BAROSSA PWRA

GROUNDWATER LEVEL AND SALINITY STATUS REPORT

2009–10

DEPARTMENT FOR WATER

Government of South Australia
Department for Water

SUMMARY 2009–10

The Barossa Prescribed Water Resources Area (PWRA) encompasses both the highland areas of the Mount Lofty Ranges and the Barossa Valley, approximately 60 km north-east of Adelaide. It is a regional scale resource for which surface water and groundwater have been prescribed under South Australia's *Natural Resources Management Act 2004*. A Water Allocation Plan provides for sustainable management of the groundwater resources.

Within the Barossa Prescribed Water Resources Area, groundwater is extracted from Tertiary sediments (Upper and Lower aquifers) within the Barossa Valley, as well as from the fractured rock aquifer that underlies and surrounds the valley. Metered extractions totalled 2103 ML for 2009–10, well below the current allocation of 7400 ML, with 54% being supplied from the Fractured Rock Aquifer, 33% from the Lower Aquifer and 13% from the Upper Aquifer. Water imported from the River Murray via the Barossa Infrastructure Limited (BIL) scheme provides an alternative water source to groundwater.

The total groundwater extraction of 2103 ML represents a decrease of 30% from the previous irrigation season, and probably reflects the higher rainfall recorded in 2009 than in previous years, and increased River Murray allocations available for BIL scheme users. During the 2006 drought, reduced River Murray allocations for BIL users resulted in increased groundwater extractions.

Groundwater level trends for the unconfined aquifers (Upper and Fractured Rock Aquifers) show a broad relationship with rainfall, with a declining trend since 2006 due to below-average rainfall. Higher rainfall in recent years has led to a recovery of levels in some areas. Seasonal fluctuations are evident in proximity to creeks and rivers and in intensely irrigated areas.

Pressure levels in the confined Lower Aquifer are generally stable with a subdued response to rainfall patterns. The seasonal drawdown observed during the irrigation season has decreased due to lower groundwater extraction.

Salinity trends in the Upper and Fractured Rock Aquifers are highly variable, however long term data for the Lower Aquifer indicates that salinity levels are rising throughout the aquifer at an average rate of 7.5 mg/L/yr. Initial evidence suggests inter-aquifer leakage may be contributing to this salinity problem.

This rise could become critical in areas where groundwater salinities are close to the tolerance level for grape vines which is approximately 1500 mg/L. The ability to access an alternative water supply (BIL scheme) may reduce this risk.

ASSESSMENT OF STATUS

The Barossa PWRA has been assigned a status of yellow "Adverse trends indicating low risk to the resource in the medium term" based on current trends. This status is supported by:

- relatively stable or slowly rising groundwater levels in response to decreasing extractions and higher rainfall; and
- the long-term gradual rise in groundwater salinity levels in the Lower Aquifer averaging 7.5 mg/L/yr since 1990. This rise could become critical in areas where groundwater salinities are close to the tolerance level for grape vines which is approximately 1500 mg/L.

Initial evidence suggests inter-aquifer leakage may be contributing to the problem of increasing salinity. Analysis of salinity results from about 160 irrigation wells collected since 2005 will give a better understanding of recent trends and also provide an indication of the extent and severity of contamination due to leaky wells.

The ability to access an alternative water supply (BIL scheme) may reduce the impacts of this rise in salinity.

STATUS (2009–10)

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 Barossa Prescribed Water Resources Area (PWRA) is located approximately 60 km north-east of Adelaide and encompasses the highland areas of both the Mount Lofty Ranges and the Barossa Valley (Fig. 1). It is a regional-scale resource for which surface water and groundwater have been prescribed under South Australia's *Natural Resources Management Act 2004*. A Water Allocation Plan provides for sustainable management of the groundwater resources.

HYDROGEOLOGY

The Barossa PWRA consists of three major aquifers; two sedimentary aquifers (upper and lower) within the valley and a fractured rock aquifer which crops out in the ranges to the east and west and also extends beneath the sedimentary aquifers (Fig. 2).

Upper Aquifer

The Upper Aquifer consists of sediments overlying a carbonaceous clay confining layer. It includes units previously referred to as the middle, upper gravel and watertable aquifers. The Upper Aquifer includes Tertiary non-carbonaceous sands, lenticular sands and gravels within Quaternary clays and Holocene gravels and sands associated with drainage channels incised into the Quaternary clay. In addition to the main valley, the Upper Aquifer also occurs in a broad valley to the south of Lyndoch.

Lower Aquifer

The Lower Aquifer is confined and consists of Tertiary carbonaceous clays, gravels, sands and silts that were deposited in the deepest part of the basin and form a complex system of interconnected sub-aquifers. It is separated from the overlying Upper Aquifer by a carbonaceous clay confining layer. Lower Aquifer water levels are subject to large seasonal fluctuations as they represent changes in pressure levels caused by pumping.

Fractured Rock Aquifer

Pre-Cambrian and Palaeozoic sandstones, siltstones and schists form the Fractured Rock Aquifer (FRA) where groundwater is stored and flows through fractures and fissures in the rock. Wells completed in this aquifer generally have very low yields, although there are significant exceptions. Beneath the valley sediments, the upper part of the FRA is generally a highly-weathered clayey layer which acts as a confining layer between the FRA and the overlying sedimentary aquifers.

All three aquifers are connected to some degree. Although recharge to the aquifers originates from rainfall, the main source of recharge to the lower confined aquifer is lateral flow from the FRA to the east.

For a more detailed description of the hydrogeology of the Barossa Valley, please see:

http://www.waterconnect.sa.gov.au/BusinessUnits/InformationUnit/Technical%20Publications/RI055.PDF

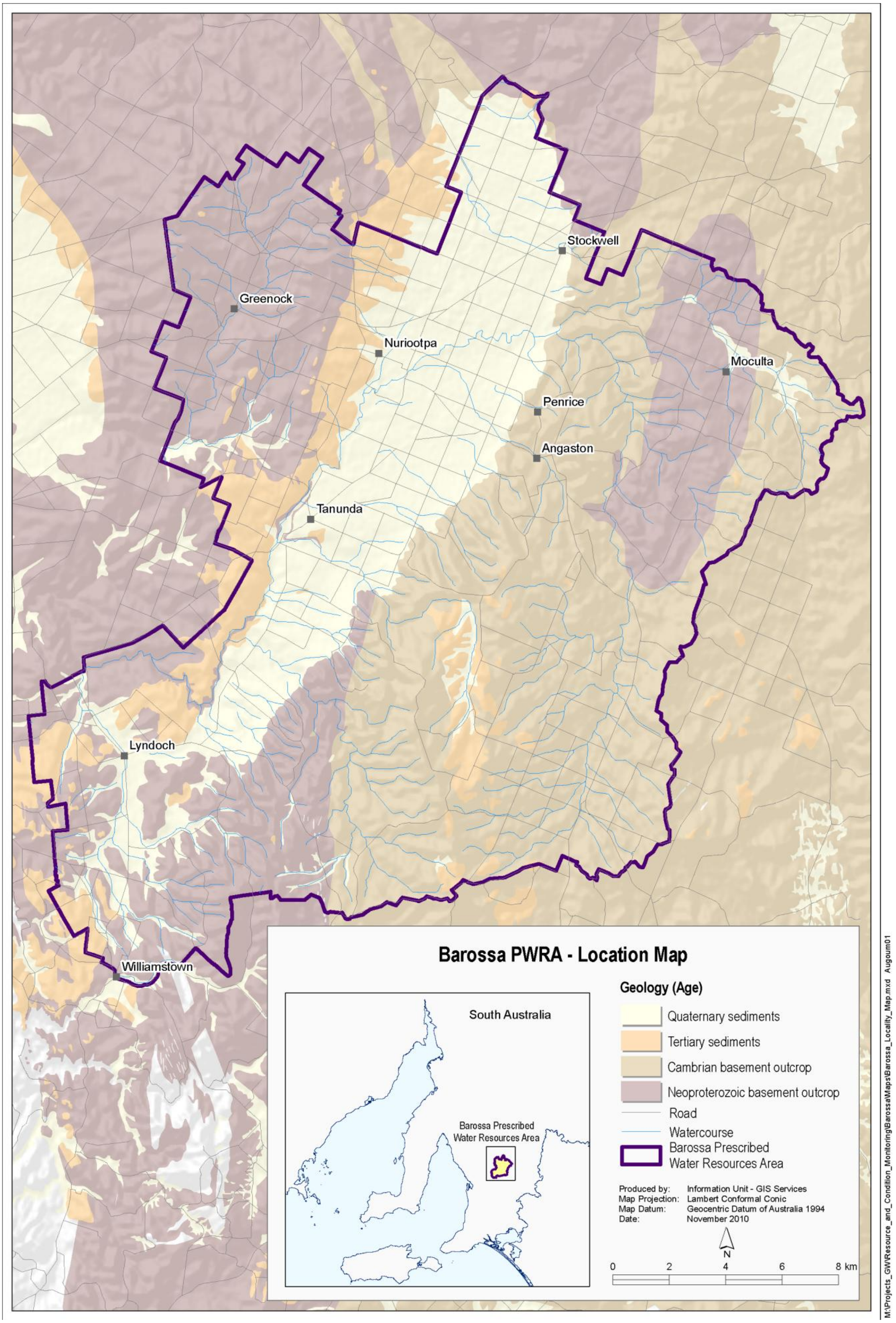

Figure 1. Location of the Barossa PWRA

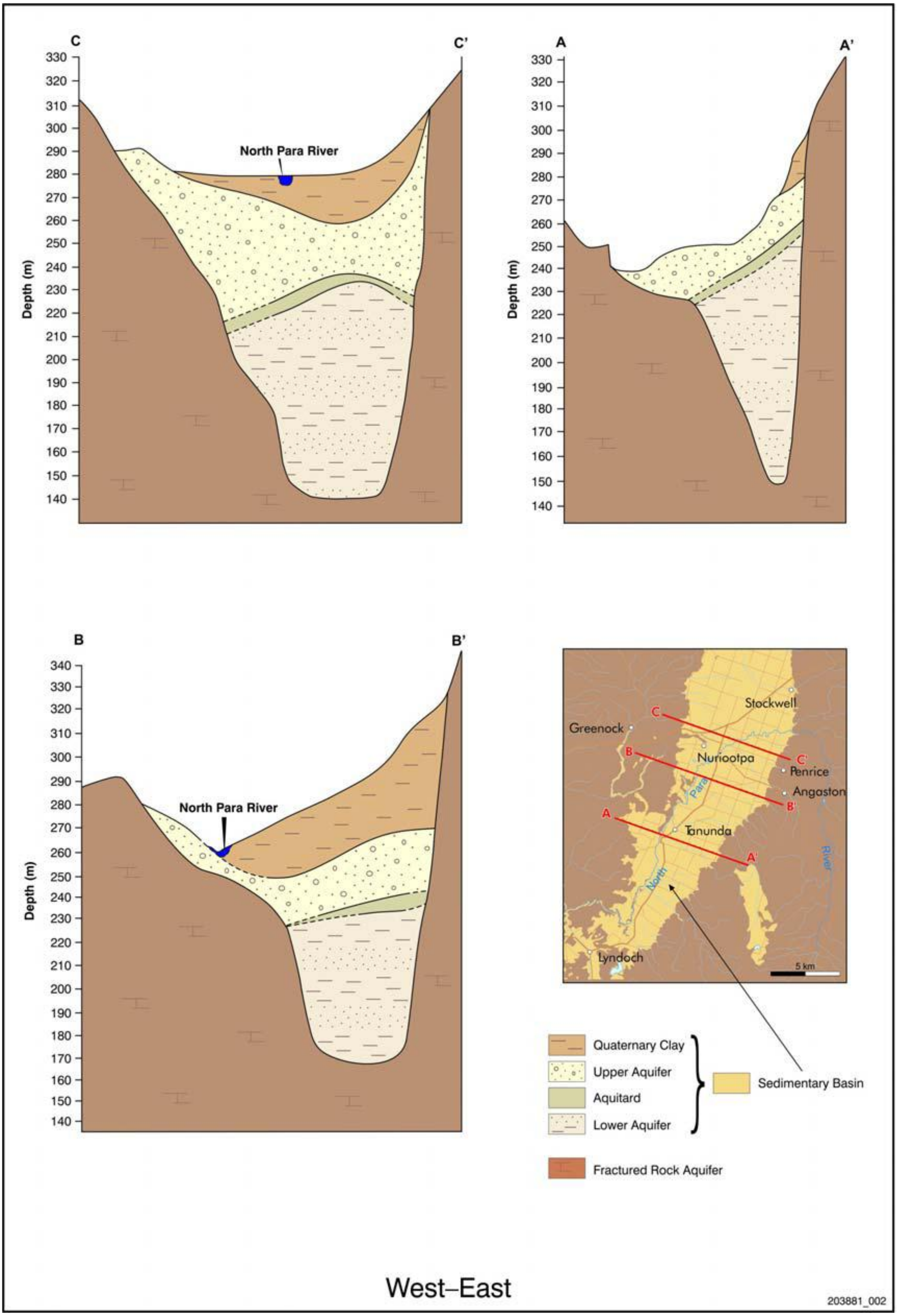

Figure 2. Schematic representation of aquifers in the Barossa PWRA

Table 1. Hydrogeology of the Barossa PWRA

AGE		STRATIGRAPHY		HYDROGEOLOGY	
		Unit	**Lithology**	**Unit**	**Description**
Quaternary	Holocene	Undifferentiated Quaternary	Sands, gravels and silts of modern drainage channels	**Upper aquifer**	Unconfined/confined aquifer, salinities from 900 to 12 000 mg/L, used for irrigation and stock supplies
	Pleistocene	Pooraka Formation	Red-brown sandy clays with minor gravel lenses near ranges		
Tertiary	Miocene (early-late)	Rowland Flat Sand	Non carbonaceous clays, gravels, sands and silts		
	Miocene (early) Oligocene (early)	Rowland Flat Sand	Carbonaceous (lignitic) clays, brown	**Aquitard**	Confining layer
			Carbonaceous clays, gravel, sands and silt	**Lower aquifer**	Confined aquifer, salinities 400 – 3000 mg/L, used extensively for irrigation
Cambrian		Kanmantoo/Normanville Groups	Metamorphosed greywacke, schist, marble	**Fractured rock aquifer**	Confined/unconfined aquifer, supplies generally low, salinities highly variable – from 450 to 3500 mg/L
Proterozoic		Adelaide System	Siltstones, shales, sandstones, quartzites		

GROUNDWATER FLOW AND SALINITY

Upper Aquifer

Groundwater flow within the Upper Aquifer is in a south-westerly direction in the valley and to the north near Lyndoch (Fig. 3). There is no significant difference between winter and summer water levels because wells completed in the Upper Aquifer generally do not show a large seasonal response. Groundwater salinities are highly variable, from 960 to 12 000 mg/L. However, the majority of wells have salinities below 3000 mg/L. The more saline wells are located in the northern extent of the aquifer.

Lower Aquifer

Groundwater flow within the Lower Aquifer is also in a south-westerly direction in the valley (Fig. 4). Although the aquifer experiences large seasonal fluctuations in water levels, the direction of groundwater flow does not change. Salinity values range between 460 and 3000 mg/L. Again, more saline wells are found to the north.

Fractured Rock Aquifer

A groundwater elevation contour map for the FRA was not generated due to the highly variable ground surface elevations and limited coverage of observation wells. However, groundwater flow within the FRA in the Barossa PWRA generally follows the topography and flows from high points in the catchments to low points where groundwater usually discharges to streams (Fig. 5). Groundwater moves westward from the ranges with some discharge to the sedimentary aquifers. Beneath the valley, the flow direction in the FRA turns southwest (Fig. 5). The salinity distribution mirrors the overlying Lower Aquifer, ranging from 450 to over 5000 mg/L. The more saline wells however, are generally found to the south-west (Fig. 5).

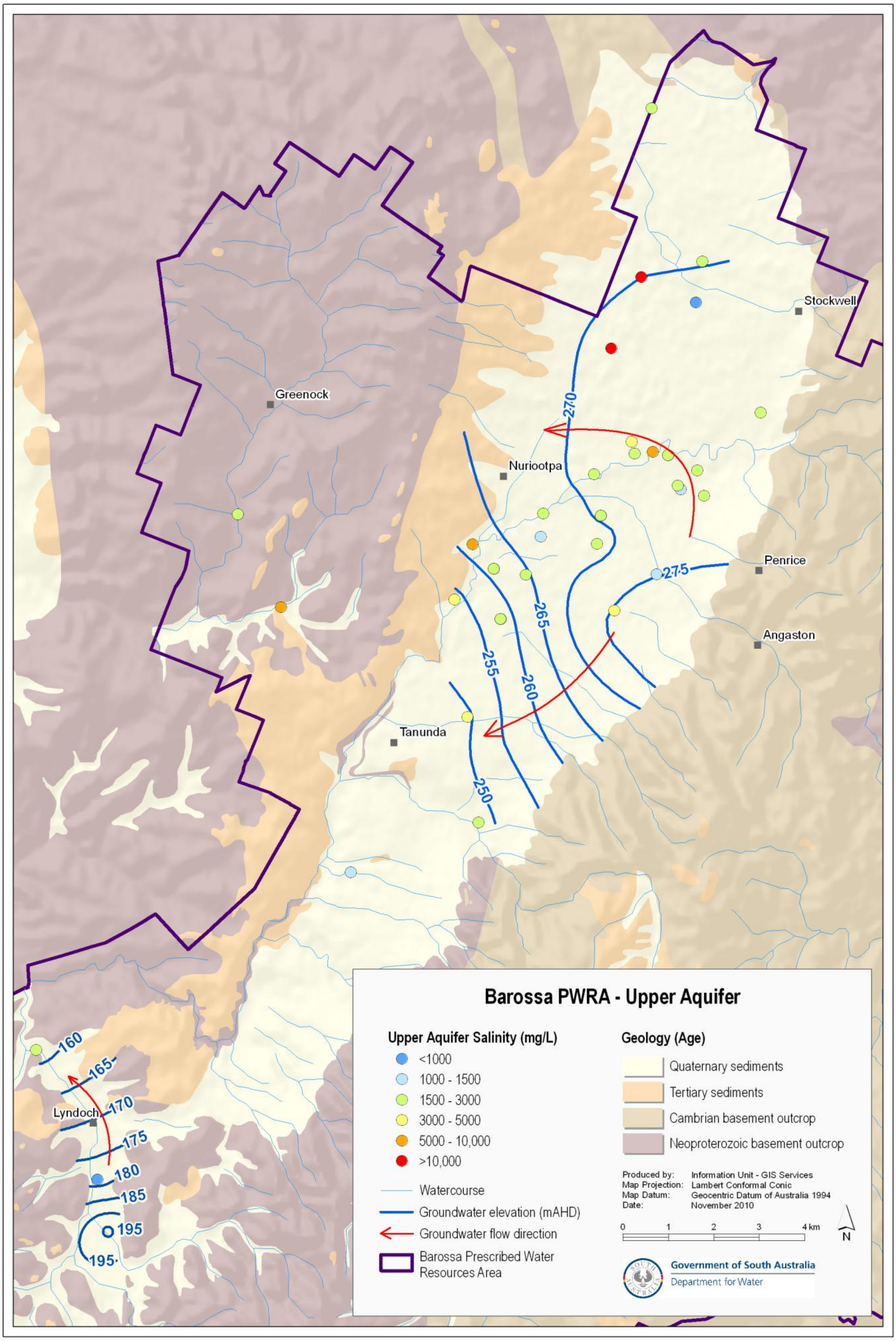

Figure 3. Groundwater flow direction and salinity distribution (2010) for the Upper aquifer in the Barossa PWRA

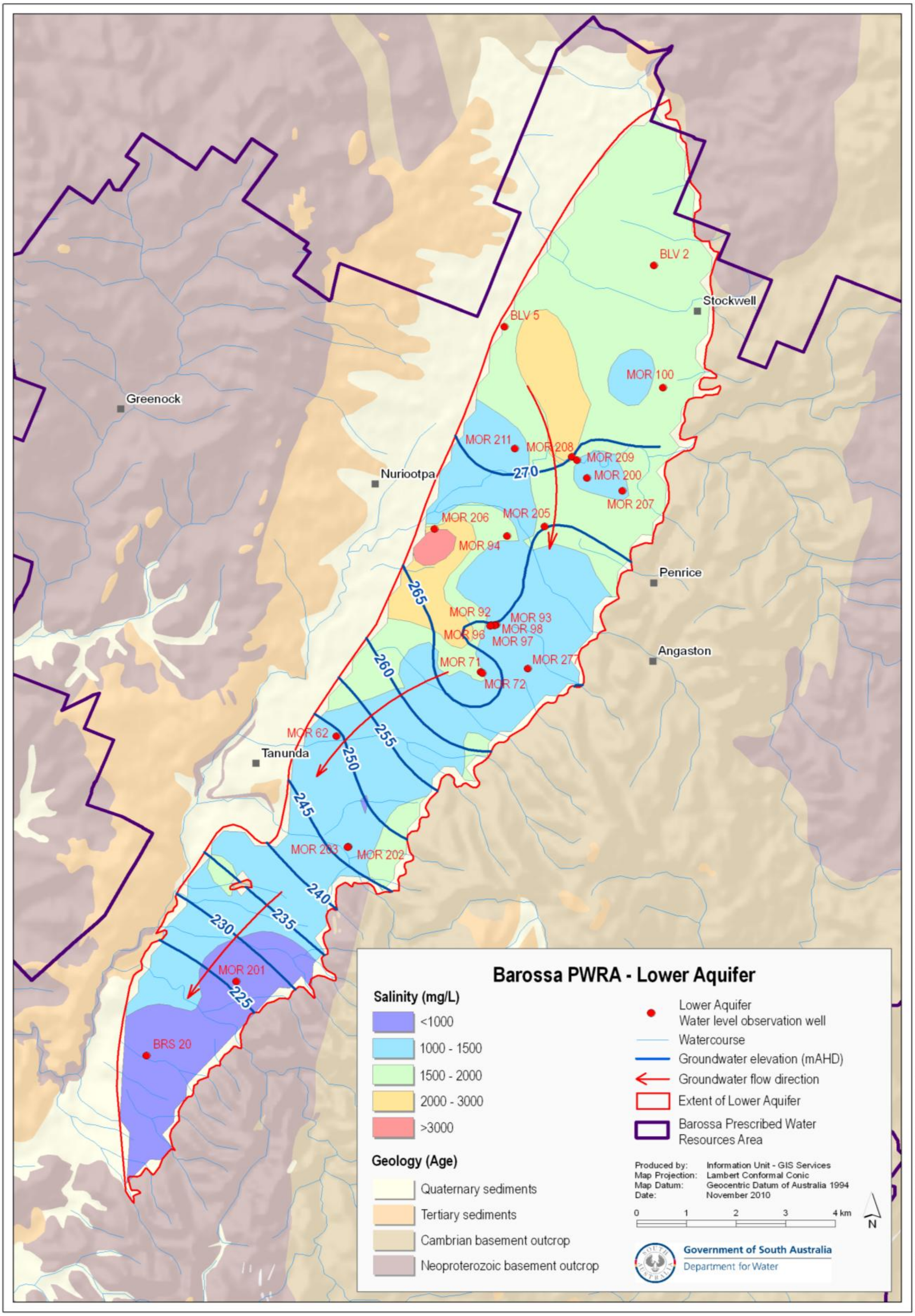

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Figure 4. Groundwater flow direction and salinity distribution (2010) for the Lower aquifer in the Barossa PWRA

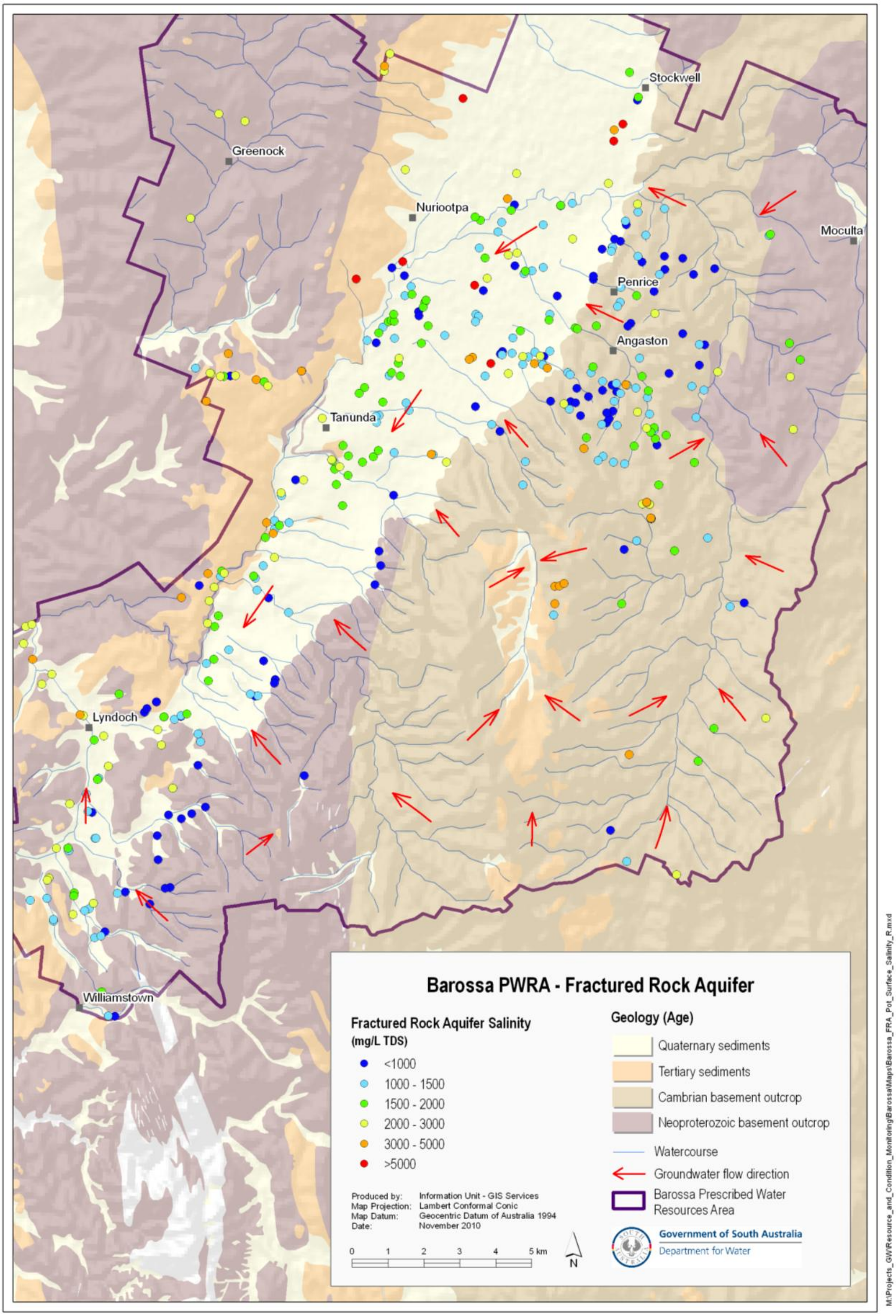

Figure 5. Groundwater flow direction and salinity distribution for the Fractured Rock Aquifer in the Barossa PWRA

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 Barossa PWRA. Water Allocation Plans must include an assessment of the water required by ecosystems; this includes 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 ten metres 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 exist throughout the Barossa PWRA, most of which are expected to be maintained through groundwater baseflow contributions from either the FRA in the hills areas, or the shallow, unconfined Quaternary aquifer on the valley floor. These permanent aquatic habitats are important refugia for aquatic biota and are known to support populations of aquatic plants, aquatic macroinvertebrates and fish.

Plants that likely access water within the shallow, unconfined Quaternary aquifer also exist along significant lengths of the watercourses within the PWRA, mostly River Redgum (*Eucalyptus camaldulensis*).

Other possible GDEs in the Barossa PWRA 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 Barossa Valley region is characterised by hot, dry summers and cool to cold, wet winters. Data from the Bureau of Meteorology rainfall station located at Angaston (station 23300; Fig. 10) was considered reasonably representative of the Barossa PWRA and was chosen for analysis of rainfall trends.

The cumulative deviation from mean monthly rainfall identifies 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.

High periods of rainfall are observed during 1974–75, 1981 and 1992–93 (Fig. 6). Since 1993 however, rainfall has been generally below average, especially after a wetter period in 2005 (Fig. 6). Rainfall during 2009 and 2010 was about average.

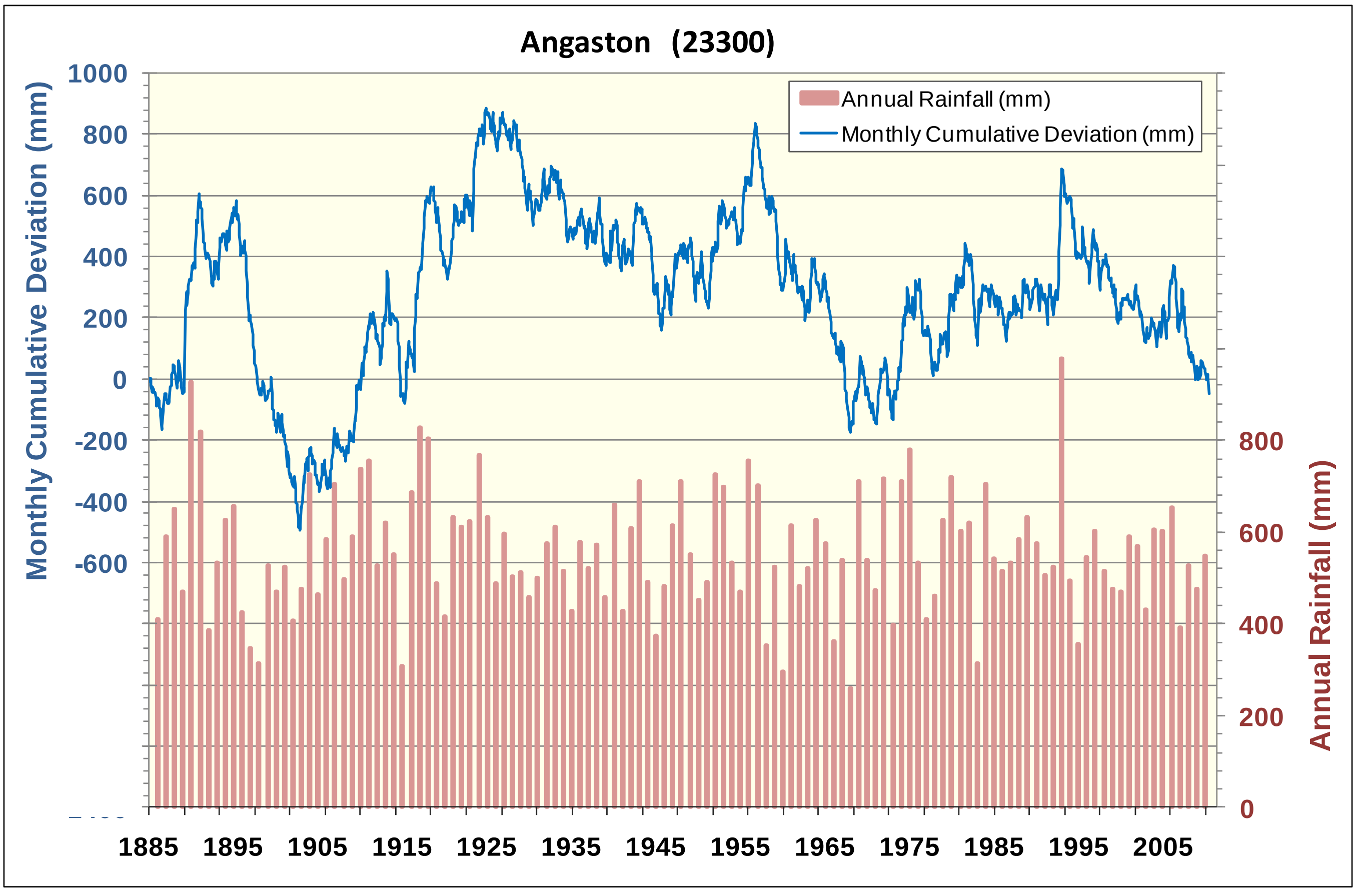

Figure 6. Annual rainfall and cumulative deviation for mean monthly rainfall for Angaston

GROUNDWATER USE

Groundwater extractions in the Barossa PWRA for 2009–10 totalled 2103 ML, a decrease of 30% from the previous year and well below the allocation limit of 7400 ML (Fig. 7). The significant decrease in groundwater extraction since 2000-01 can be attributed to the transfer of supply from groundwater to imported River Murray water, delivered by the BIL scheme. However, the 2006 drought resulted in reduced River Murray allocations and hence demand returned to groundwater for several years. The reduced 2009–10 extractions reflect higher rainfall than in previous years and increased River Murray (BIL) allocations.

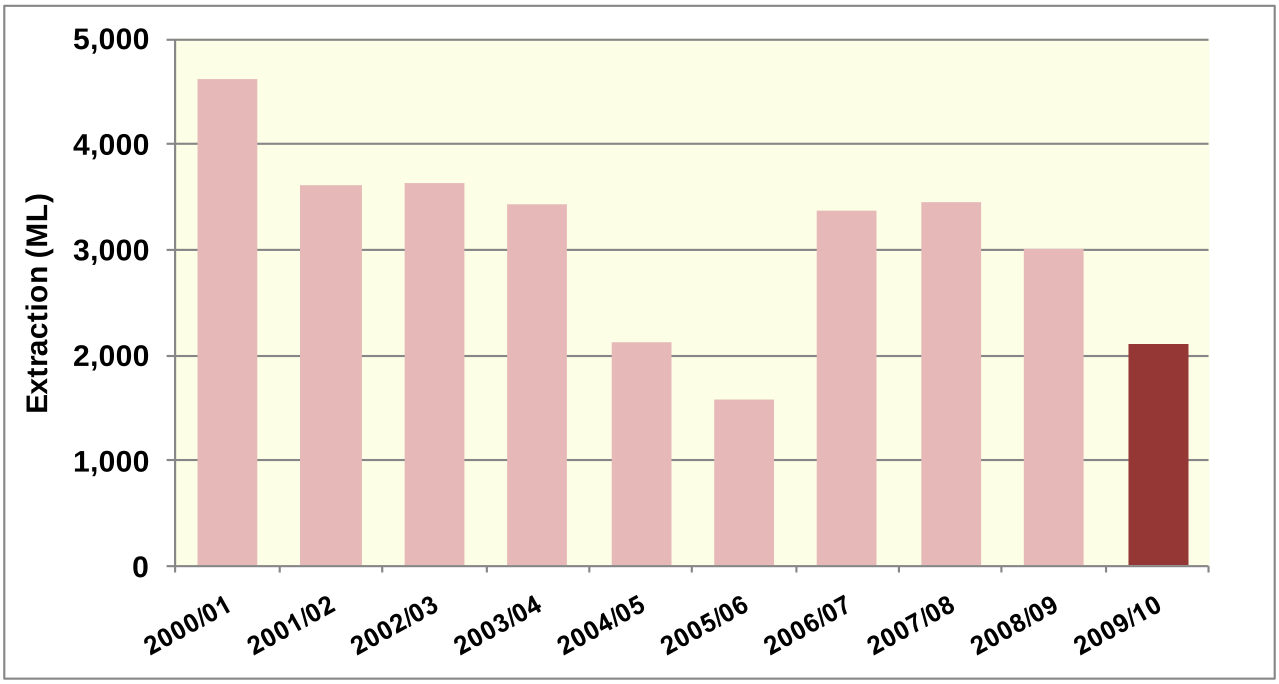

Figure 7. Historic licensed groundwater extraction in the Barossa PWRA

Historically, extractions from the FRA have dominated, representing 54% of total groundwater use, followed by the Lower Aquifer at 33% (Fig. 8). Poorer-quality groundwater within the Upper Aquifer has resulted in minor extractions (13%). Patterns of extraction from each aquifer follow the general trend.

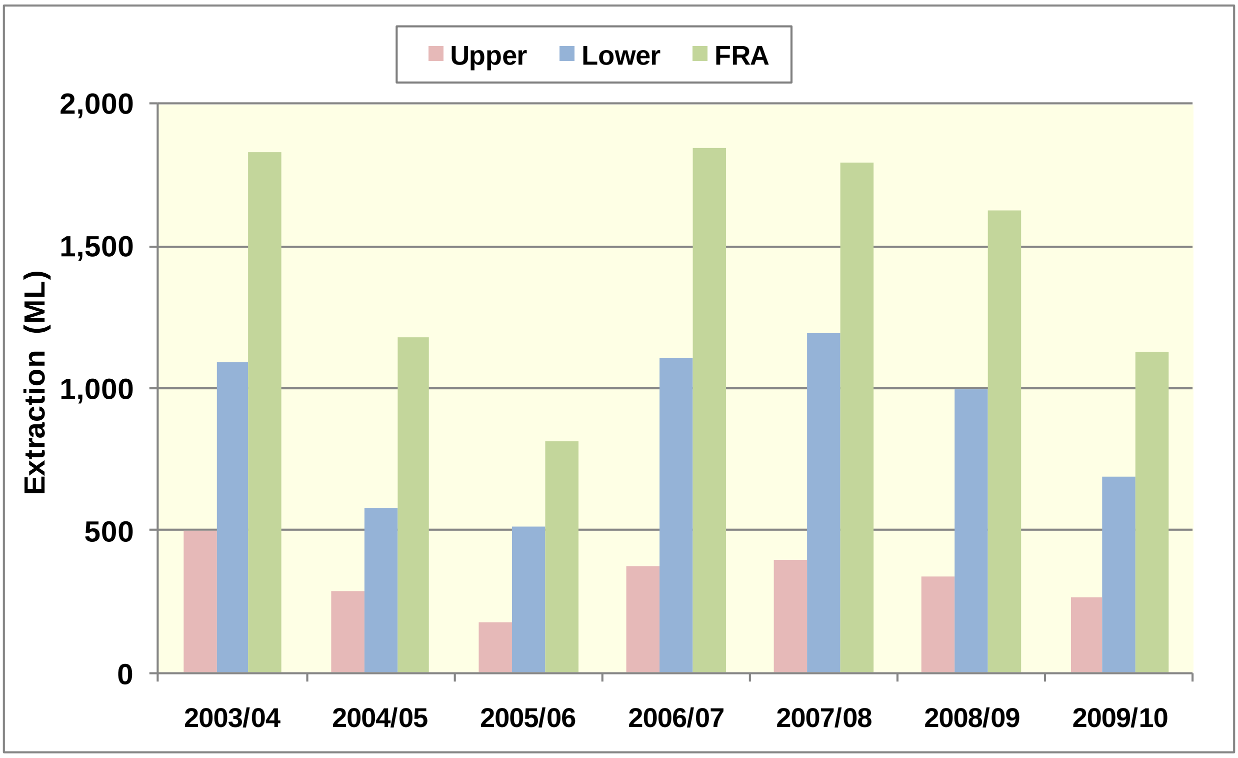

Figure 8. Historic groundwater extraction by aquifer in the Barossa PWRA

The spatial distribution of extractions from licensed wells within the Barossa PWRA is presented in Figure 9. The view is looking toward the south, with the extractions from the various aquifers colour coded. The height of the column relates to the volume extracted from each well during the 2009–10 irrigation season. Extractions from the Lower Aquifer dominate within the valley.

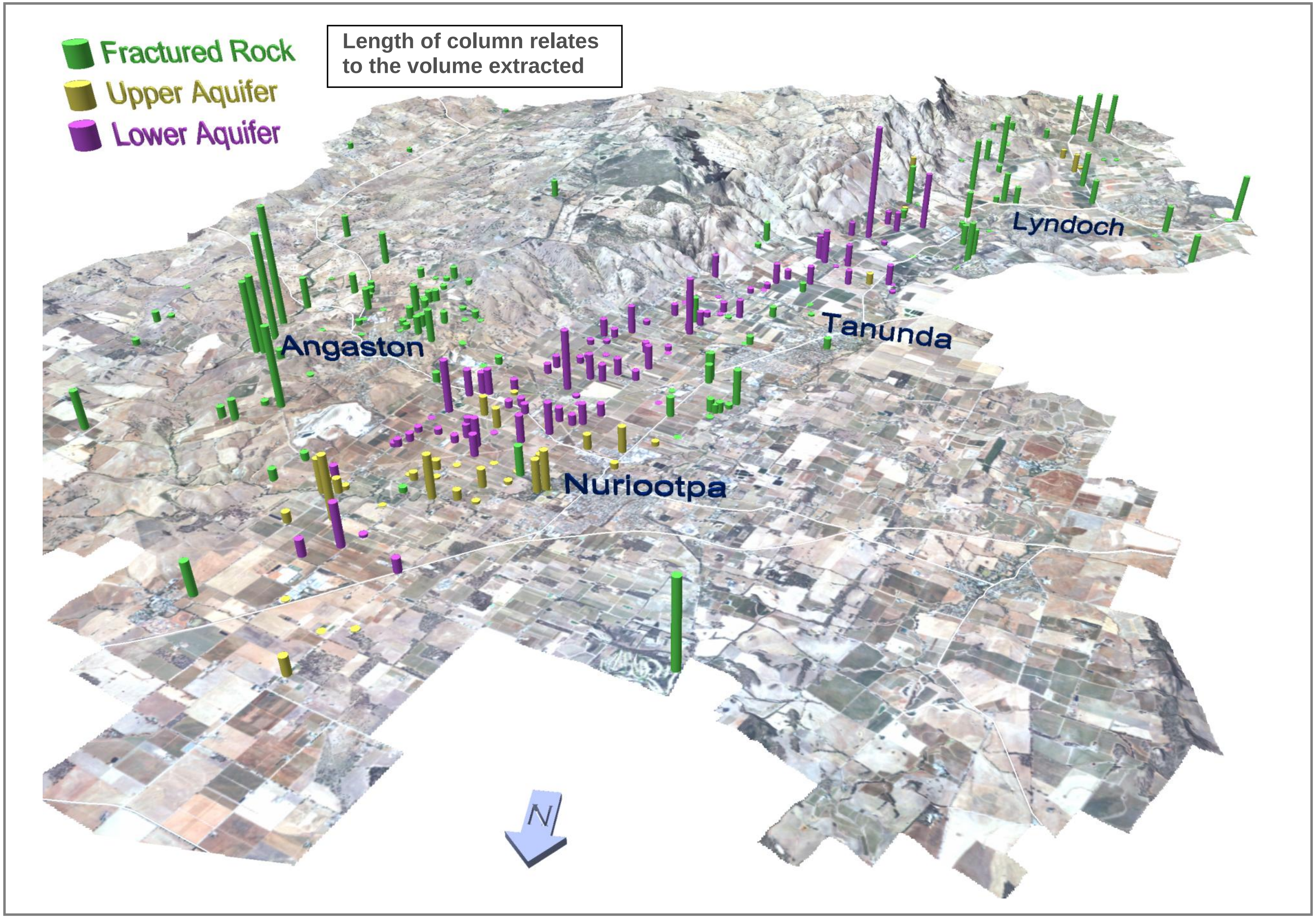

Figure 9. Spatial distribution of licensed groundwater extraction from each well during the 2009–10 irrigation season in the Barossa PWRA

WATER LEVEL NETWORK

The Barossa groundwater level observation network consists of 103 wells, comprising 37 in the Upper Aquifer, 24 in the Lower Aquifer and 42 in the FRA (Fig. 10). A concentration of observation wells is located on the valley floor area in the centre of the Barossa PWRA to monitor the drawdown impacts of irrigation extractions from the sedimentary and underlying fractured rock aquifers.

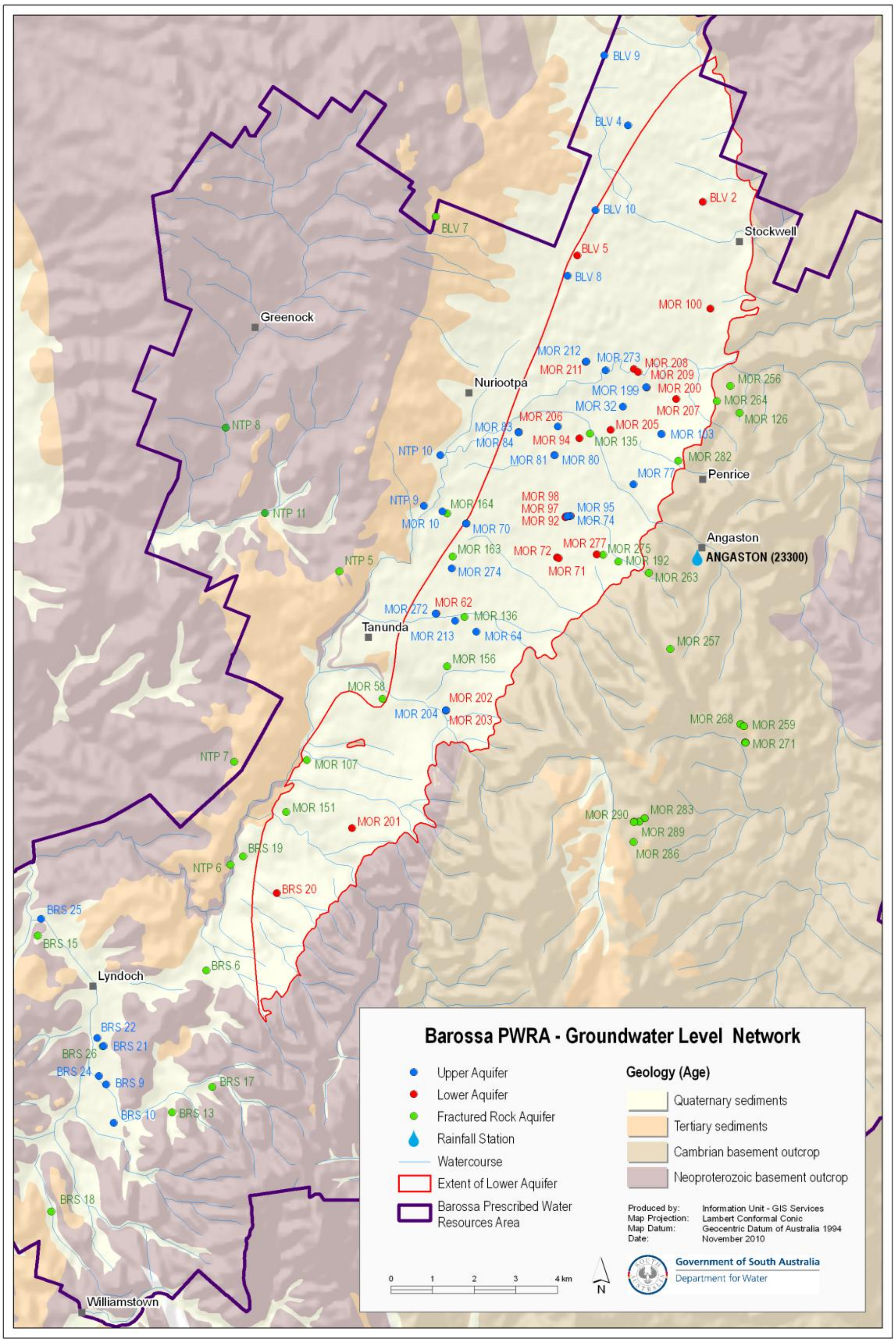

Figure 10. Location of groundwater level observation wells in the Barossa PWRA

SALINITY NETWORK

The Barossa groundwater salinity observation network consists of 66 wells, comprising 30 in the Upper Aquifer, 22 in the Lower Aquifer and 14 in the FRA (Fig. 11). In addition to these wells, salinity samples have been collected on an annual basis from about 140 irrigation wells since 2005.

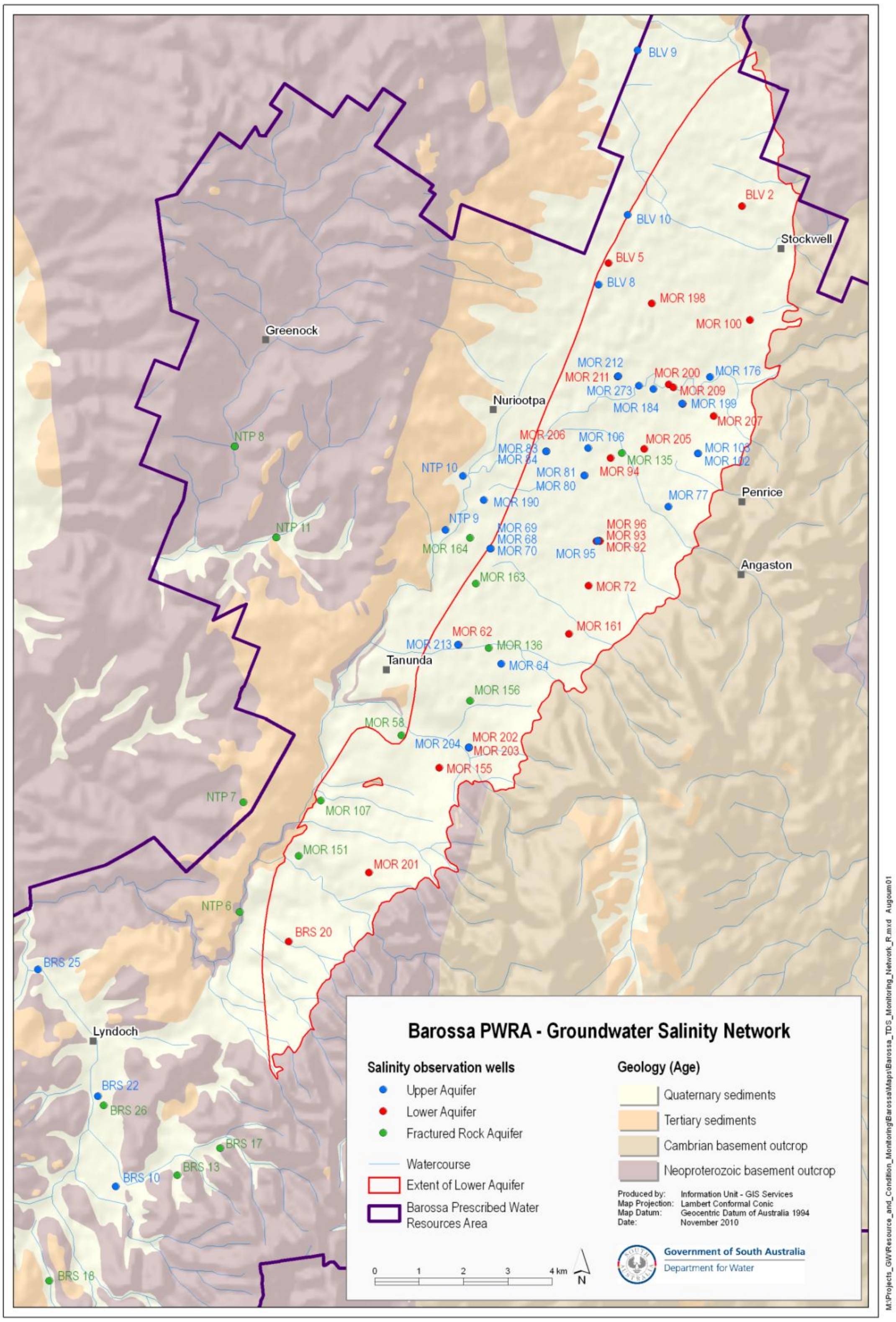

Figure 11. Location of groundwater salinity observation wells in the Barossa PWRA

UPPER AQUIFER

The Upper Aquifer observation wells exhibit a variety of trends, ranging from stable to declining (Fig. 12). There is a subdued relationship with the cumulative deviation from mean monthly rainfall graphed in light blue, with water level rises of up to a metre occurring in very wet years such as 1981, 1993, 1996 and 2006. Seasonal responses to recharge of several metres are common, except where the aquifer underlies the Quaternary clay (observation well MOR064). The declining trends may be caused by downward leakage into the lower aquifer where extractions from that aquifer are high.

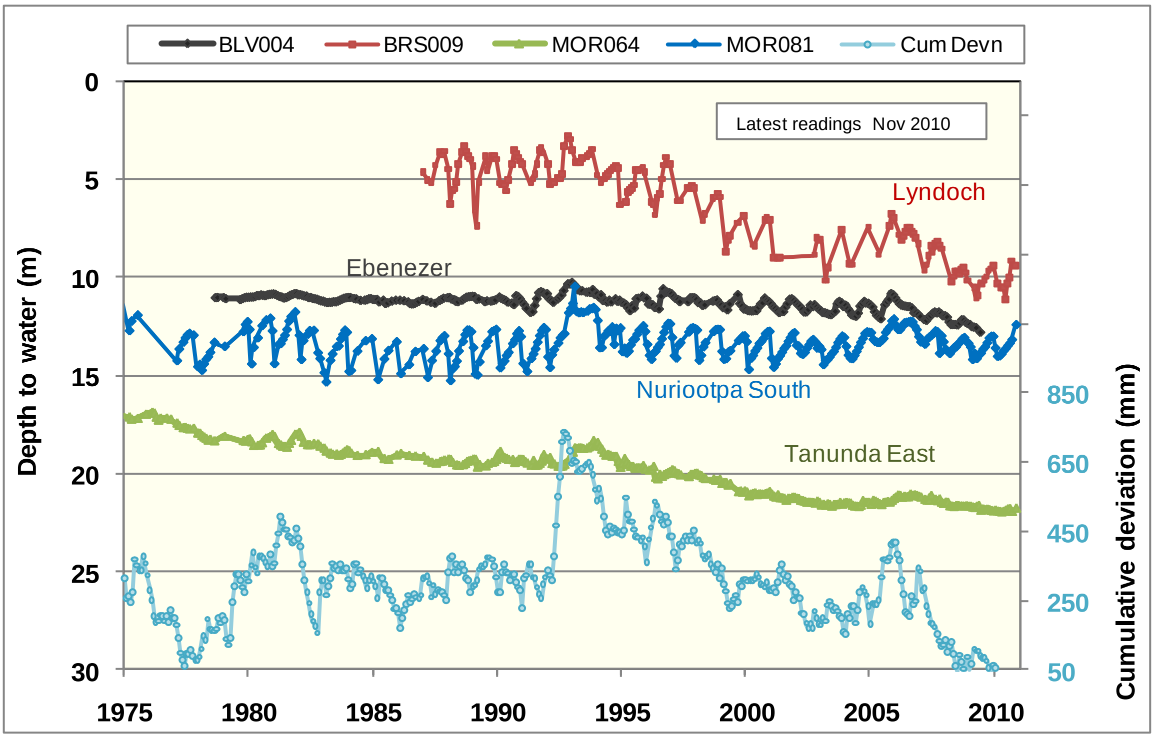

Figure 12. Groundwater level trends for the Upper Aquifer in the Barossa PWRA

LOWER AQUIFER

The groundwater level trends for the Lower Aquifer (Fig. 13) indicate that in areas of intensive groundwater extraction for irrigation, there are large seasonal drawdowns of up to 20 m due to the pressure response to pumping in the confined aquifer. Observation wells MOR062 and MOR094 have shown stable trends, with minor responses to wet years (1981, 1993 and 2006) as shown by the cumulative deviation from mean monthly rainfall graphed in light blue. The smaller seasonal drawdowns observed since 1992 most likely reflect decreasing extractions from the aquifer. The period of high water levels in 2004–05 and 2005–06 reflect the decrease in extractions following the introduction of the BIL scheme.

Although there is no direct rainfall recharge to deep confined aquifers, there may be an indirect correlation between groundwater levels and rainfall because dry years will result in increased groundwater pumping that may lead to a lowering of groundwater levels. In particular, a dry winter may lead to an earlier start to pumping for the irrigation season which may prevent water levels from recovering to their normal levels in spring. Conversely, a wet spring may delay the start of irrigation, leading to a higher than normal recovery in water levels.

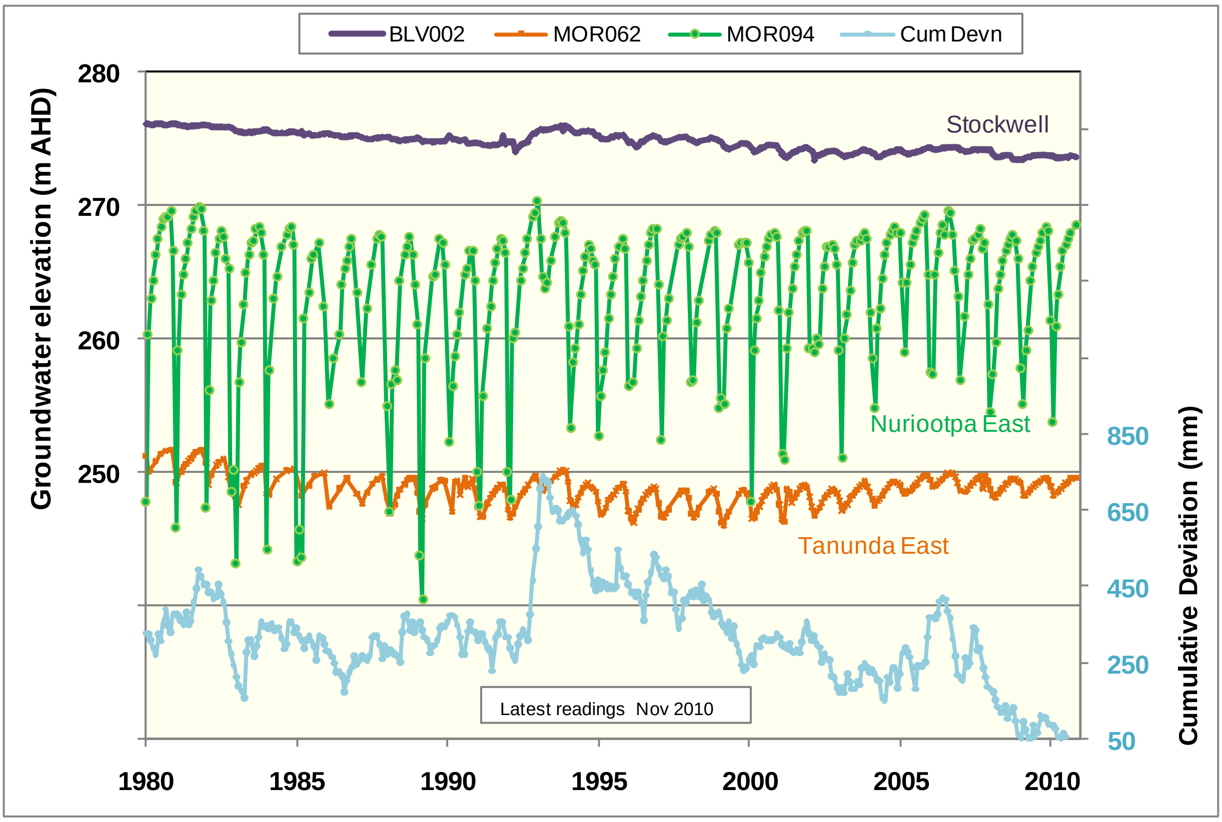

Figure 13. Groundwater level trends for the Lower Aquifer in the Barossa PWRA

FRACTURED ROCK AQUIFER

Groundwater levels in the FRA in the highlands (Fig. 14) display a broad relationship with rainfall patterns (observation wells BRS017 and MOR0126), with water level rises of several metres occurring in very wet years such as 1981, 1993, 1996 and 2006. FRA observation wells beneath the Tertiary sediments tend to show a more subdued response, as seen with MOR156 which also shows a reduction in seasonal drawdown since 2006, probably as a result of reduced pumping. Observation well BLV007 is displaying an atypical decreasing trend. The period of high water levels in 2004–05 and 2005–06 may reflect the decrease in extractions following the introduction of the BIL scheme.

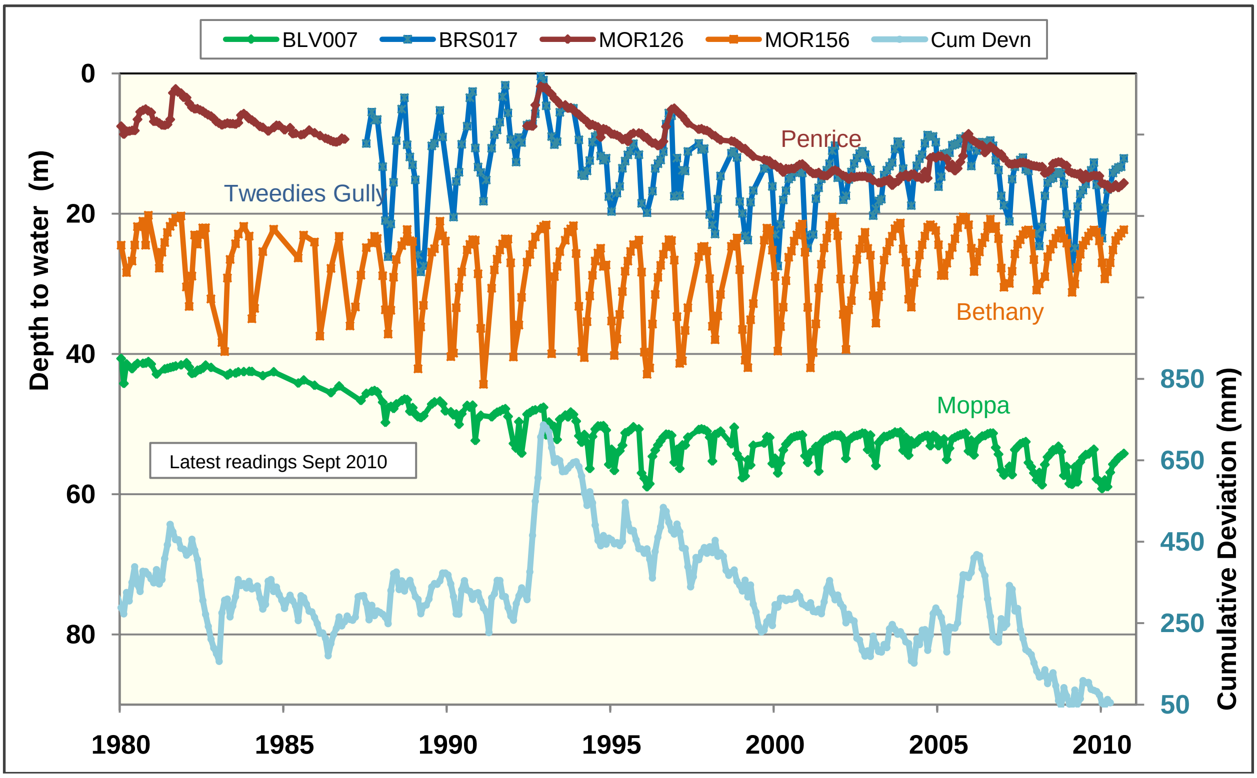

Figure 14. Groundwater level trends for the Fractured Rock Aquifer in the Barossa PWRA

UPPER AQUIFER

Groundwater salinity trends in the Upper Aquifer are quite variable with both increasing and decreasing trends observable over the past 30 years (Fig. 15). Observation well MOR184 is showing a close relationship with the cumulative deviation from mean monthly rainfall graphed in light blue, with a decrease in salinity observed after the wet year in 1993 and an increase during the period of below-average rainfall from 1993 to 2006.

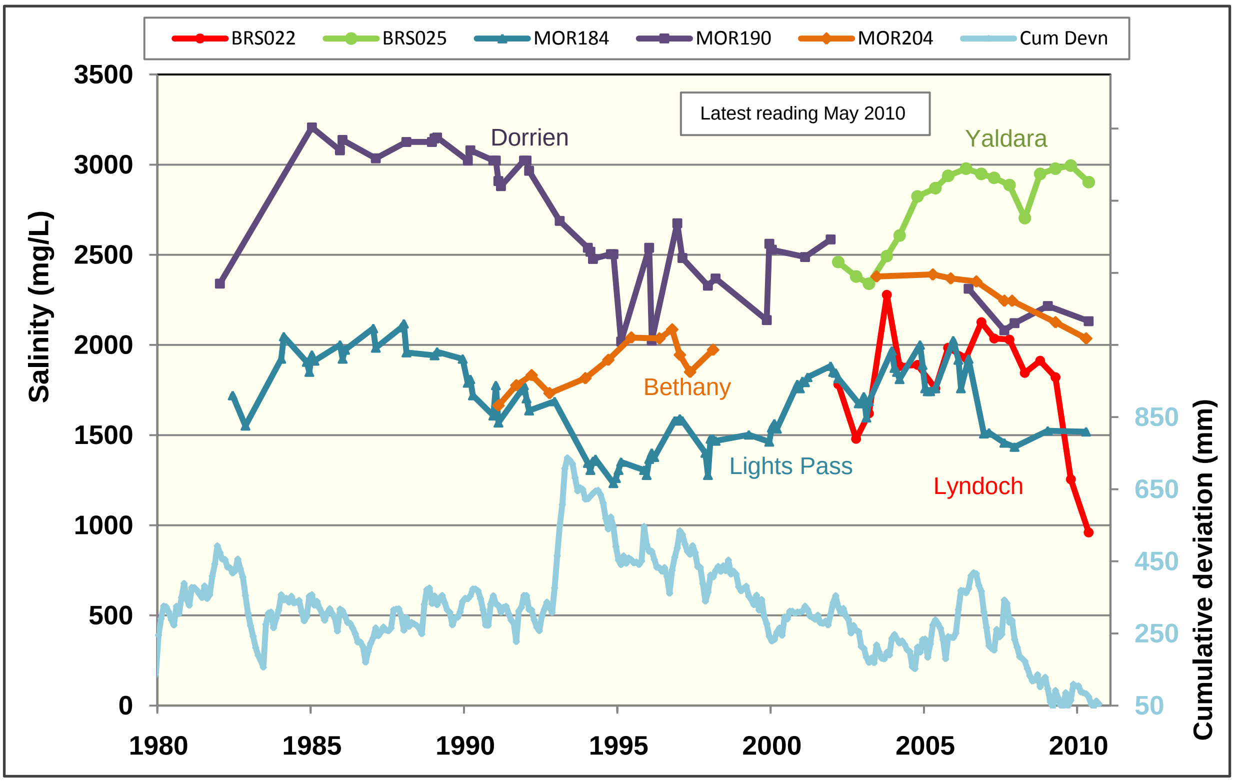

Figure 15. Groundwater salinity trends for the Upper Aquifer in the Barossa PWRA

LOWER AQUIFER

Of the 22 observation wells that monitor groundwater salinity within the Lower Aquifer, 17 are showing a steady increase in salinity which has averaged 7.5 mg/L/yr since 1990 (the maximum rate was 16 mg/L/yr). These rises in groundwater salinity have been observed throughout the aquifer (Fig. 16). Further work will be undertaken to define the causes of this increase, with initial evidence suggesting inter-aquifer leakage may be contributing to the problem. An investigation into the integrity of well casings is required to ensure leakage of shallow saline groundwater is not influencing salinity measurements.

This rise in salinity could become critical in areas where groundwater salinities are close to the tolerance level for grape vines which is about 1500 mg/L. The ability to access an alternative water supply through the BIL scheme may reduce this risk.

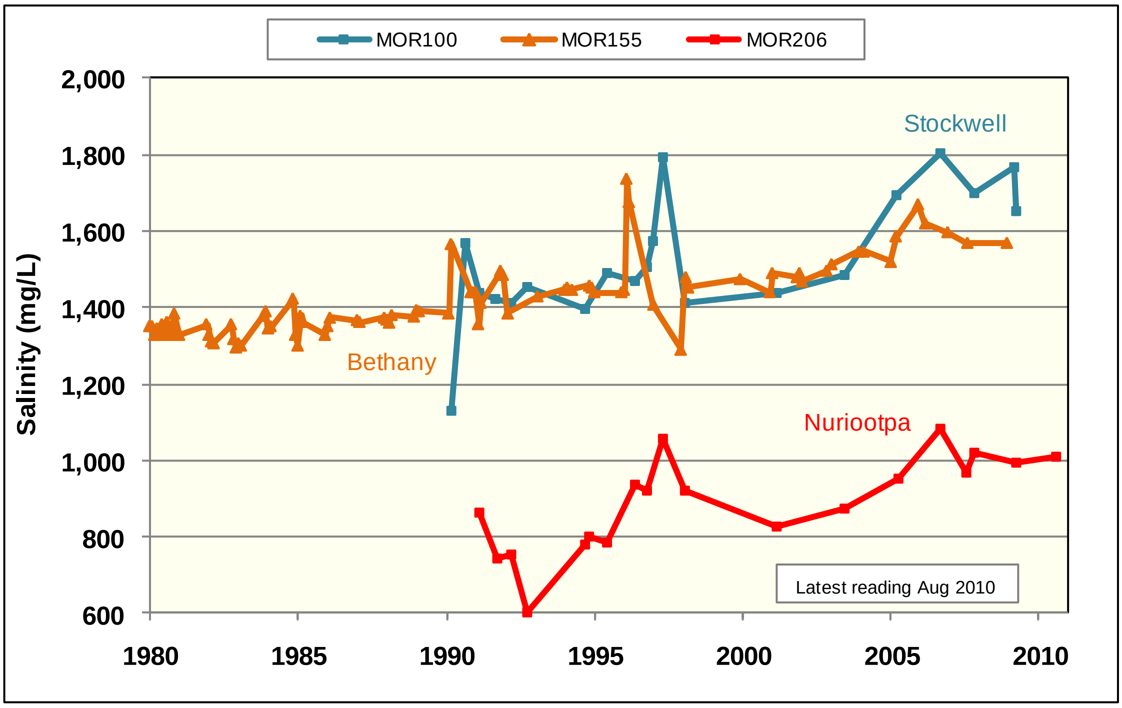

Figure 16. Groundwater salinity trends for the Lower Aquifer in the Barossa PWRA

FRACTURED ROCK AQUIFER

Long-term trends for the FRA are highly variable due to the complex system of preferential flow paths affecting recharge and movement through the aquifer (Fig. 17). For example, the salinity observation well MOR164 has remained fairly consistent since 1988 after an earlier increasing trend, while salinities in MOR156 have decreased since 1995 after a similar earlier rising trend. BRS026 has nearly doubled in salinity over the past ten years.

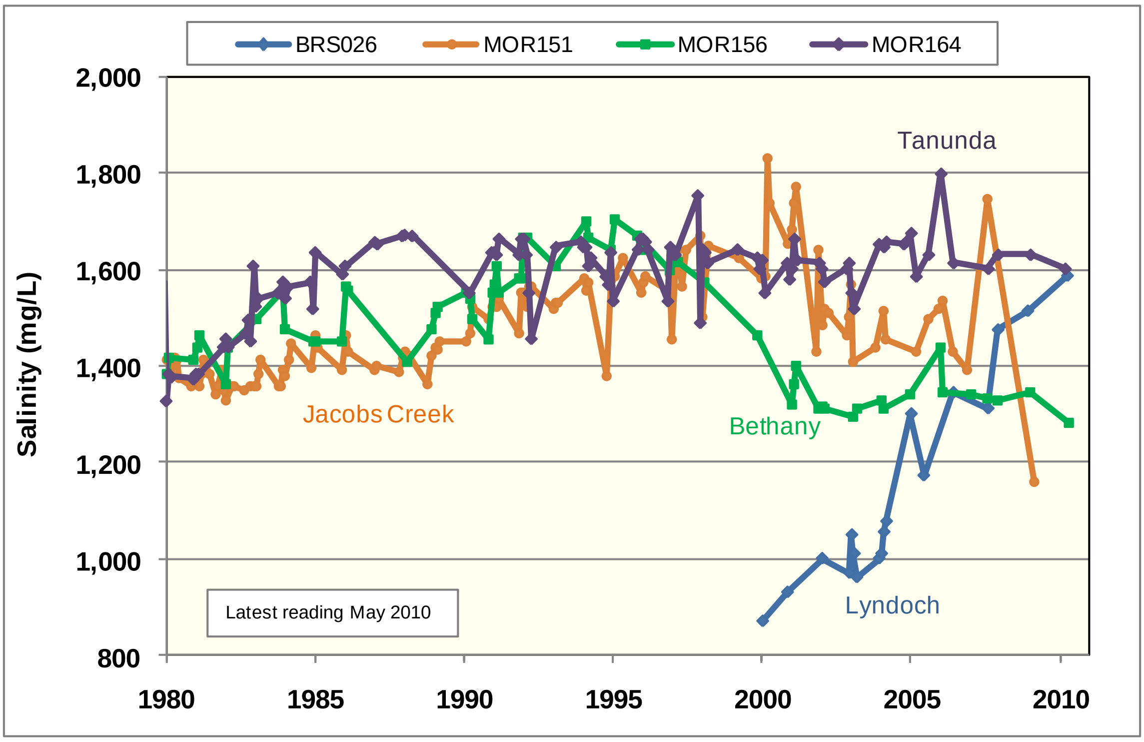

Figure 17. Groundwater salinity trends for the Fractured Rock Aquifer in the Barossa PWRA