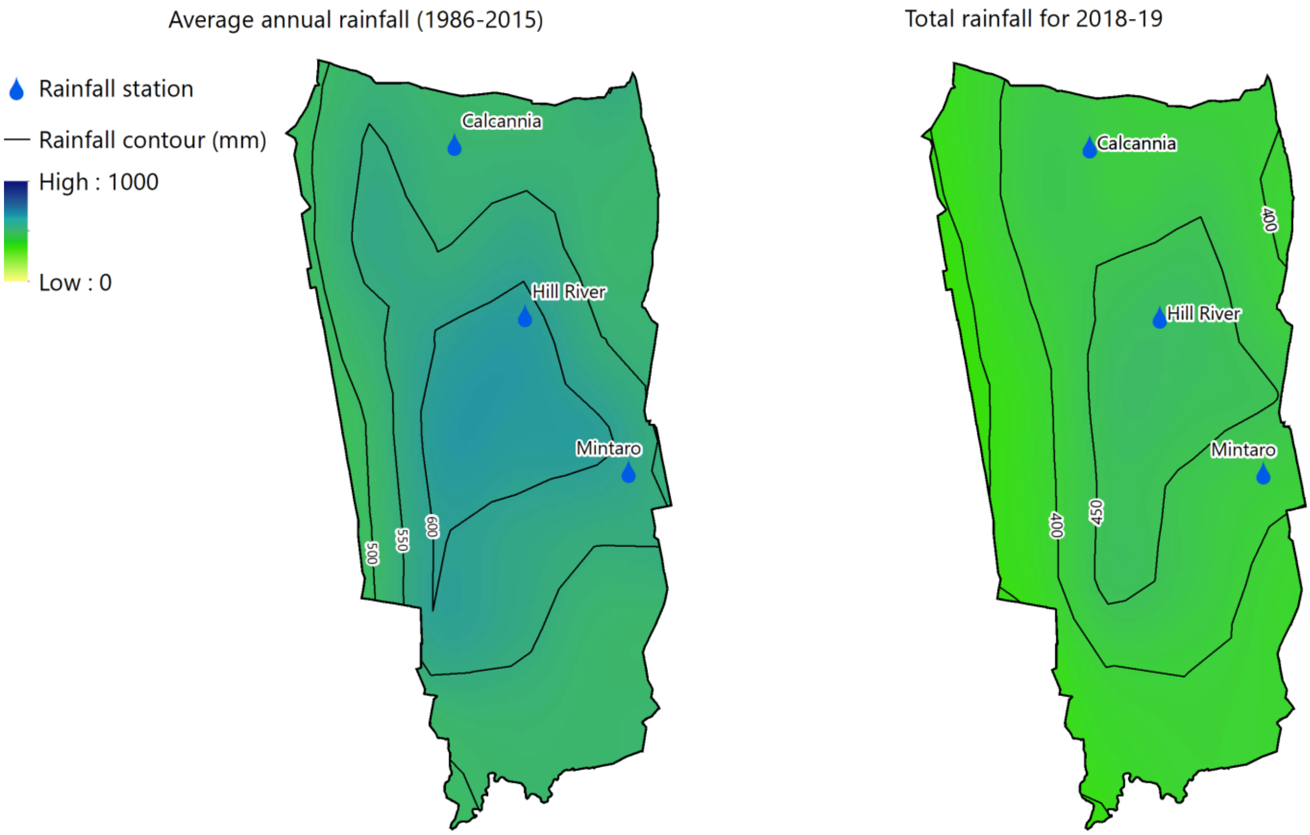

Figure 3.3 Rainfall in the Clare Valley PWRA for 2018–19 compared to the 30-year average (1986-2015)

- The Calcannia rainfall station (BoM station 21075) is located at the northern edge of the PWRA. The annual total recorded for 2018–19 was 410 mm. This was 131 mm lower than the annual average rainfall of 541 mm (1970-71 to 2018–19). Annual rainfall was below average for the last 4 out of 5 years.
- Rainfall at other stations in the PWRA was also below average in 2018–19:
  - Hill River (BoM station 21025), in the central part of the PWRA, recorded 463 mm in 2018–19 compared to an average of 633 mm (170 mm lower than the average).
  - Mintaro (BoM station 21033), on the eastern edge of the PWRA, recorded 441 mm in 2018–19 compared to the average of 587 mm (146 mm lower than the average).
- Conditions in early winter 2018 and early spring 2018 were drier-than-average. In particular, the summer of 2018–19 was very dry compared to average conditions (Figure 3.2).
- Rainfall in 2018–19 was consistently lower than the long-term average across the PWRA, but the general pattern of slightly higher rainfall in the central and elevated parts of the PWRA was still observed (Figure 3.3)[4].

[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 topography in the Clare Valley PWRA essentially divides the area between the north and the south. The northern area comprises part of the Broughton River catchment that drains to Spencer Gulf near Port Pirie, as well as the ephemeral Hill and Hutt Rivers. The southern area comprises part of the ephemeral Wakefield River catchment that drains to Saint Vincent Gulf near Port Wakefield. Trends in streamflow and salinity are primarily rainfall 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. Prolonged drier-than-average rainfall years combined with hotter and drier conditions associated with changing climate is expected to have direct implications to management of water resources in the Clare Valley PWRA.

Three streamflow gauging stations (Figure 1.1) are used as representative stations when assessing streamflow in the Clare Valley PWRA (Figure 4.1):

- Wakefield River (A5060500) gauging station, located at the downstream outlet of the PWRA.
- Hill River (A5070500) and the Hutt River (A5070501) gauging stations are located outside the PWRA but provide representative data for the region and are used to inform the streamflow analysis. Some of the upstream catchment area of these two gauging stations is located outside of the PWRA.

In 2018–19, lower-than-average streamflow was recorded in all three of the representative gauging stations (Figure 4.1). The Hill River recorded 'lowest on record' streamflow and the Hutt and Wakefield Rivers, 'very much below average' streamflow. Further detail on methodologies used for analysis can be found in Section 2.

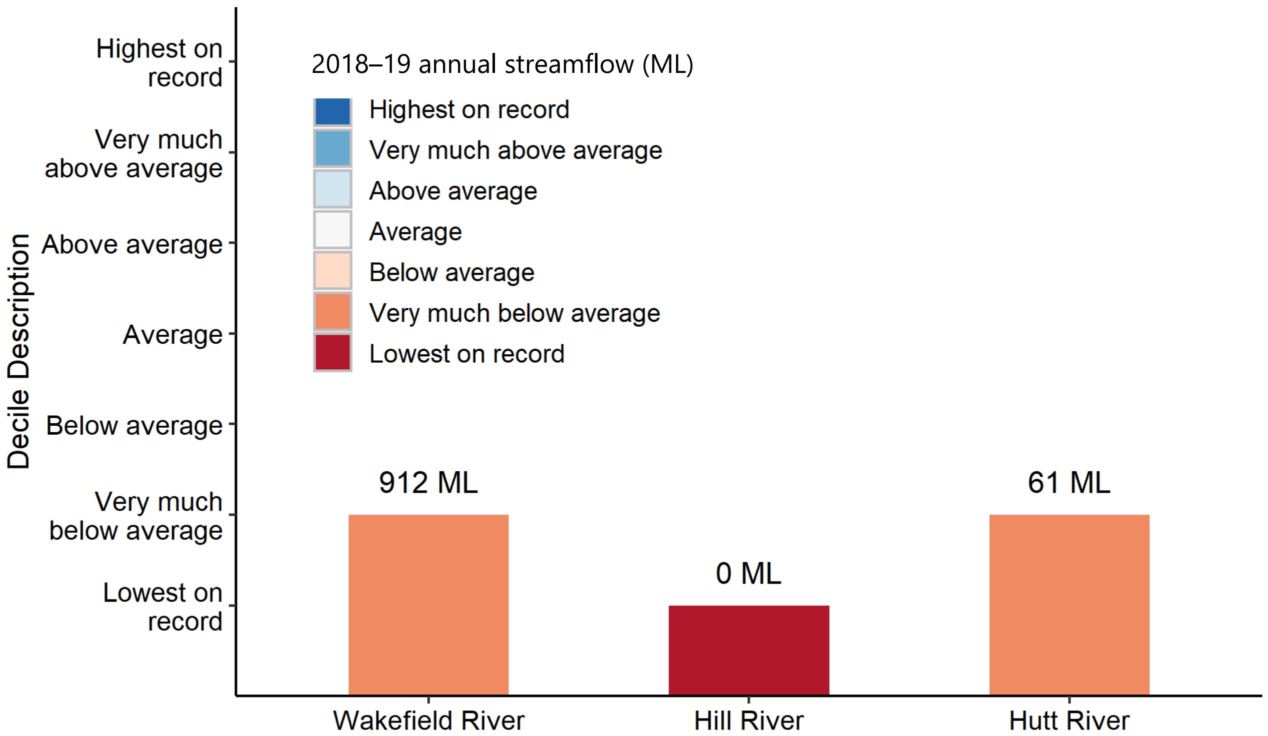

Figure 4.1 Clare Valley PWRA annual streamflow summary 2018–19

4.1.1 Wakefield River (A5060500)

The principal long-term streamflow gauging station for the PWRA is located on the Wakefield River at the outlet of the catchment and covers a catchment area of 416 km^2.

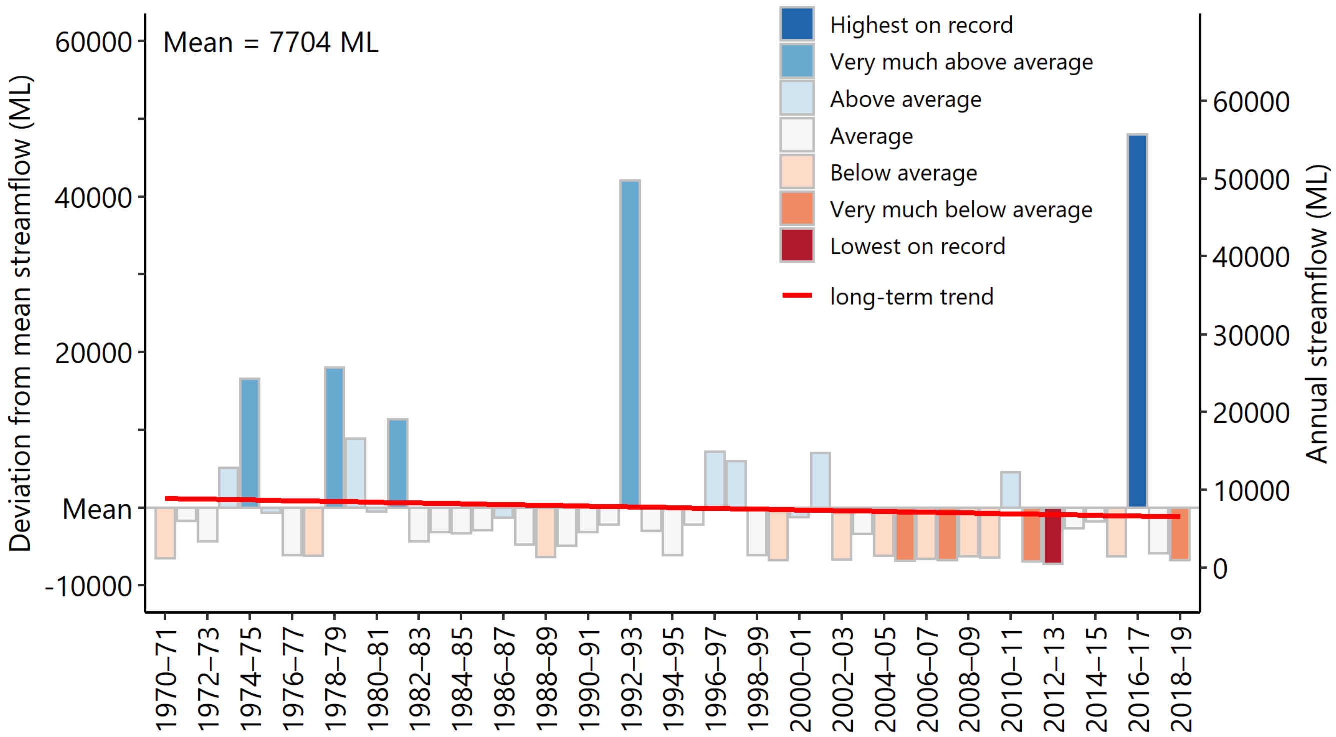

Figure 4.2 Annual deviation from mean streamflow at the Wakefield River (1970–71 to 2018–19)

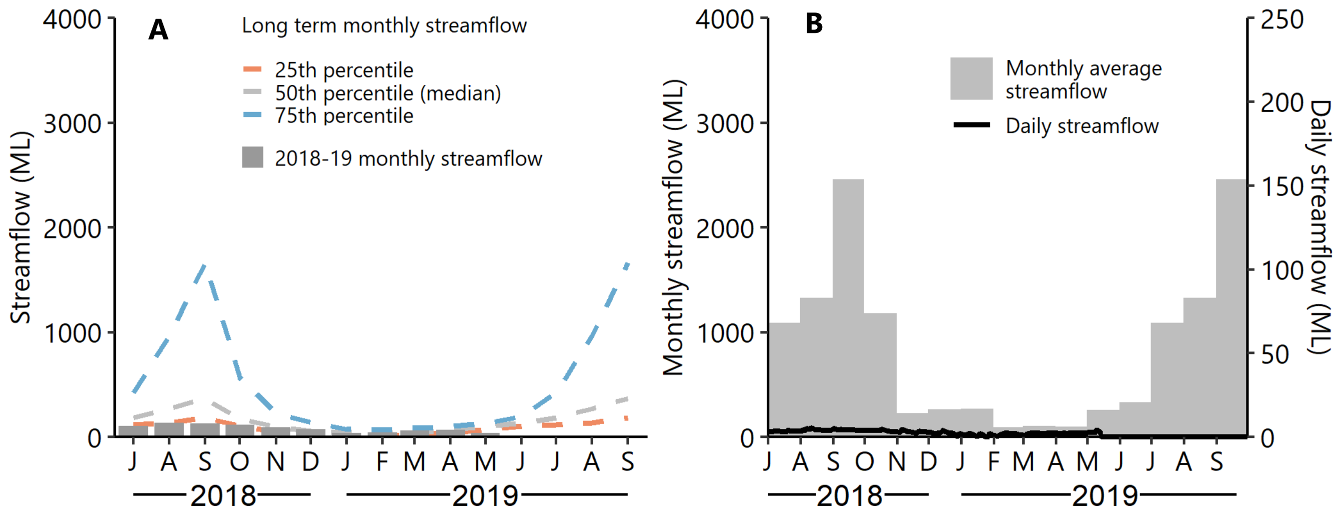

Figure 4.3 (A) Long-term monthly statistics and 2018–19 monthly streamflow on the Wakefield River; (B) Long-term average monthly streamflow and 2018–19 daily streamflow on the Wakefield River

The deviation of each individual year's streamflow from the long-term average streamflow is shown in Figure 4.2. The Wakefield River gauging station recorded an annual streamflow of 912 ML in 2018–19, which is almost 6800 ML (88%) below the average annual streamflow of 7704 ML (1970–71 to 2018–19).

The annual total is ranked as 'very much below average' assessed for the period 1970–71 to 2018-2019. Annual streamflow at the Wakefield River gauging station indicates a long-term declining trend, with 13 out of the last 15 years experiencing flows below the average annual streamflow (Figure 4.2).

Figure 4.3A shows the monthly streamflow for 2018–19 (grey bars) relative to the long-term monthly streamflow (1970–71 to 2018–19) for (a) low flows (25th percentile), (b) median flows (50th percentile) and high flows (75th percentile). Flow was persistent throughout the majority of 2018–19 however, lower streamflow is typically experienced in the months of February to May. In the period from July to September 2019, zero flows were recorded at the Wakefield River streamflow gauging station.

Figure 4.3B presents the long-term average monthly streamflow (1970–71 to 2018–19) and the daily flows for 2018–19. Maximum daily flows were recorded in August 2018 and there were 47 zero flow days experienced in 2018–19. The majority of these were in June 2019.

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 at the Wakefield River (A5060500) and Skillogalee Creek (A5061008) streamflow gauging stations in the PWRA and they provide a good indication of salinity in the PWRA.

Figure 4.4 shows the long-term monthly salinity statistics for the period 1992 to 2019 recorded at the Wakefield River streamflow gauging station. Median monthly salinity values for 2018–19 (red dots) are also shown in Figure 4.4.

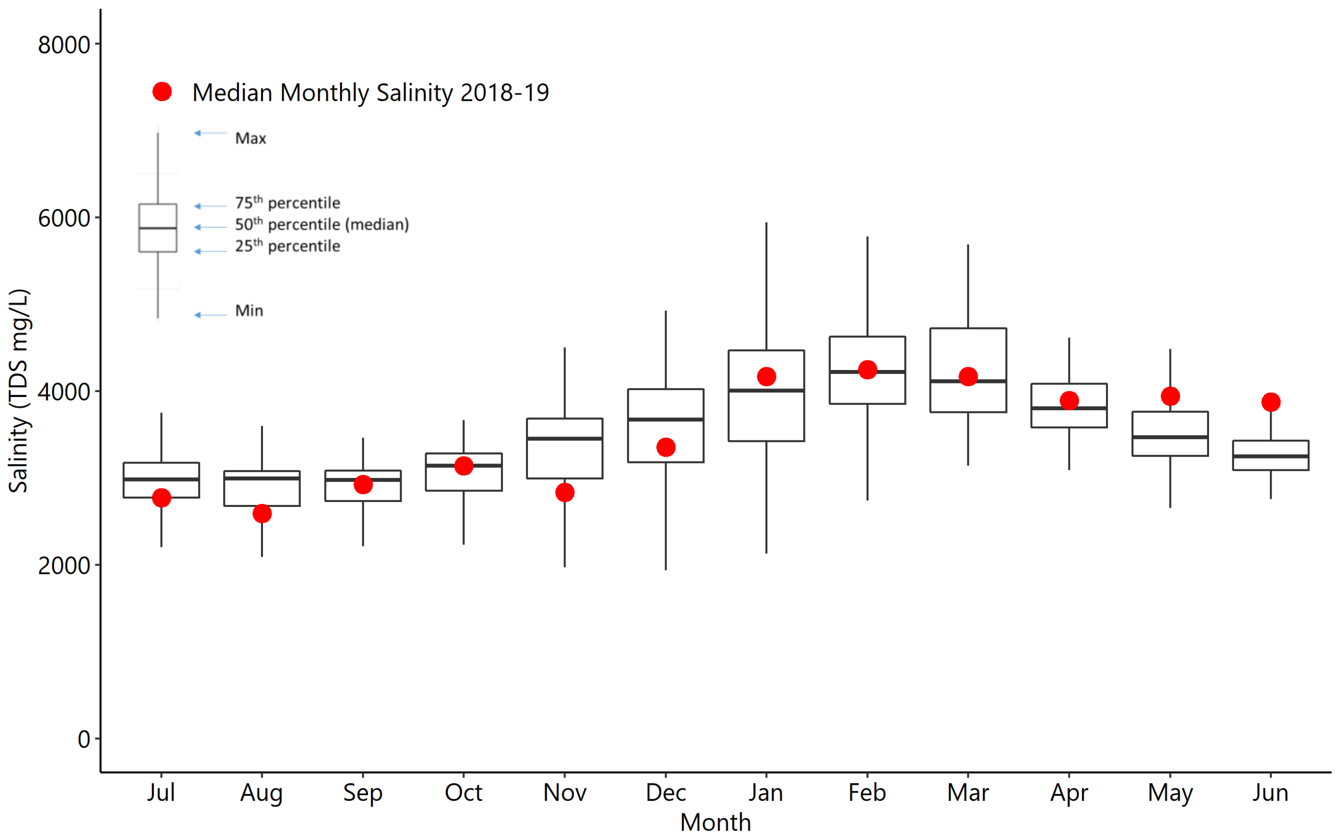

Figure 4.4 Long-term and 2018–19 monthly salinity at Wakefield River streamflow gauging station (A5060500)

Over 70% of the salinity values recorded at the Wakefield River streamflow gauging station are between 2500-4000 mg/L. The long-term monthly data at this site indicates a lower variability in monthly salinity, which is indicated by the smaller range between the minimum and maximum values.

The 2018–19 median salinity values remain within the historical range of salinities experienced each month and higher salinity is typically experienced in the summer months when there is less dilution of salts. The highest salinity recorded at the Wakefield River streamflow gauging station in 2018–19 was 5683 mg/L. Salinity is also measured on the Skillogalee Creek and this site is comparably less saline than the Wakefield River with 92% of salinity data less than 2500 mg/L. The highest salinity recorded on the Skillogalee Creek in 2018–19 was 2146 mg/L.

5 Groundwater

There are two groundwater systems within the Clare Valley region: a Quaternary alluvial aquifer which occurs at shallow depths of less than 15 m in valley floors and extensive fractured rock aquifers that underlie the Quaternary aquifer and occur throughout the area. The fractured rock aquifer is the main groundwater system in the Clare Valley and is the focus of this report. The Quaternary aquifer provides only a small portion of the groundwater resource.

Groundwater levels are affected by the amount of rainfall recharge to both the Quaternary and fractured rock aquifers. Periods of above-average rainfall are likely to result in rising groundwater levels and decreasing groundwater salinity, while years of below-average rainfall are likely to result in declining groundwater levels and increasing groundwater salinity.

5.1 Hydrogeology

5.1.1 Fractured rock aquifer

The fractured rock aquifer occurs in Proterozoic rocks of the Burra and Umberatana Groups, consisting of siltstones, shales, dolomites and quartzites. Four major fractured rock units provide groundwater for irrigation in the Clare region: Mintaro Shale, Saddleworth Formation, Undalya Quartzite and the Skillogalee Dolomite. Within these formations, the fractures act as conduits for groundwater flow. The yield of groundwater from a particular well is dependent on the size and spacing between fractures and the orientation of fractures intercepted. Variations in supply from individual bores are likely to be the result of fracturing or other geological structural constraints rather than the rock type.

The fractured rock aquifer can be divided into two zones; a relatively permeable zone in the upper 20-40 m within which fractures are closely spaced (generally <0.5 m apart) and a deeper, low-permeability, regional zone. The size and spacing of fractures tends to decrease with depth.

5.2 Fractured rock aquifer - water level

Following the 2018–19 irrigation season, below-average recovered water levels were observed in the majority (74%) of fractured rock aquifer monitoring wells with long-term records. These wells are spread across the area with the majority located from Stanley Flat in the north to Watervale, where most groundwater extraction occurs (Figure 5.1). In fourteen wells, the observed water level was their lowest level on record. The change in water level over the last 20 years in wells with suitable long-term records ranged from a decline of 20.0 m to a rise of 0.56 m. The median change is a decline of 3.10 m.

Five-year trends in water level are declining in 80% of wells with rates overall ranging from a decline of 1.11 m/y to a rise of 0.36 m/y (the median change over this period is a decline of 0.37 m/y; Figure 5.2).

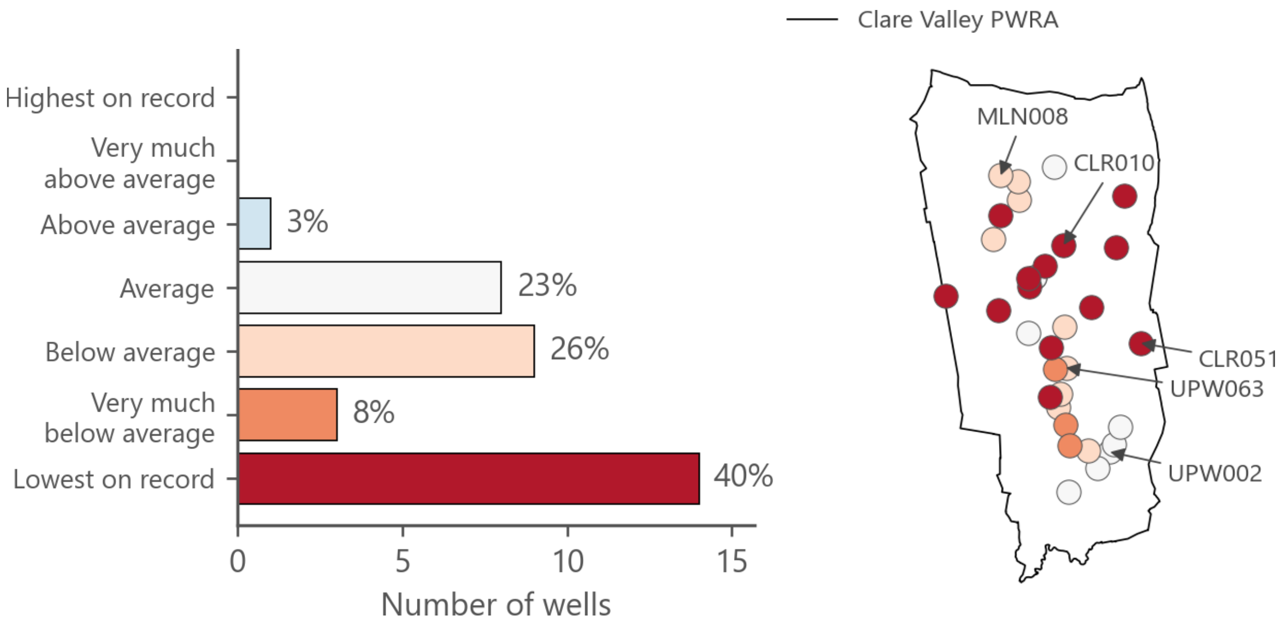

Figure 5.1 2019 recovered water levels for wells in the fractured rock aquifers

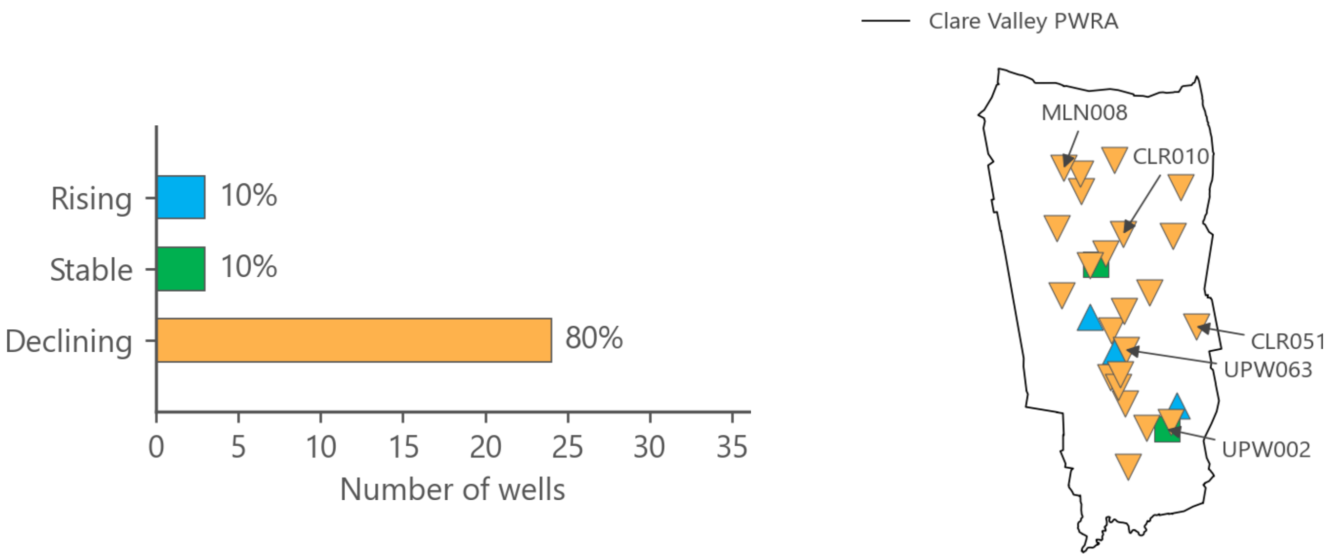

Figure 5.2 2015-2019 trend in recovered water levels for wells in the fractured rock aquifers

Groundwater is extracted from fractured rock aquifers across the entire area. Extraction volumes are slightly higher in the north, around Stanley Flat (MLN008) and Clare (CLR010), and in the southeast (UPW002). Extraction volumes are lower in the south around Watervale (UPW063).

Similar long-term trends have been observed in most monitoring wells, with a general decline of water levels from the beginning of monitoring in the 1990s until the end of the Millennium drought around 2009 (Figure 5.3). Following the drought, monitoring wells have experienced variable degrees of recovery up until 2017 and then steady decline to the present. In 2019, some monitoring wells experienced levels lower than that of the Millennium drought, which is most likely due to a number of years with below-average rainfall from 2012–2013 onwards in the northern areas as shown in Figure 3.1. In the south-east of the area, between Auburn and Mintaro, long-term trends of groundwater have been generally more stable (UPW002) and in 2019 water levels recovered to average historical levels (Figure 5.3). These monitoring wells are generally located in the vicinity of Wakefield River and it is likely that shallower parts of fractured rock aquifers gain from flows in the Wakefield River.

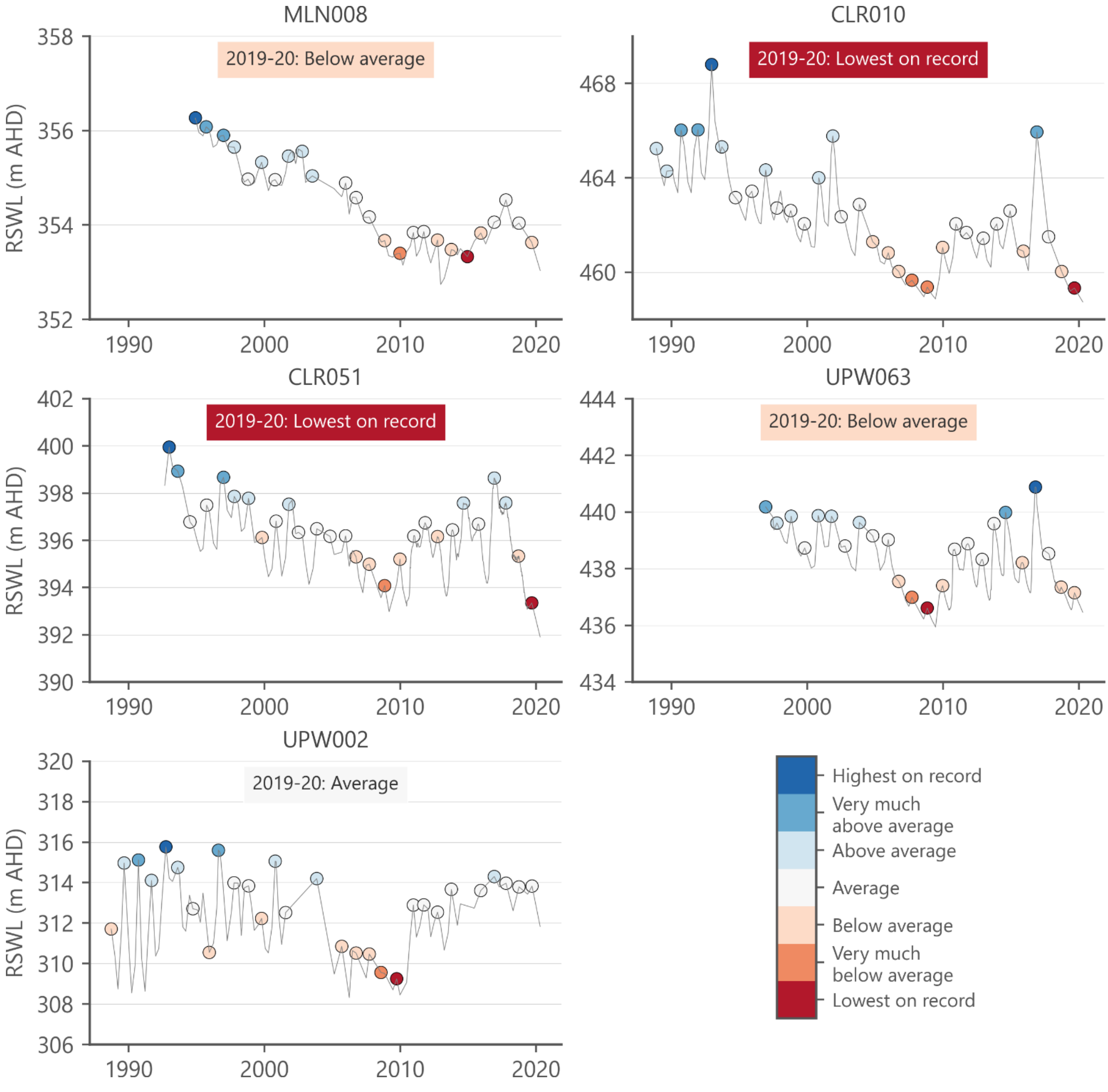

Figure 5.3 Selected fractured rock aquifer hydrographs

5.3 Fractured rock aquifers - salinity

Across the Clare Valley, the freshest groundwater generally occurs in locations with higher topography and higher rainfall. In 2019, groundwater salinity from 13 wells ranged between 622 and 3058 mg/L. Most wells have salinities between 1000 and 1500 mg/L (Figure 5.4).

In the five years to 2019, the majority of monitoring wells (60%) show stable trends in salinity (Figure 5.5). Of the remaining wells, two show decreasing salinities at rates of 15 and 29 mg/L/y while two wells show increasing salinity trends, both at a rate of 30 mg/L/y.

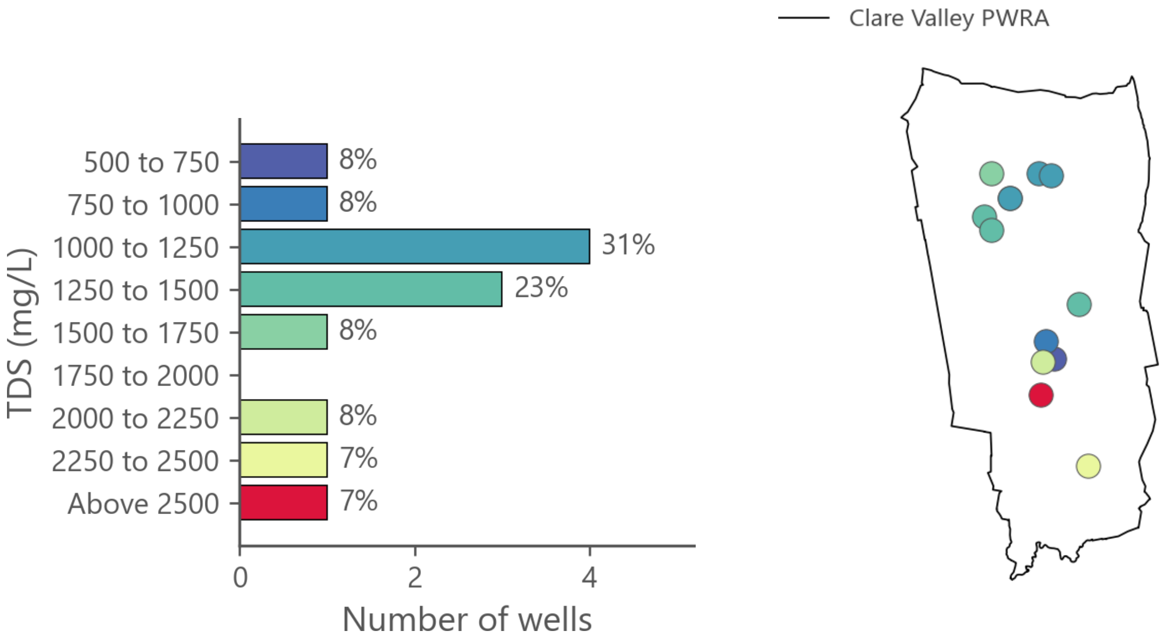

Figure 5.4 2019 salinity observations from wells in the fractured rock aquifer

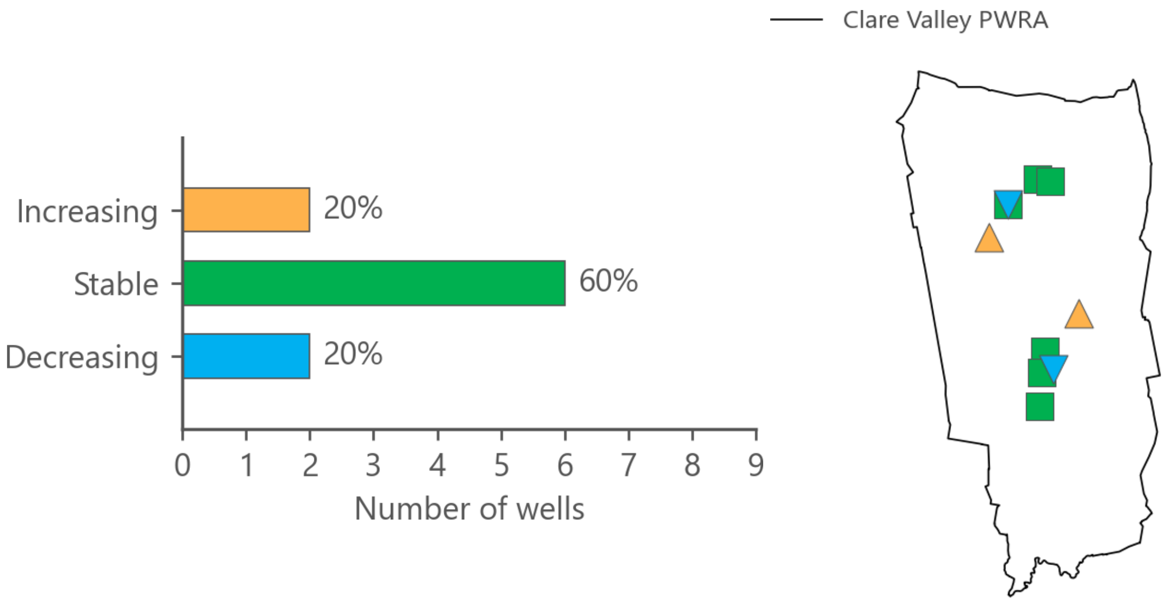

Figure 5.5 2015-2019 trend in groundwater salinities for wells in the fractured rock aquifer

6 Water use

Water sources in the Clare Valley PWRA include watercourses, farm dams, groundwater and imported water from SA Water's Clare Valley Water Supply Scheme (WSS). This scheme brings filtered water from the River Murray for the purposes of municipal water supply and irrigation of high value crops. The largest source of water used is now imported River Murray water.

Total water use for consumptive purposes was 4320 ML in 2018–19 (Figure 6.1). This includes licensed surface water and groundwater extracted from the Clare Valley and also imported River Murray water.

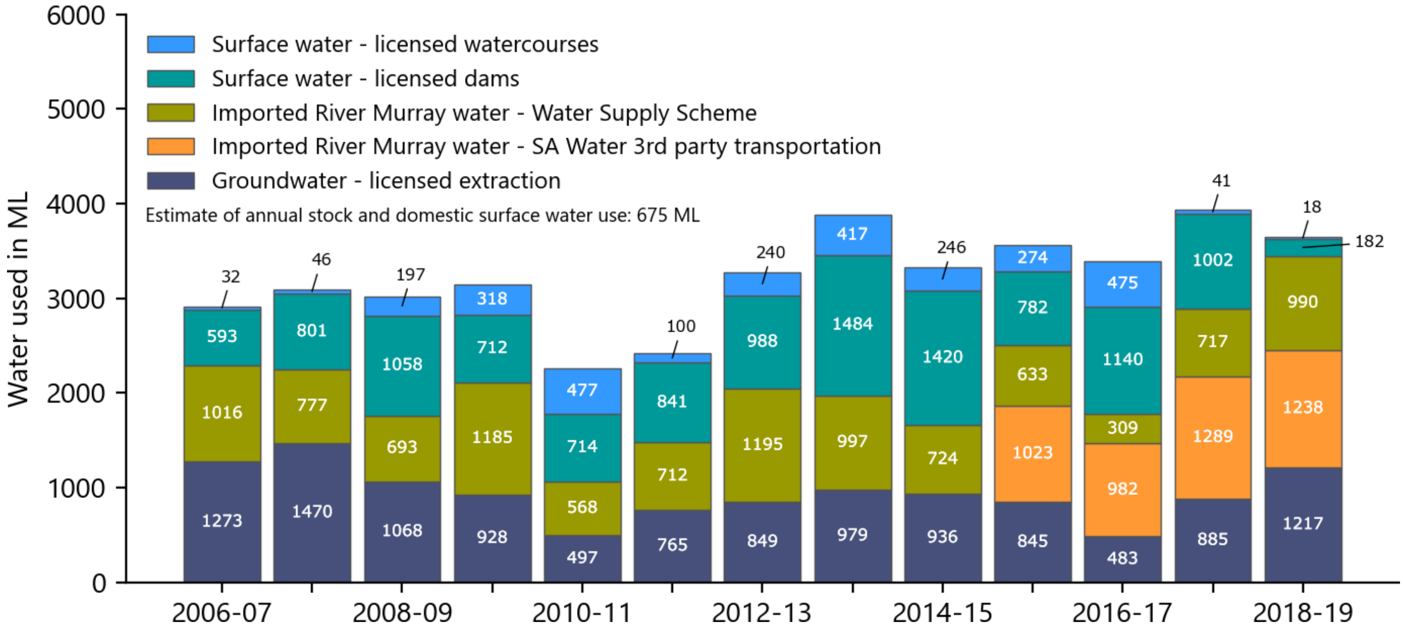

Figure 6.1 Water used from 2006–07 to 2018–19 for the Clare Valley PWRA

6.1 Surface water use

In 2018–19, use from licensed surface water sources (dams and watercourses) was 200 ML compared to 1043 ML in 2017-18). This data is based on meter readings from licensed water users. Non-licensed water demand (stock and domestic) was estimated at 675 ML based on 30% of dam capacity; this estimate is based on analysis in the water allocation plan (NY NRM Board, 2009).

The total volume of imported River Murray water into the Clare Valley PWRA was 2228 ML in 2018–19. This is imported via the Clare Valley Water Supply Scheme (WSS) and by a third-party transportation agreement with SA Water. There has been a greater reliance on water from the River Murray due to the lower rainfall experienced across the Clare Valley PWRA in 2018–19. Hence, why a reduction in use from licensed surface water sources can be observed.

6.3 Groundwater use

Groundwater is extracted from the fractured rock aquifer primarily for the irrigation of crops such as grapes and stock and domestic use. Water taken for irrigation is metered and is managed through a water licensing system while water taken for stock and domestic purposes is exempt from this requirement.

In 2018–19, a total volume of 1217 ML was extracted from the fractured rock aquifer. This is an increase of 38% compared to the previous year and is the highest groundwater extraction since 2007–08, which was a very low-rainfall year. Available metered data suggest a similar spatial distribution of groundwater extraction volumes across the PWRA as in previous years.

6.4 Farm dams

The Clare Valley WAP (NY 2009) states that there are 1435 farm dams within the Clare Valley PWRA, with an estimated capacity of 6451 ML. Of these dams 14% are licensed and they represent 62% of the total estimated storage capacity.

Across the PWRA, smaller dams (capacity less than 5 ML) account for the majority of the number of dams (88%), but represent only a small proportion (29%) of the total storage capacity of dams. Larger dams (5 ML or greater capacity) make up only 12% of the total dam count but contribute to 71% of the total storage capacity (Figure 6.2). The average farm dam density of the PWRA is 10 ML/km^2, with the higher rainfall headwaters having a higher density in comparison to lower rainfall areas (Figure 6.2).

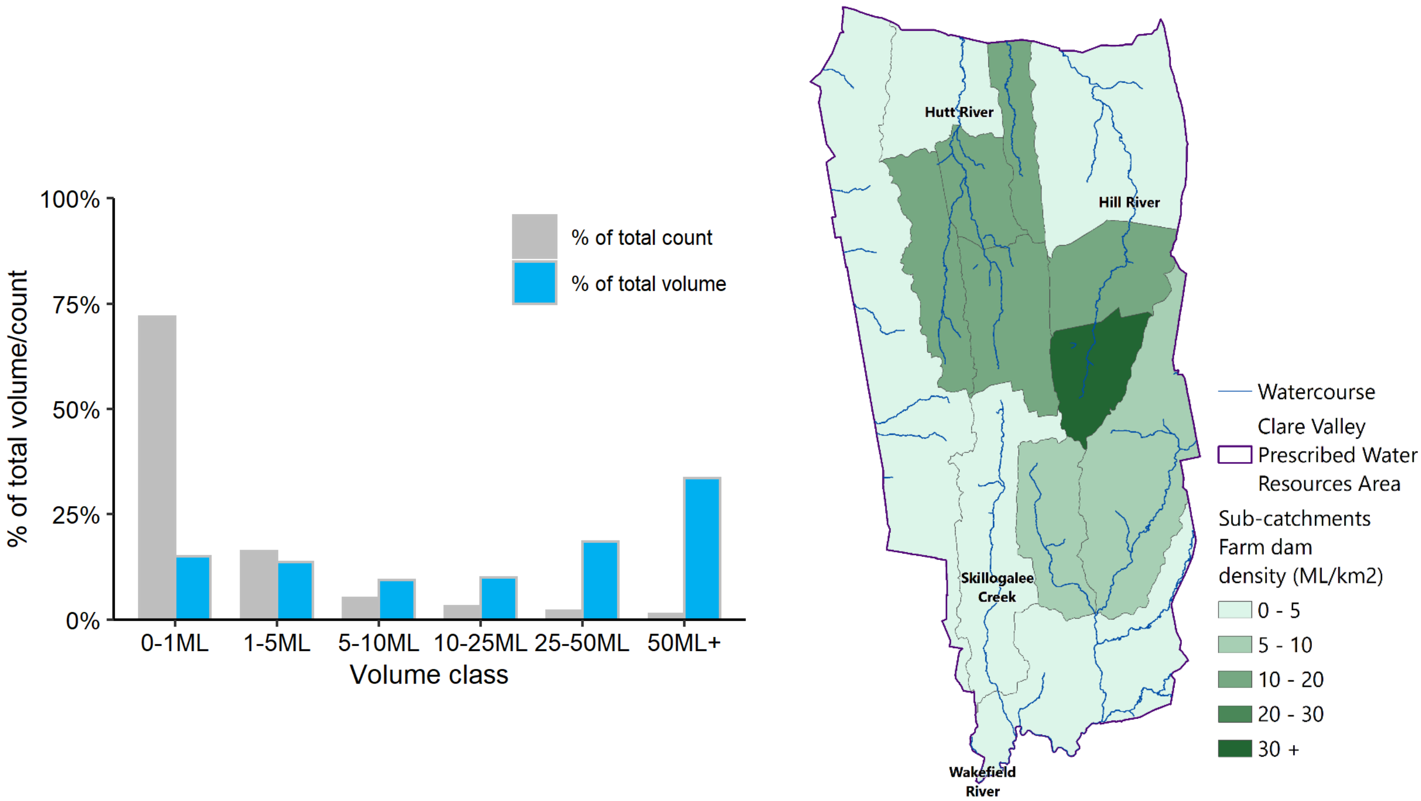

Figure 6.2 Farm dam volume, count analysis, and density in the Clare Valley PWRA

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