WILLOCHRA BASIN

GROUNDWATER STATUS REPORT

2009-10

Government of South Australia
Department for Water

SUMMARY 2009 - 10

The Willochra Basin is situated in the southern Flinders Ranges in the Mid-North of South Australia, approximately 50 km east of Port Augusta and 350 km north of Adelaide. It is a local scale groundwater resource which has no management regime in place as it has not been prescribed under South Australia's *Natural Resources Management Act 2004*.

The Basin consists of an inter-montane valley filled with sediments which are up to 150 m thick. Extractions occur mainly from the deep Tertiary confined aquifer and are estimated to be 510 ML/yr, comprising 300 ML for lucerne irrigation, 150 ML for stock use and 60 ML for town water supply. This is well below the estimated extraction limit of 1,000 ML/yr.

Groundwater levels in both the shallow Quaternary and Tertiary confined aquifer have been showing a long term declining trend up until 2009 which was predominantly caused by reduced recharge due to a prolonged period of below average rainfall. Higher rainfall in 2009 and 2010 has resulted in a rise in water levels.

Groundwater salinity trends in both aquifers appear to be stable with no obvious trend, with the exception of rising salinity in some wells in the shallow aquifer on the margins of the low salinity areas that were previously recharged by streamflow.

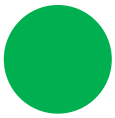
ASSESSMENT OF STATUS

The Willochra Basin has been assigned a status of green "No adverse trends, indicating a stable or improving situation" based on current trends. This status is supported by;

- Gradual decline in groundwater levels over the last 10 years appears to have been climate driven, and recent wet years have resulted in a small recovery in water levels.
- Stable salinity levels.

At the current level of extraction, it is considered that the observed groundwater level and salinity trends are unlikely to lead to a change in capacity to serve the current consumptive uses of the groundwater resource in the long term.

STATUS



No adverse trends, indicating a stable or improving situation

Trends are either stable (no significant change), or improving (i.e. decreasing salinity or rising water levels).

Adverse trends indicating low risk to the resource in the medium term

Observed adverse trends are gradual and if continued, will not lead to a change in the current beneficial uses of the groundwater resource for at least 15 years. Beneficial uses may be drinking water, irrigation or stock watering.

Adverse trends indicating high risk to the resource eventuating in the short to medium term

Observed adverse trends are significant and if continued, will lead to a change in the current beneficial uses of the groundwater resource in about 10 years.

Degradation of the resource compromising present use within the short term

Trends indicate degradation of the resource is occurring, or will occur within 5 years. Degradation will result in a change in the beneficial use (i.e. no longer suitable for drinking or irrigation purposes) and may take the form of increasing groundwater salinities, or a fall in the groundwater levels such that extractions from the aquifer may not be possible.

BACKGROUND

The Willochra Basin is situated in the southern Flinders Ranges in the Mid-North of South Australia, approximately 50 km east of Port Augusta and 350 km north of Adelaide. It is a local scale groundwater resource which has no management regime in place as it has not been prescribed under South Australia's *Natural Resources Management Act 2004*.

HYDROGEOLOGY

The Willochra Basin consists of an inter-montane valley about 80 km long orientated in a north-south direction, flanked by Adelaidean fractured rocks. The valley is filled with fluvial and lacustrine Tertiary sediments which are up to 150 m thick. These sediments are overlain by alluvial outwash sediments of Quaternary to Recent age up to 50 m thick.

The Quaternary sediments consist of interbedded sandy clays and thin sandy beds. The shallow Quaternary aquifers provide stock quality groundwater throughout the basin, with small areas having groundwater of suitable quality for irrigation where recharge occurs from ephemeral streams flowing out of the Ranges. The best quality groundwater is found in the vicinity of Spring Creek where salinities are as low as 400 mg/L.

The confined Tertiary aquifer directly overlies bedrock and is continuous over the full length of the basin. Its effective thickness is about 15 m in the south, reducing to less than 6 m in the north. Its lithology varies from sandy clays to a fine grained sand which requires careful well construction and development. The aquifer is artesian in the central parts of the basin.

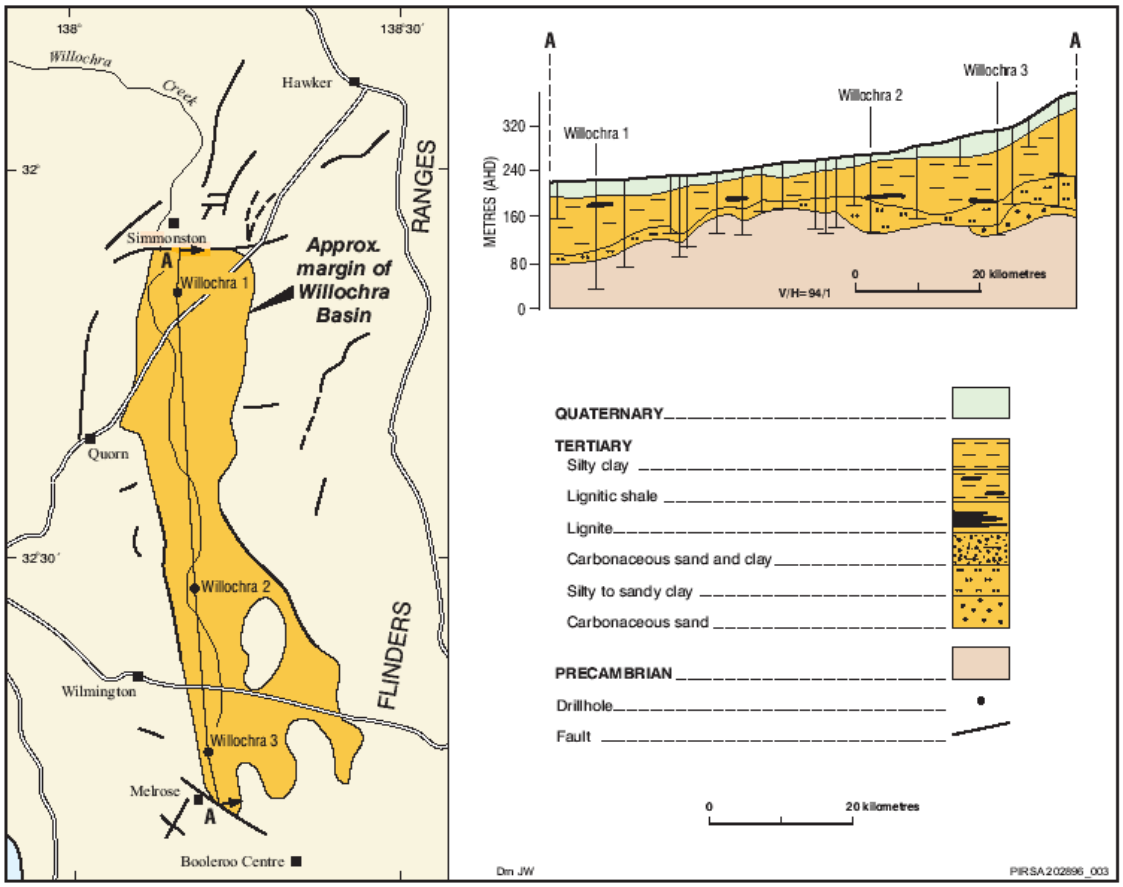


Figure 1. Geological cross section and plan view of Willochra Basin

GROUNDWATER FLOW AND SALINITY

The salinity distribution for the Tertiary confined aquifer is presented in Figure 2. Groundwater movement in the Tertiary confined aquifer is from the recharge areas in the south toward the north. Groundwater salinities are generally below 3,000 mg/L in the southwest of the basin adjacent to high rainfall areas in the ranges, with the higher salinities over 3,000 mg/L located further to the north and east. The isolated zone below 1,000 mg/L to the east of Wilmington is probably a "fossil" resource that is no longer being recharged, given it is surrounded by groundwater of higher salinity.

For further information, see the 2005 monitoring status report:
http://www.waterforgood.sa.gov.au/wp-content/uploads/2010/06/Technical%20Reports/ki_dwlbc_2005_39.pdf

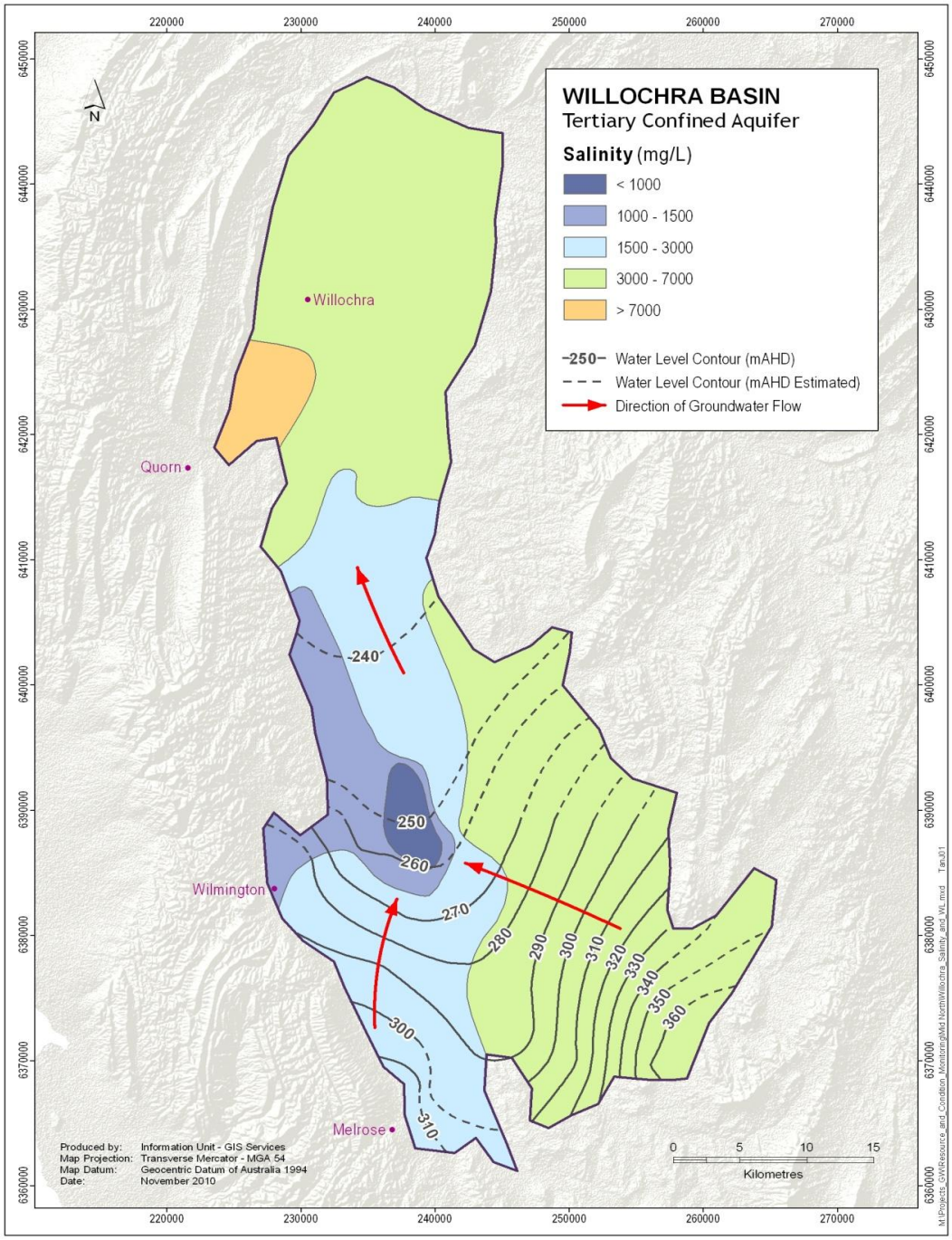


Figure 2. **Groundwater flow and salinity distribution for the Tertiary confined aquifer of the Willochra Basin**

GROUNDWATER DEPENDENT ECOSYSTEMS

Whilst groundwater dependent ecosystems (GDEs) have not been used in the assessment of the status of the resource, it is important to note the presence and ecological characteristics of the GDEs found in the Willochra Basin. Water Allocation Plans must include an assessment of the water required by ecosystems, including water from both surface water and groundwater resources. Groundwater dependent ecosystems can be defined as ecosystems where groundwater provides all or part of the water quantity, chemistry or temperature either permanently, seasonally or intermittently. It is generally considered that shallow watertables, i.e. those less than 10 m below the surface are more likely to support GDEs than deeper watertables. The exception to this is stygofauna (animals that inhabit water filled cracks and pools below the ground), which can be found at greater depths.

Permanent pools in the northern and southern watercourses in the Willochra catchment are thought to be maintained by groundwater inflow from the fractured rock aquifers that surround the Willochra Basin. Anecdotal evidence suggests that persistent pools once extended through the middle reaches of the catchment, but have since reduced in number and extent.

The Lake Eyre Hardyhead is a native fish which has been found to rely upon the permanent pools in the Willochra Creek in the section north of Simmonston to Warrakimbo, but opportunistically inhabits pools in the middle reaches of the Willochra Basin.

Groundwater levels in the shallow Quaternary aquifer are sufficiently shallow to support plants that have a dependence on groundwater; such plants have been mapped in the southern and western areas of the Basin and consist largely of River Redgum (*Eucalyptus camaldulensis*).

It is possible that permanent pools and associated biota, and plants with a dependence on groundwater exist in other unmapped regions of the catchment. Other possible GDEs in the Willochra Basin include stygofauna.

RAINFALL

Rainfall is a very important part of the groundwater balance because it is a source of replenishment or recharge to aquifers by infiltration through the soil or by percolation from streamflow in drainage lines.

The climate of the Willochra Basin is characterised by hot, dry summers and cool to cold, wet winters. Two Bureau of Meteorology rainfall stations have been selected to analyse trends; Melrose (19024) and Bruce (19008). Annual average rainfalls for the selected stations are 576 and 260 mm respectively, indicating a strong gradient of decreasing rainfall to the north (Fig. 3).

Cumulative deviation from mean monthly rainfall is graphed in blue in Figure 4 to identify periods where rainfall trends are above or below average. An upward slope indicates a period where the rainfall is greater than the average, while a downward slope indicates a period where the rainfall is below the average.

All stations show essentially below average rainfall between 1993 and 2008, but since then, rainfall has been above average for 2009-10.

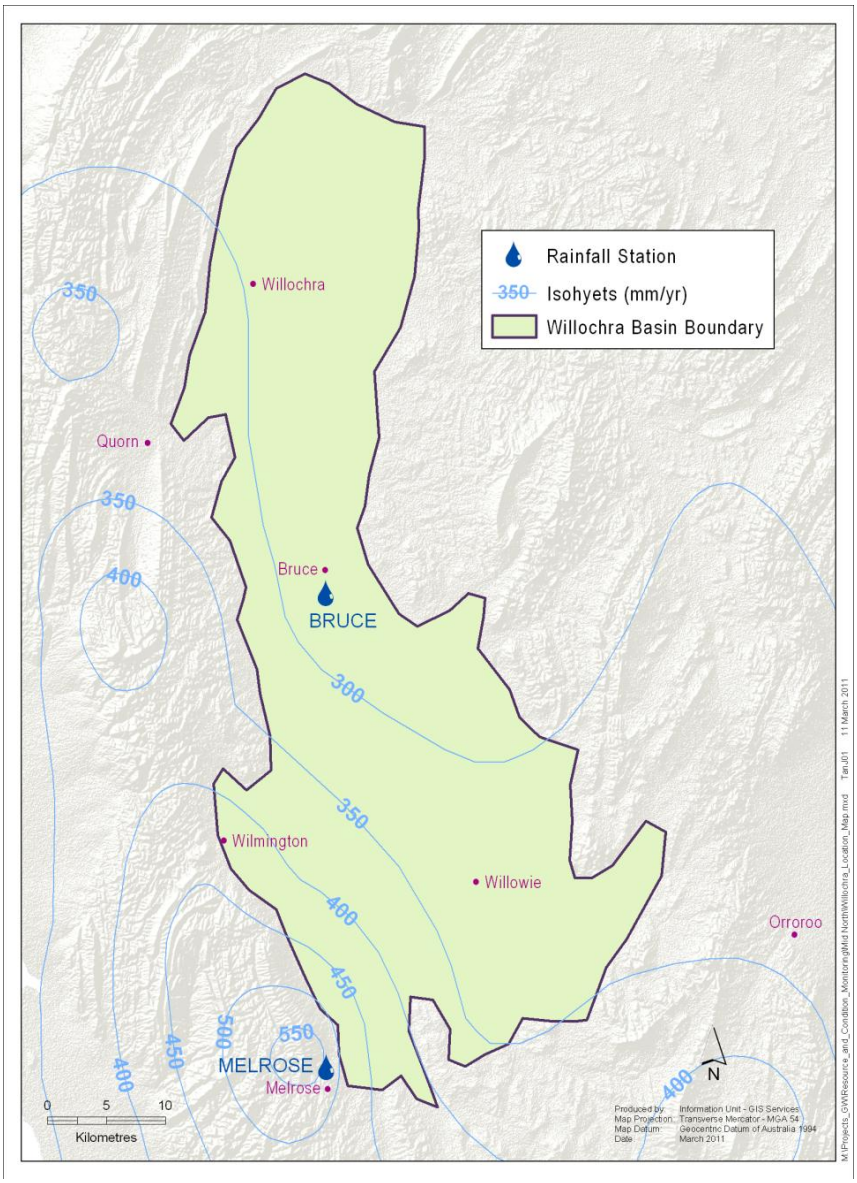
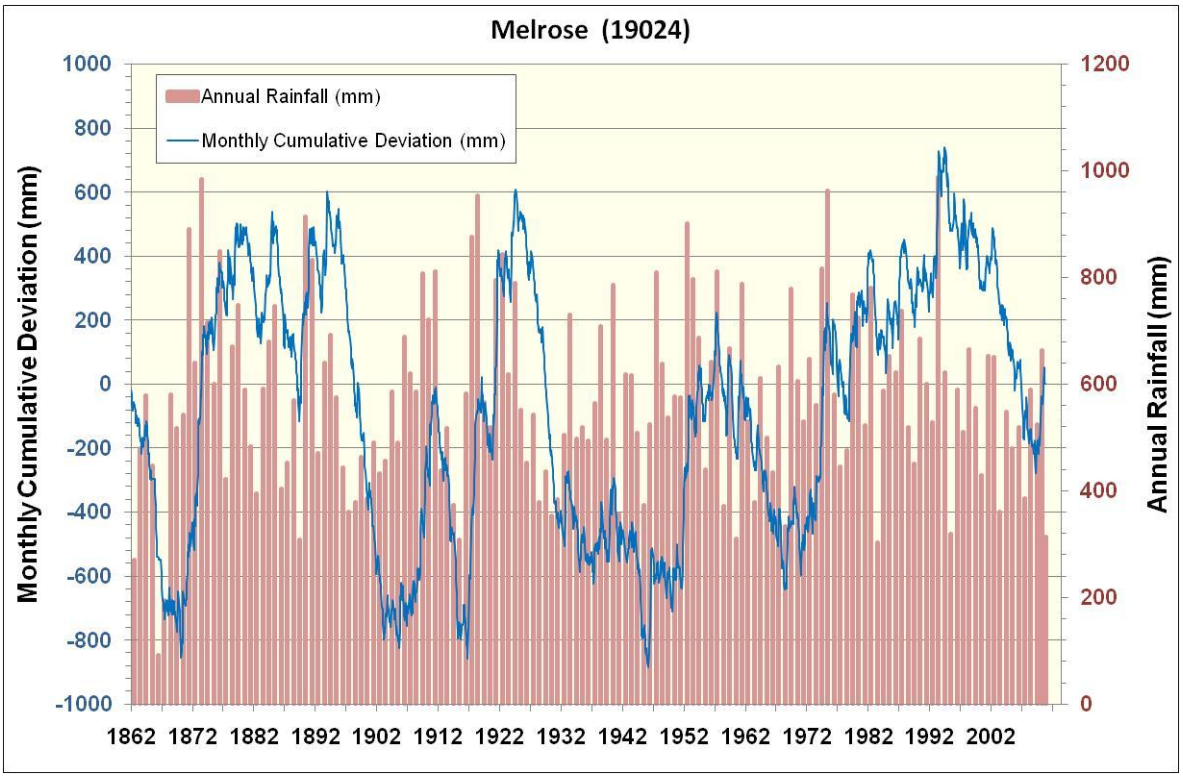


Figure 3. Location of rainfall stations in the Willochra Basin



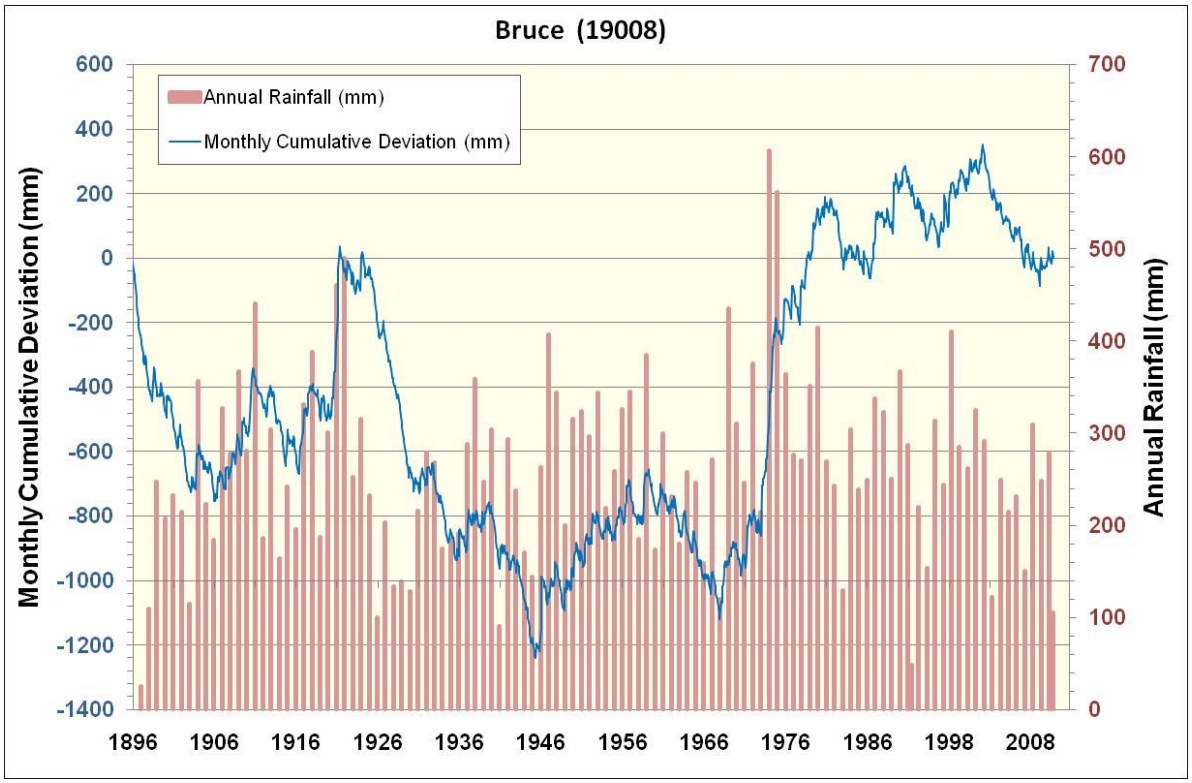


Figure 4. Annual Rainfall and cumulative deviation from mean monthly rainfall for two stations in the Willochra Basin

GROUNDWATER USE

Groundwater is the primary source of water in the basin and is used for town water supplies, the irrigation of lucerne, stock supplies and domestic use. As the Willochra Basin is not prescribed under the *Natural Resources Management Act 2004*, there is no licensing of groundwater extractions and no metering of extraction volumes (apart from town water supplies).

Examination of 2010 satellite imagery revealed approximately 60 ha of lucerne or pasture irrigation from the Tertiary confined aquifer, which would equate to about 300 ML/yr, assuming an application rate of 5 ML/ha/yr which is based on visual inspection of the irrigated crops.

The town water supply use for Melrose in 2009-10 was 60 ML which is obtained from two wells located about 5 km northeast of the town. One well extracted 25 ML from the Tertiary confined aquifer while the other extracted 35 ML from the fractured rock aquifer underlying this aquifer. Stock water use is not known with certainty, but is estimated at 150 ML/yr.

These extractions are well below the estimated extraction limit of 1,000 ML/yr.

Figure 5 gives the groundwater use type and estimated volume.

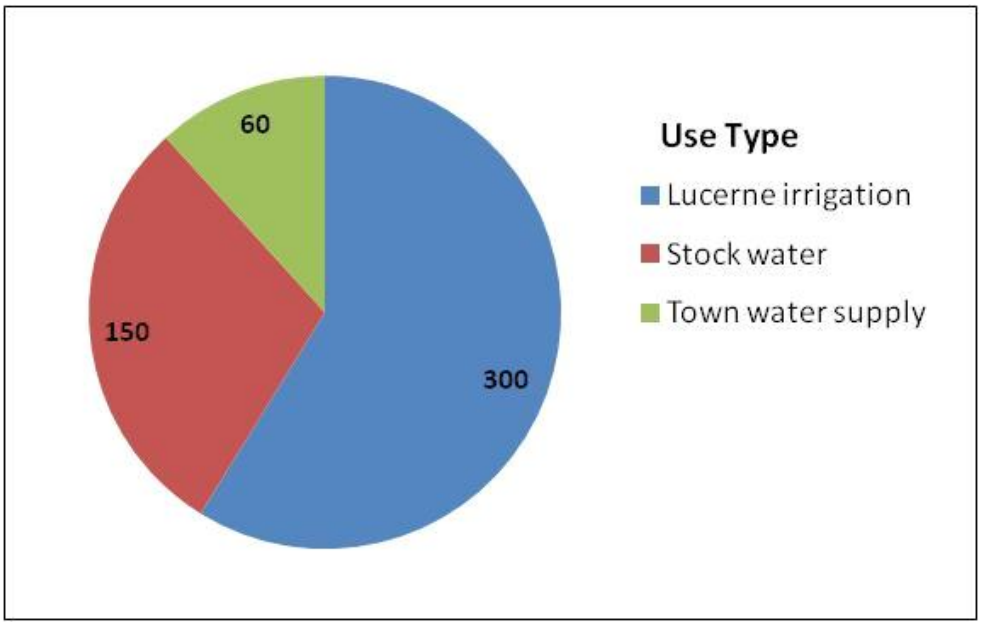


Figure 5. Estimated groundwater volumes extracted per type of use (ML)

WATER LEVEL NETWORK

The groundwater level observation network for the Willochra Basin is shown in Figure 6. Monitoring began in 1985, and there are currently 15 wells located in the southern half of the basin being monitored on a semi regular three monthly frequency.

Two aquifers are monitored;

1. Ten wells are monitored in the shallow Quaternary aquifer (less than 50 m deep) which consists mainly of silts and clays,
2. Five wells are monitored in the main Tertiary confined aquifer (more than 50 m deep) which comprises fine sand layers interbedded with clay. The majority of extractions occur from this aquifer.

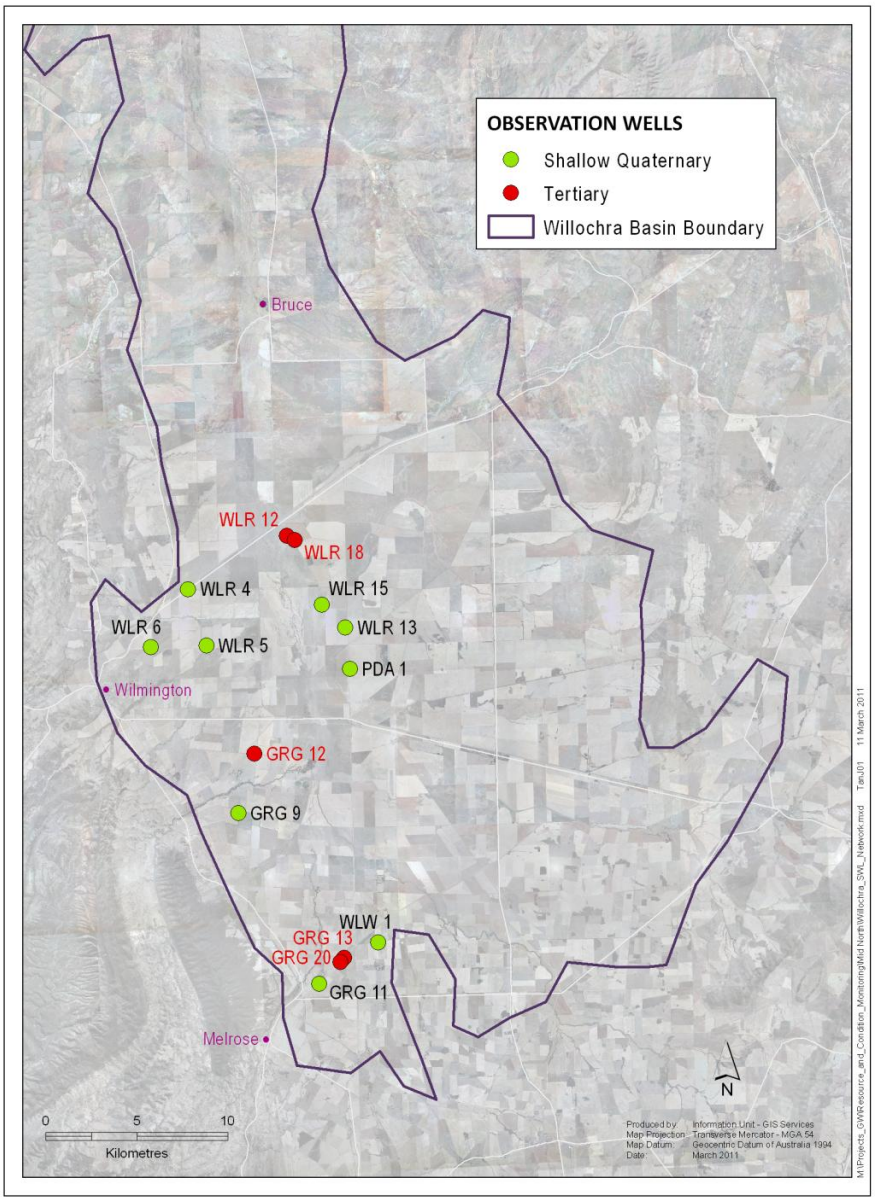


Figure 6. Location of groundwater level observation wells in the Willochra Basin

SALINITY NETWORK

The groundwater salinity observation network for the Willochra Basin is shown below in Figure 7. There are currently three wells that have groundwater salinity monitored randomly, although up to 13 wells were monitored in the past.

Three aquifers are monitored;

1. One well in the shallow Quaternary aquifer (less than 50 m deep) which consists mainly of silts and clays,
2. One well in the main Tertiary confined aquifer (more than 50 m deep) which comprises fine sand layers interbedded with clay,
3. One well in the Basement fractured rock aquifer.

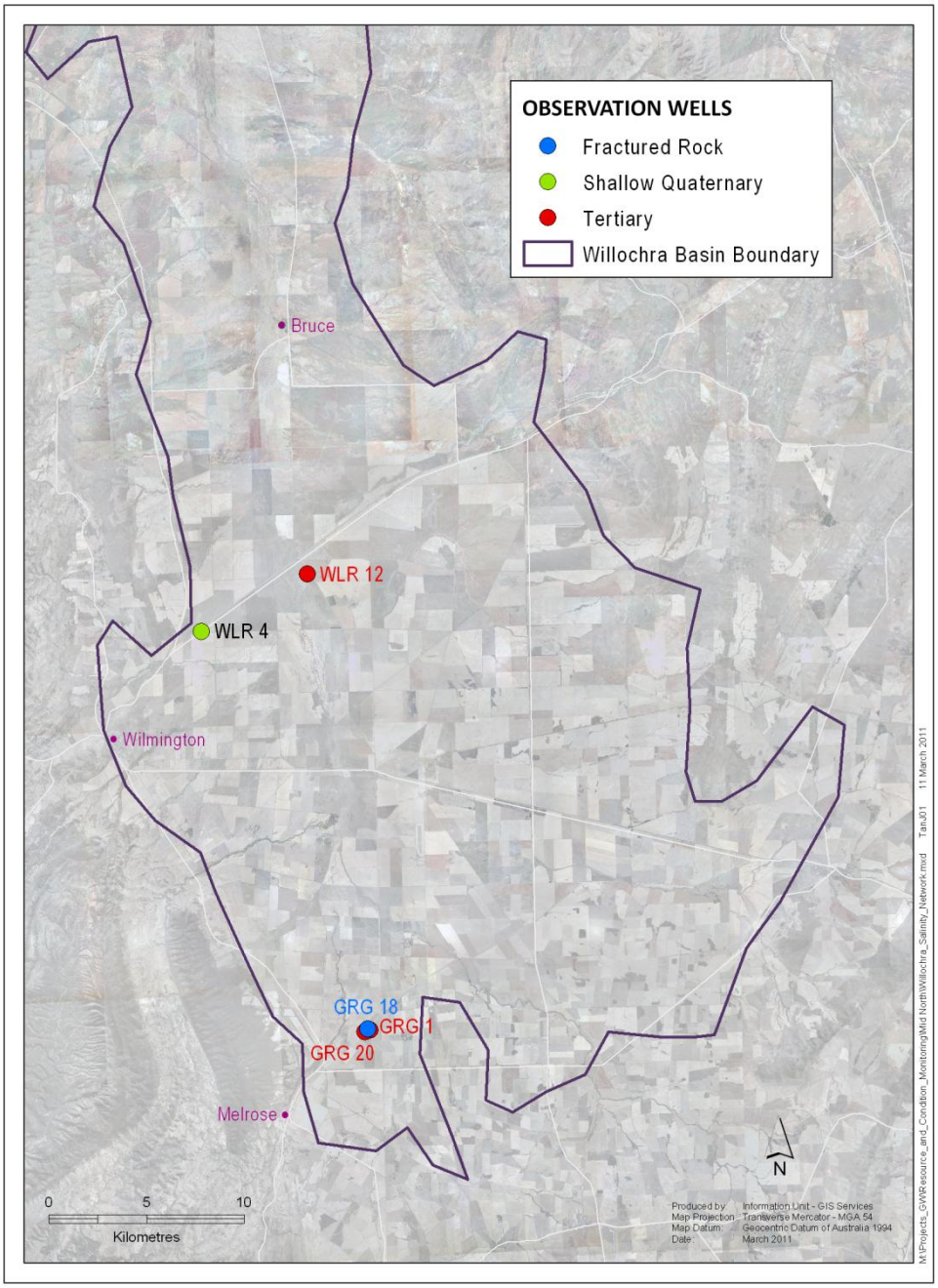


Figure 7. Location of groundwater salinity observation wells in the Willochra Basin

GROUNDWATER LEVEL TRENDS

Hydrographs are presented following for observation wells located in the two different aquifers in the Willochra Basin.

SHALLOW QUATERNARY AQUIFER

All watertable trends in the shallow aquifer (Fig. 8) have shown a steady decline since 1992 which was the last very wet year as seen in Figure 2. This decline has averaged 25 cm/yr, and because of very limited extraction from this aquifer, it can be attributed solely to the consistently below average rainfall since 1992 (with the exception of 2002). Higher rainfall during 2009 and 2010 has resulted in a small rise in most wells.

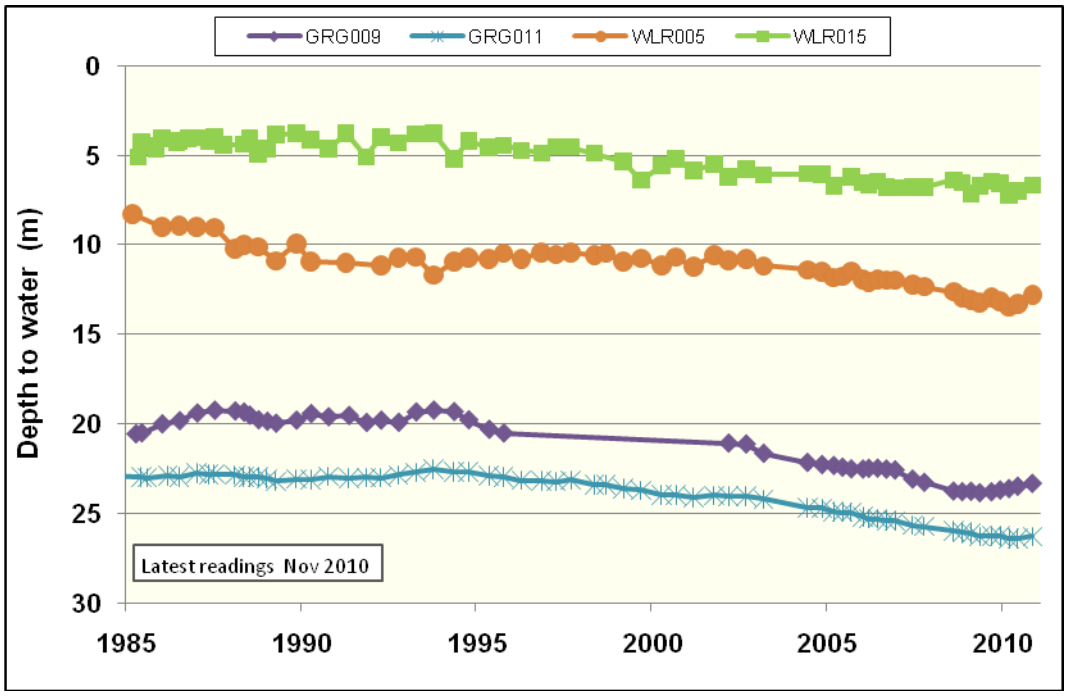


Figure 8. Groundwater level trends of the shallow Quaternary aquifer in the Willochra Basin

TERTIARY CONFINED AQUIFER

Most confined observation wells have showed decreasing trends averaging about 45 cm/yr since 2002, which mirror the overlying watertable trends and also show a broad relationship with rainfall that has been consistently below average. This could be due to a good lateral connection with the fractured rock aquifers in the ranges to the west, or the process of hydrostatic loading. A rising watertable results in more water being stored in the unconfined aquifer, and consequently more weight pressing down on the confining layer. This extra weight increases the hydrostatic pressure on the underlying confined aquifer and causes confined water levels to rise.

Observation well WLR012 is located within 3 km of three irrigation wells that supply most of the irrigation extractions in the Willochra Basin. As a result, it shows seasonal drawdowns in water levels of about 4 m (Fig. 9). Well GRG013 is located close to the Melrose town water supply wells and displays a small seasonal drawdown in response to that extraction.

Water levels have recently shown a rise following higher rainfall during 2009 and 2010, similar to those observed in the unconfined aquifer.

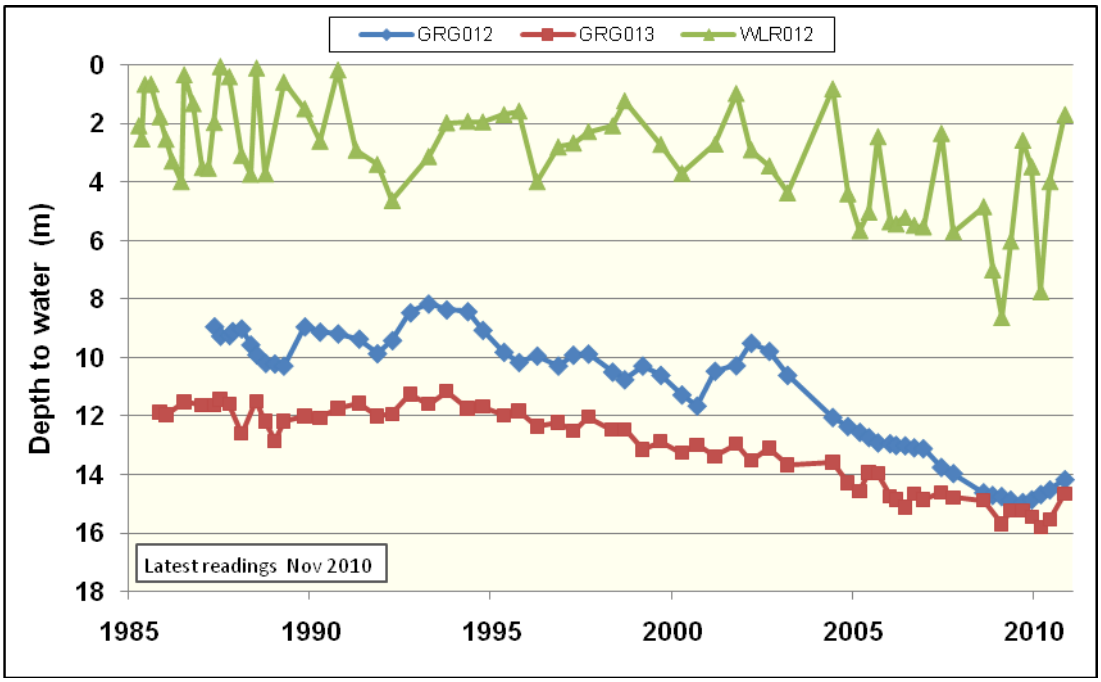


Figure 9. Groundwater level trends of the Tertiary confined aquifer in Willochra Basin

GROUNDWATER SALINITY TRENDS

There are a variety of salinity trends being observed in this network. There is limited current monitoring of salinity apart from town water supply wells, and so most of the trends are based on historical information.

SHALLOW QUATERNARY AQUIFER

Figure 10 shows trends in the shallow unconfined aquifer, which receives recharge from surface runoff that intermittently flows from the ranges. Trends are reasonably stable, although the rising trend of GRG007 possibly reflects the impacts of reduced runoff caused by below average rainfall.

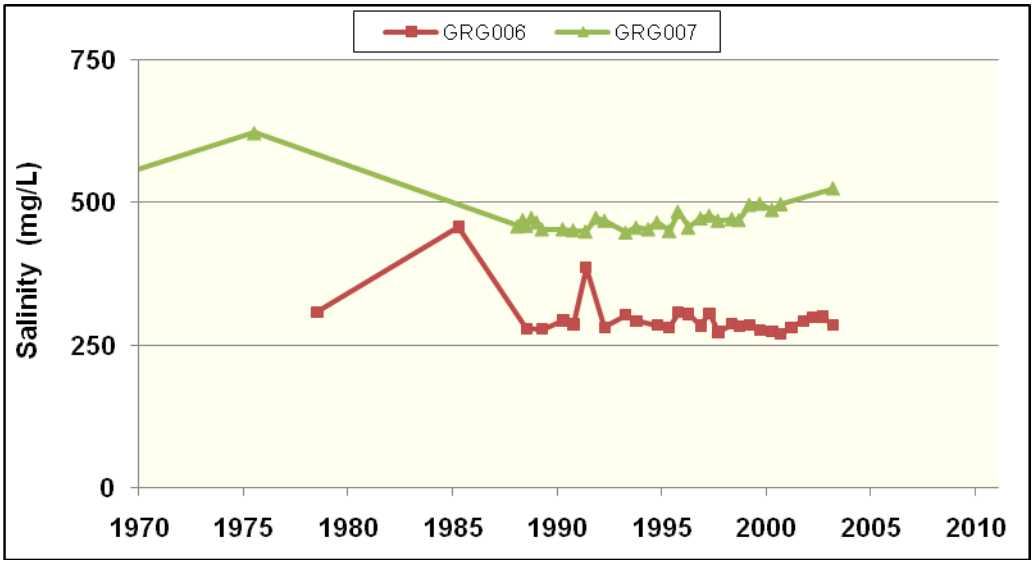


Figure 10. **Groundwater salinity trends for the shallow Quaternary aquifer near streams in the Willochra Basin**

Wells located at a distance from the intermittent streams have higher salinities have no major trend obvious, as shown in Figure 11.

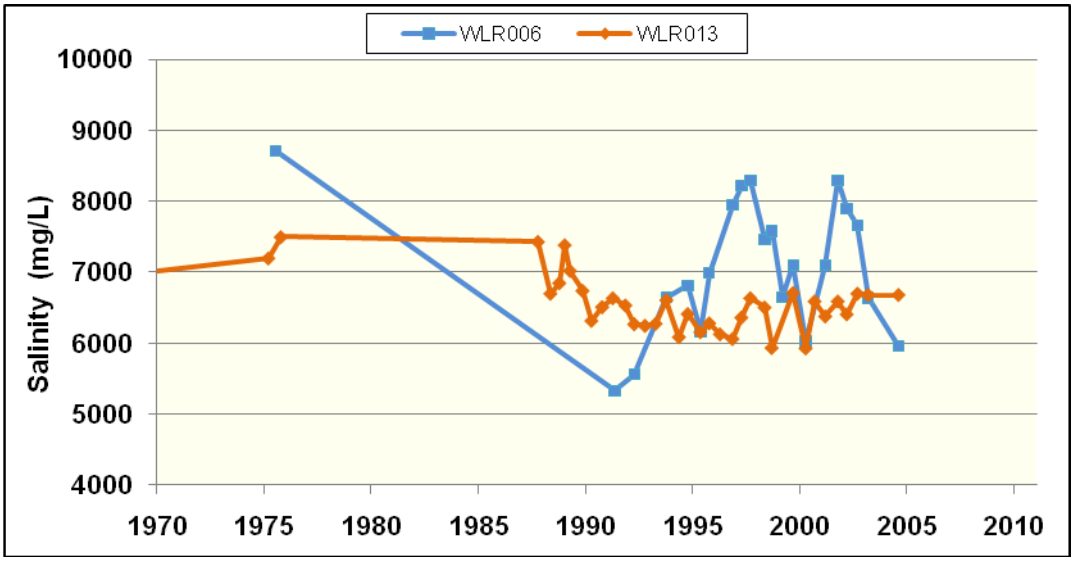


Figure 11. **Groundwater salinity trends for the shallow Quaternary aquifer distant from streams in the Willochra Basin**

TERTIARY CONFINED AQUIFER

Salinities in the confined aquifer monitored in town water supply wells appear quite stable as indicated below in Figure 12. Apart from some variations that are probably due to sampling procedures, the salinity levels have shown no significant change over the last 25 years.

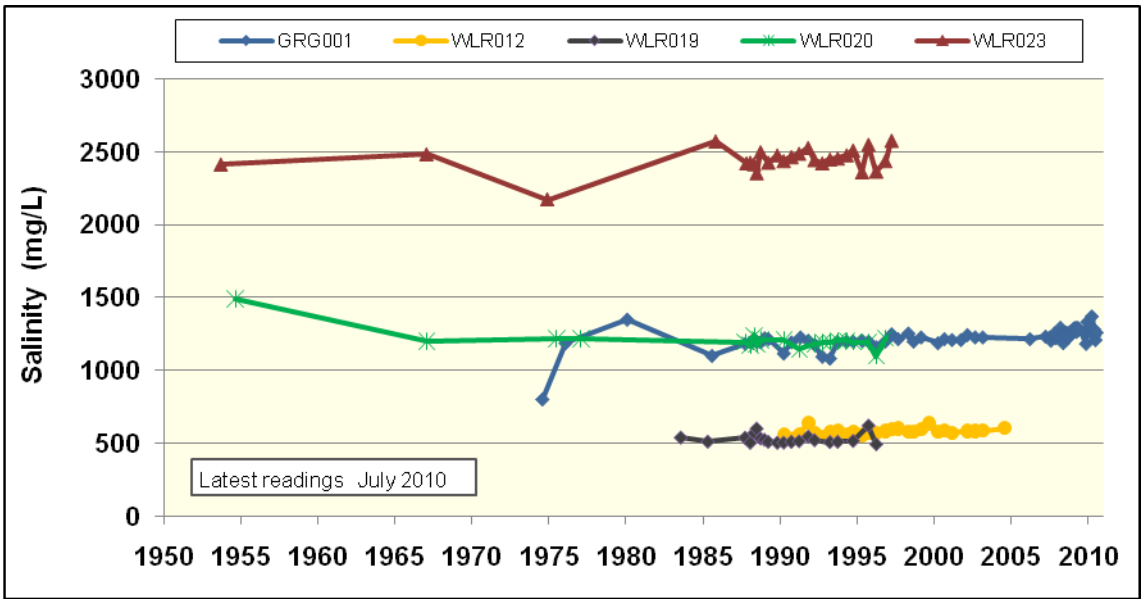


Figure 12. Groundwater salinity trends for the Tertiary confined aquifer in the Willochra Basin