SOUTHERN BASINS PWA

GROUNDWATER LEVEL AND SALINITY STATUS REPORT

2011

Government of South Australia
Department for Water

Science, Monitoring and Information Division
Department for Water
25 Grenfell Street, Adelaide
GPO Box 2834, Adelaide SA 5001
Telephone National (08) 8463 6946
International +61 8 8463 6946
Fax National (08) 8463 6999
International +61 8 8463 6999
Website www.waterforgood.sa.gov.au

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SUMMARY 2011

The Southern Basins Prescribed Wells Area (PWA) is located in southern Eyre Peninsula, approximately 270 km west of Adelaide. It is prescribed under South Australia's *Natural Resources Management Act 2004* and a Water Allocation Plan provides for the sustainable use of the groundwater resources.

Groundwater extractions in the Southern Basins PWA occur primarily from the Quaternary Limestone aquifer. Metered extractions for the 2010–11 water-use year totalled 5631 ML, which represents a decrease of 15% from the previous water-use year and is the lowest recorded in the past ten years. The majority of the extractions (5583 ML) are for public water supply, with the Uley South lens providing nearly 90% of this volume.

After long periods of declining groundwater levels, above-average rainfall since 2009 has increased recharge and led to watertable rises of up to 0.4 m in some areas. During 2011, despite small localised declines in some areas, there has been an overall general increase in groundwater levels across the majority of the PWA when compared to water levels at the same time the previous year.

Groundwater salinity is variable across the Southern Basins PWA with both increases and decreases in salinity recorded in 2011. Lincoln Basin is the most vulnerable to increases in salinity due to the up-coning of saline groundwater underlying the fresh groundwater lenses.

While the status assigned to the groundwater lenses of the Southern Basins PWA reflects the generally positive trends observed during 2011, it must be remembered that in the past, a prolonged period of below-average rainfall resulted in declining water levels and a gradual rise in groundwater salinities. The reoccurrence of similar low-rainfall periods must be considered in long-term planning.

ASSESSMENT OF STATUS

The Uley South, Uley Wanilla, Uley East and Coffin Bay lenses have been assigned a green status of “No adverse trends, indicating a stable or improving situation” for 2011. This status is supported by:

- the overall rise of groundwater levels when compared to the same time the previous year due to near-average rainfall during 2011, despite some small localised declines in some area
- a reduction in salinity in some areas due to increased recharge.

The Lincoln Basin has been assigned a yellow status of “Adverse trends, indicating low risk to the resource in the medium term” for 2011. This status is based on the relatively higher groundwater salinities and vulnerability to saline water intrusion due to both vertical and lateral groundwater flow.

While the status assigned to these lenses reflects the positive trends observed during 2011, it must be remembered that in the past, a prolonged period of below-average rainfall resulted in declining water levels and a gradual rise in groundwater salinities. The reoccurrence of similar low-rainfall periods must be considered in long-term planning.

The Quaternary Limestone aquifer responds rapidly to changes in rainfall patterns and consequently, the status of the resource may change from year to year.

STATUS 2011

🟢	🟡
Uley South, Uley Wanilla, Uley East and Coffin Bay lenses	**Lincoln Basin**

🟢 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 five years. Degradation will result in a change in the beneficial use (e.g. 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 Southern Basins Prescribed Wells Area (PWA) is located at the southern most part of the Eyre Peninsula, approximately 270 km west from Adelaide (Fig. 1). It is prescribed under South Australia's *Natural Resources Management Act 2004* and a Water Allocation Plan provides for the sustainable use of the groundwater resources.

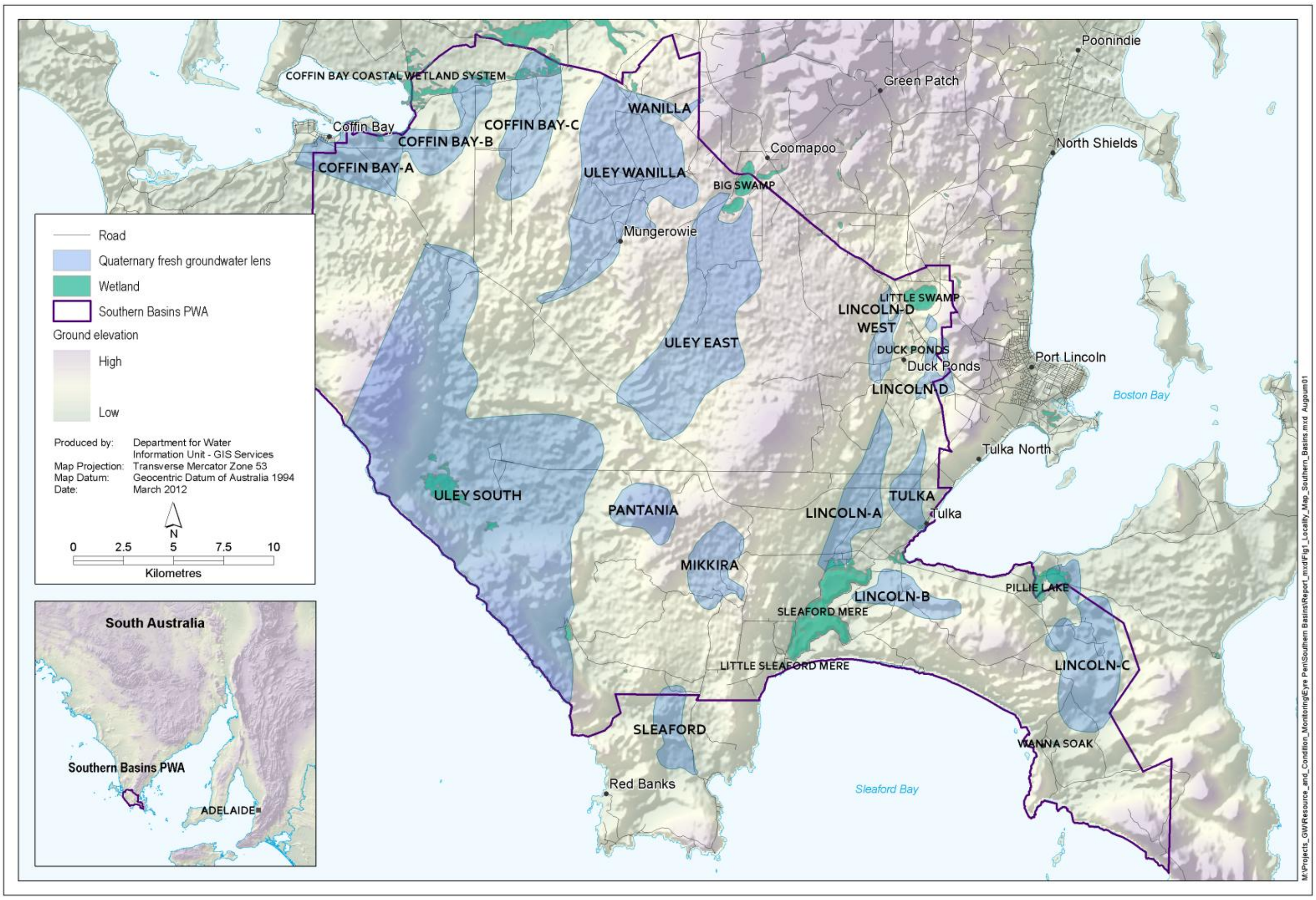

Figure 1. The Southern Basins Prescribed Wells Area with location of Quaternary fresh groundwater lenses as described in the current Water Allocation Plan and delineated in DWLBC Report 2002/13

HYDROGEOLOGY

Within the Southern Basins PWA there are two main sedimentary sequences containing groundwater that overlie basement rocks: the Quaternary Limestone aquifer and the Tertiary Sands aquifer (Fig. 2).

Quaternary Limestone aquifer

The Quaternary Limestone aquifer comprises a generally thin veneer of aeolianite sediments of the Bridgewater Formation and is continuous across the PWA. These calcarenite (i.e. sand comprising of shell fragments, calcareous algae fragments and silicate grains) dune sediments are known to be over 130 m thick in parts of the Uley South Basin. The Bridgewater Formation is generally unconsolidated or loosely aggregated, although hard cemented calcrete layers are present. Secondary porosity appears to be common, evidenced by regular occurrences of surface solution features.

Groundwater resources within the PWAs are extracted predominantly from the Quaternary Limestone aquifer. Quaternary aquifer salinities generally range between 400 and 1800 mg/L and well yields are generally high. Areas defined by salinity of less than 1000 mg/L are described as fresh groundwater lenses (Fig. 1) in the current Water Allocation Plan and delineated in DWLBC Report 2002/13.[1] Their extent is partly controlled by geological structures.

Groundwater flow in the Quaternary Limestone aquifer is predominantly in a direction toward the nearest coastline in the Southern Basins PWA.

Tertiary Sand aquifer

The Tertiary Sand aquifer extends over most of the Southern Basins PWA and consists of unconsolidated fine quartz-sands of the Wanilla Formation that are largely separated from the overlying Quaternary Limestone aquifer by a clay confining layer known as the Uley Formation. Where this confining layer is thin or absent, hydraulic connection between the two aquifers is thought to occur. Due to low yields and generally higher salinities than the Quaternary aquifer (up to 7500 mg/L), the Tertiary Sand aquifer has only been developed locally for stock and domestic supplies.

Basement aquifer

There is limited information and conceptual understanding of the basement aquifers in Eyre Peninsula. Groundwater occurring within basement aquifers is irregular and salinities and yields are variable, which is typical of groundwater resources occurring within fractured rock environments. Basement aquifers around Green Patch (immediately north-west of the Southern Basins PWA) have been developed for irrigation purposes, although the volumes extracted are likely to be small.

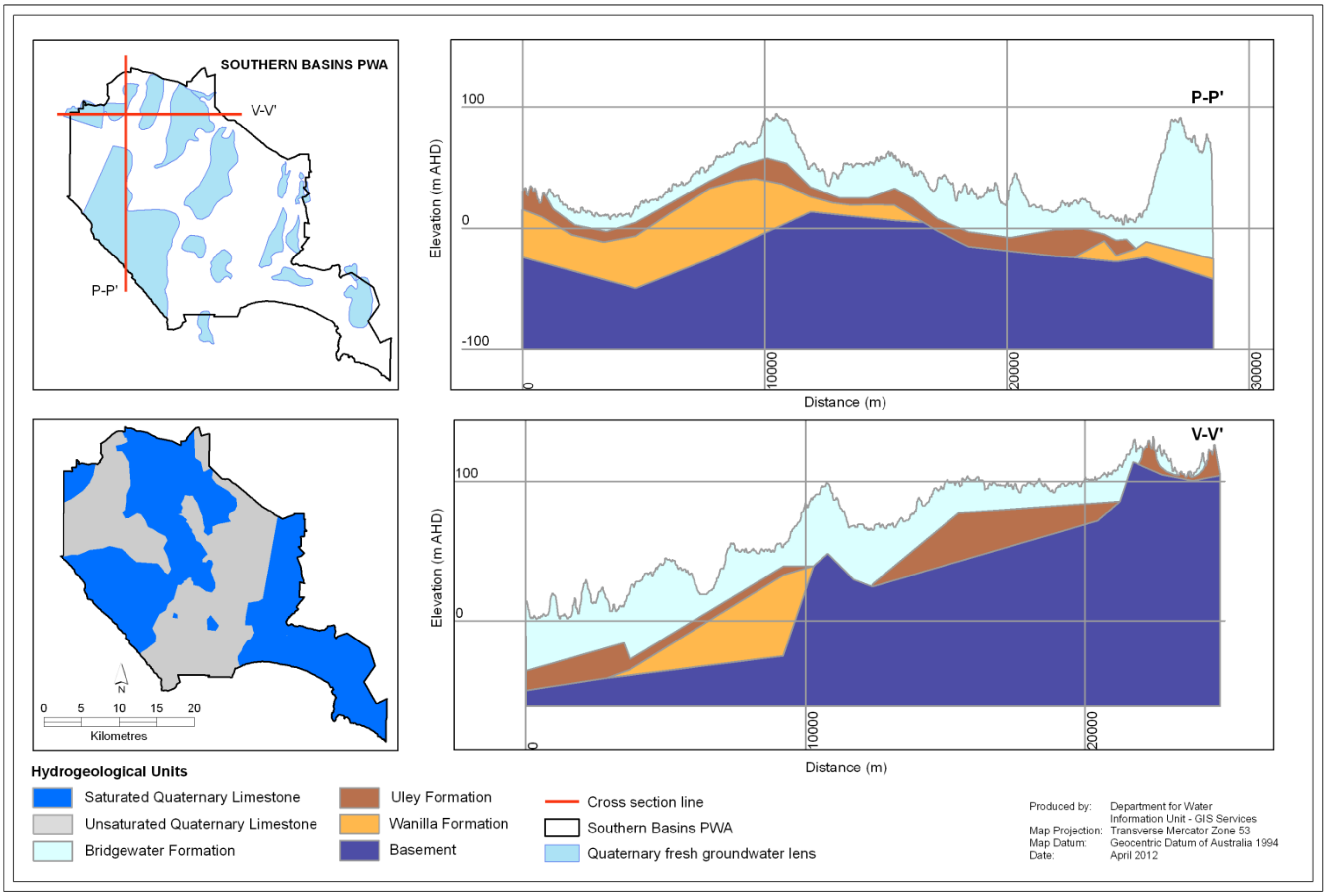

Figure 2. Geological cross-section of stratigraphic units in the Southern Basins PWA (50 x vertical exaggeration)

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[1] Evans, SL 2002, Southern Basins Prescribed Wells Area groundwater monitoring status report 2002, Report DWLBC 2002/13

GROUNDWATER DEPENDENT ECOSYSTEMS

Whilst groundwater dependent ecosystems (GDEs) have not been considered in this assessment of the status of the groundwater resources, it is important to note the presence and ecological characteristics of the GDEs found in the Southern Basins PWA. Groundwater dependent ecosystems can be defined as ecosystems where groundwater provides all or part of the water quantity, chemistry or temperature requirements, either permanently, seasonally or intermittently. It is generally considered that shallow watertables (less than 10 m below the surface) are more likely to support GDEs than deeper watertables.

Ecosystems that are potentially dependent on groundwater have been mapped throughout the Southern Basins PWA and comprise wetlands, terrestrial plants and subsurface biota inhabiting water-filled voids (stygofauna). Direct groundwater discharge to the marine environment, which may also support marine animals and plants, occurs from the Quaternary Limestone aquifer along the coastal margin of the PWA.

Groundwater dependent wetlands are primarily located around the perimeter of the Southern Basins PWA and are closely aligned with, or located immediately outside, mapped freshwater lenses. Most of the mapped groundwater dependent wetlands are intermittent or seasonal and support bird populations and a range of groundwater dependent aquatic and terrestrial vegetation species. Sleaford Mere is the only permanent groundwater dependent wetland mapped within the PWA (Fig. 1).

RAINFALL

The Southern Basins region is characterised as a Mediterranean climate with warm to hot, dry summers and mild, wet winters. Rainfall is winter dominant with May through to August receiving the most rainfall. The average annual rainfall decreases to the north and east. Data from the Westmere (18137) and Big Swamp (18017) rainfall stations were chosen for the analysis of rainfall trends (Fig. 3).

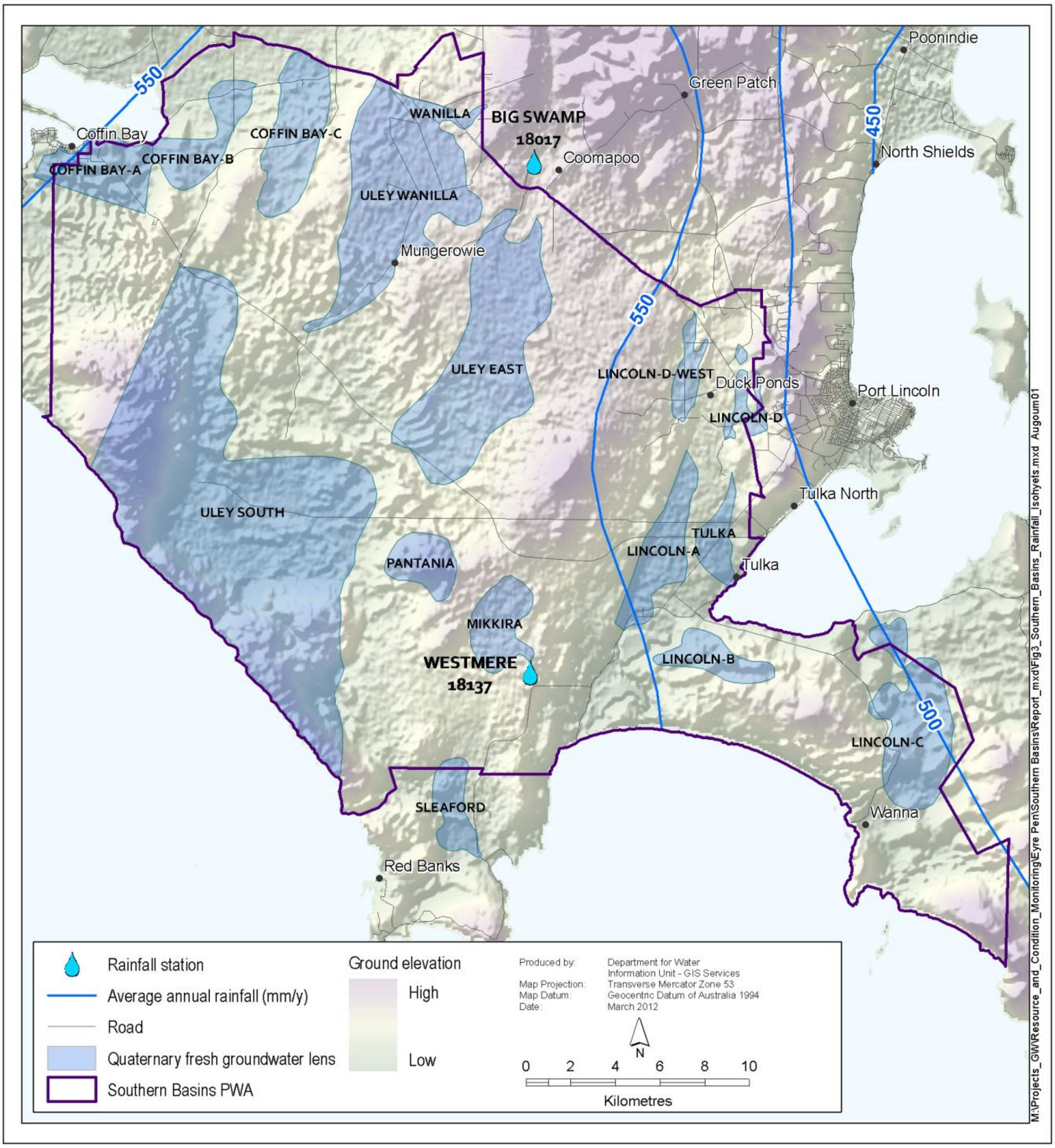

Figure 3. **Location of the Westmere and Big Swamp rainfall stations in the Southern Basins PWA**

From 1910 to 2011, the long-term average annual rainfall at the Big Swamp rainfall station is 559 mm (Fig. 4). The cumulative deviation from the average annual rainfall is graphed in orange to identify periods when annual rainfall trends are above or below the average. An upward slope indicates a period when the rainfall is greater than the average, while a downward slope indicates a period when the rainfall is below the average.

From 1910 to 1940, rainfall at the Big Swamp rainfall station was typically above average, with very wet years in 1910, 1916, 1917, 1920, 1923 and 1932. From 1940, rainfall was predominantly below average until 1968 when the station recorded its highest reading of 925 mm. After this particularly wet year, rainfall displayed an overall upwards trend, reaching 874 mm in 1992. Since 1992, rainfall has generally been below average until 2008. The last three years have been above average.

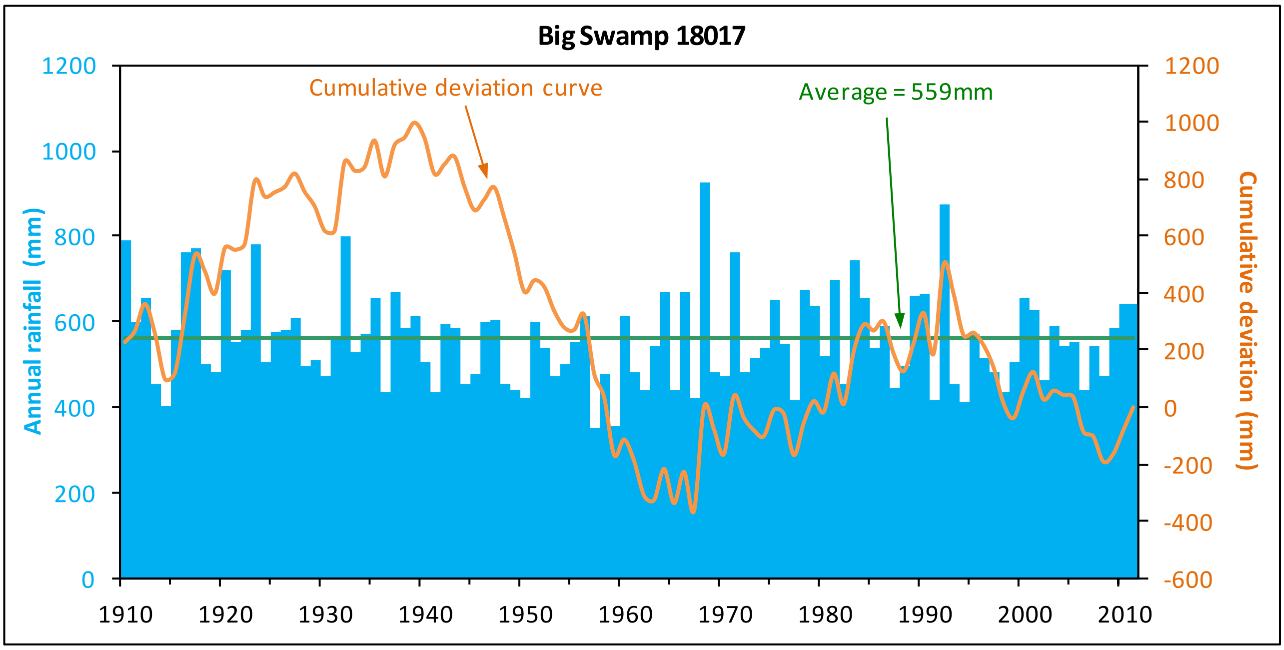

Figure 4. Annual rainfall and cumulative deviation from the average annual rainfall for the Big Swamp rainfall station in the Southern Basins PWA

From 1910 to 2011, the long-term average annual rainfall at the Westmere rainfall station is 575 mm (Fig. 5). The trends are broadly similar to Big Swamp after 1968 when the station recorded its highest reading of 1034 mm. From 1926 to 1950, rainfall was predominantly below average, whereas the period from 1950 to 1968 was generally above average. The last three years (2009, 2010 and 2011) have recorded slightly above-average rainfall.

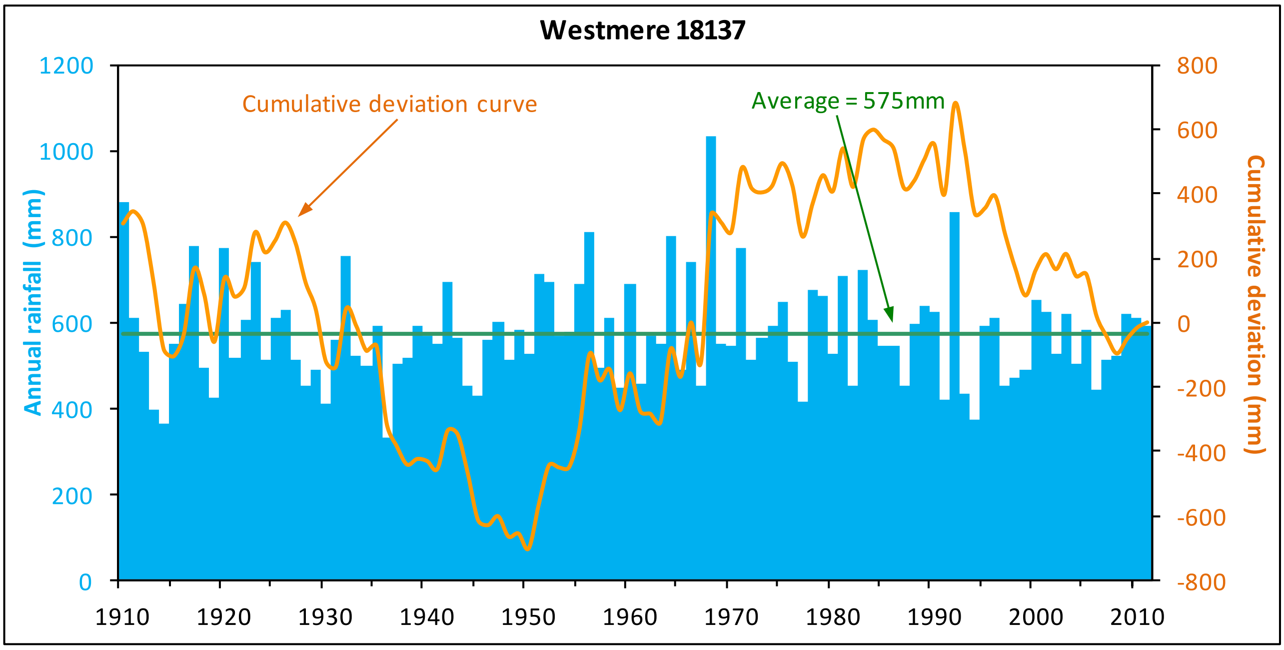

Figure 5. Annual rainfall and cumulative deviation from the average annual rainfall for the Westmere rainfall station in the Southern Basins PWA

The sustainability of the groundwater resources in the Southern Basins PWA is highly dependent on recharge from rainfall and the historical data has indicated that periods of above or below-average rainfall trends can last for up to 25 years. Greater recharge responses have been observed when rainfall occurs in high-intensity events.

GROUNDWATER USE

Licensed groundwater extractions in the Southern Basins PWA for the 2010–11 water-use year totalled 5631 ML (Fig. 6). This amount is derived from metered data and represents a decrease of 15% from the previous water-use year, the lowest extraction recorded in the past ten years. Water restrictions imposed at various levels since 2002 have reduced the demand for groundwater and these restrictions were lifted in April 2011. Extractions have been considerably lower than the licensed allocation limit since 2007–08. The licensed allocation limit is determined in accordance with the current Water Allocation Plan.

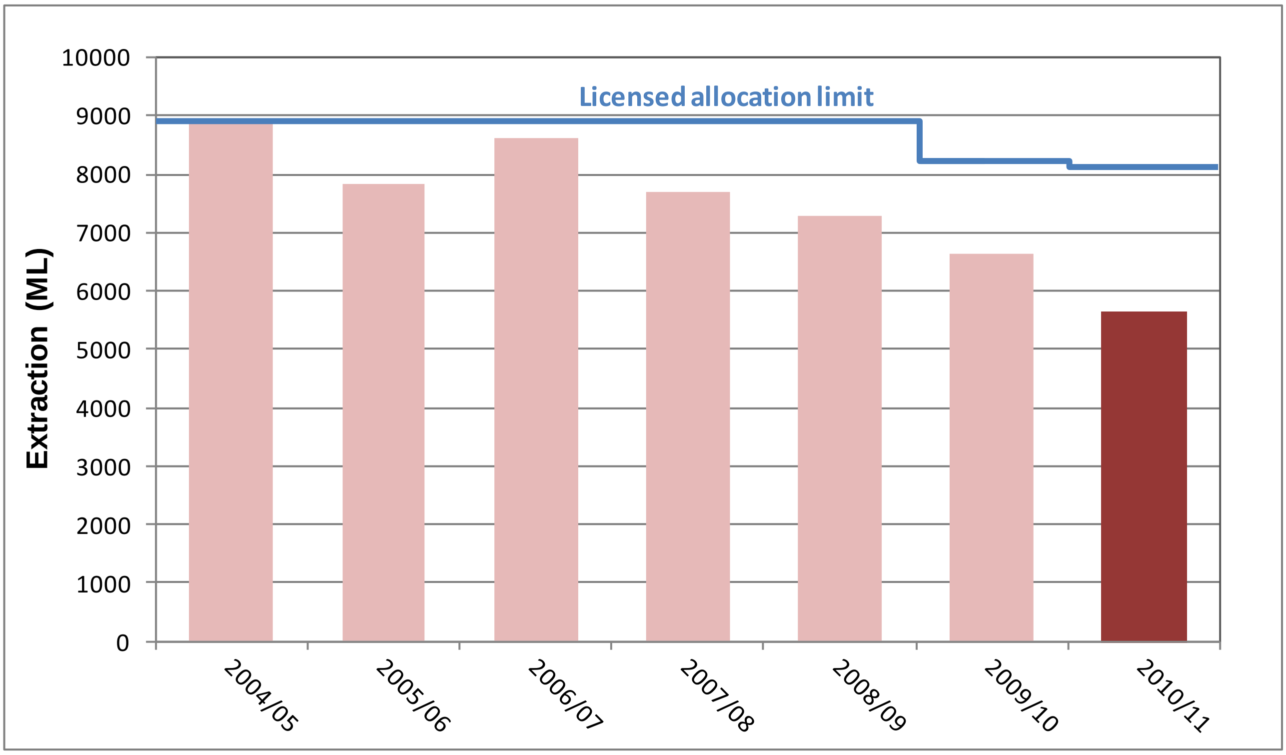

Figure 6. Historic licensed groundwater use and licensed allocation limit in the Southern Basins PWA

Groundwater extraction from the Quaternary Limestone aquifer is primarily from the fresh groundwater lenses (less than 1000 mg/L). The majority of extraction is for town water supply and around 90% of the total volume extracted from the Southern Basins PWA comes from the Uley South Basin Lens (Table 1). Unlicensed groundwater extractions for stock and domestic purposes are estimated to be around 133 ML/y[2].

Table 1. Groundwater extraction from each source for 2010–11

Source	Extraction (ML)
Uley South	4940
Lincoln	441
Uley Wanilla	121
Coffin Bay-A	103
Basement	26
Total	**5631**

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[2] Stewart, S, Alcoe, A and Risby, L, (2012), Science support for the Southern Basins and Musgrave Prescribed Wells Areas Water Allocation Plan, Department for Water

GROUNDWATER OBSERVATION NETWORKS

WATER LEVEL NETWORK

Monitoring of the groundwater levels in the Southern Basins PWA began in 1962 in response to the need for a suitable and sustainable water supply. The lengths of monitoring records vary between the sub-regions (Uley, Lincoln, Coffin Bay) as they were developed at different times.

There are currently 128 wells monitoring groundwater levels with 97 monitoring the Quaternary Limestone aquifer (Fig. 7; Table 2). These wells are monitored on a monthly or six-monthly basis to enable the assessment of both long-term and short-term trends.

Two observation wells (SLE069 and ULE205) are completed across both the Quaternary Limestone and Tertiary Sand aquifers to monitor the position of the fresh water–seawater interface. Observation wells ULE210, ULE211, ULE212, ULE156 and ULE209 are also used to monitor the fresh water–seawater interface.

Table 2. Groundwater level observation wells per aquifer and lens

Aquifer	Lens	Number of wells	Monitoring frequency
Quaternary Limestone (Bridgewater Formation)	Uley South	35	34 x monthly & 1 x 6 monthly
	Uley Wanilla	13	12 x monthly & 1 x 6 monthly
	Uley East	7	2 x monthly & 5 x 6 monthly
	Coffin Bay A	13	13 x monthly
	Coffin Bay B	1	1 x 6 monthly
	Coffin Bay C	2	2 x 6 monthly
	Lincoln A	8	8 x monthly
	Lincoln B	8	8 x monthly
	Lincoln C	10	10 x monthly
Tertiary aquitard (Uley Formation)		4	1 x monthly & 3 x 6 monthly
Tertiary Sand (Wanilla Formation)		23	12 x monthly & 11 x 6 monthly
Quaternary and Tertiary (seawater interface)		2	2 x monthly
Tertiary and basement		1	1 x 6 monthly
Basement (Sleaford Complex)		1	1 x 6 monthly
Total		**128**	

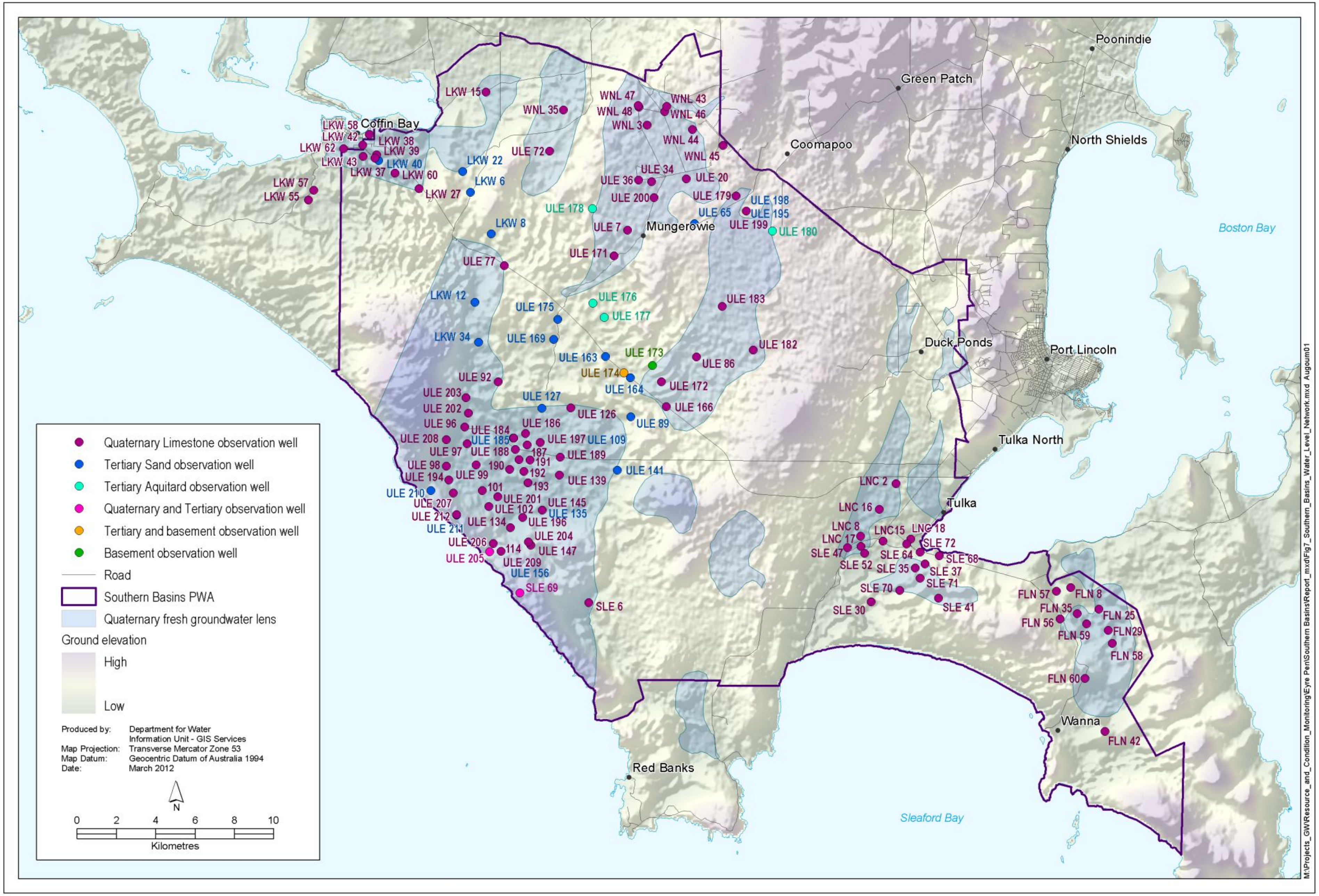

Figure 7. Location of groundwater level observation wells in the Southern Basins PWA as at 5 April 2012

SALINITY NETWORK

Within the Southern Basins PWA, there are currently 128 observation wells monitoring salinity on a yearly or three-yearly basis (Fig. 8). Of this total, 97 monitor the Quaternary Limestone aquifer (Table 3). Regular salinity monitoring is conducted on 48 SA Water production wells located within the Southern Basins PWA.

Table 3. Groundwater salinity observation wells per aquifer and lens

Aquifer	Lens	Number of wells	Monitoring frequency
Quaternary Limestone (Bridgewater Formation)	Uley South	35	3 x yearly & 32 every three years
	Uley Wanilla	13	1 x yearly & 12 every three years
	Uley East	7	7 every three years
	Coffin Bay A	13	5 x yearly & 8 every three years
	Coffin Bay B	1	every three years
	Coffin Bay C	2	every three years
	Lincoln A	8	3 x yearly & 5 every three years
	Lincoln B	8	5 x yearly & 3 every three years
	Lincoln C	10	5 x yearly & 5 every three years
Tertiary aquitard (Uley Formation)		4	every three years
Tertiary Sand (Wanilla Formation)		23	2 x yearly & 21 every three years
Quaternary and Tertiary (seawater interface)		2	every three years
Tertiary Sand and basement (Sleaford Complex)		1	every three years
Basement (Sleaford Complex)		1	every three years
Total		**128**	

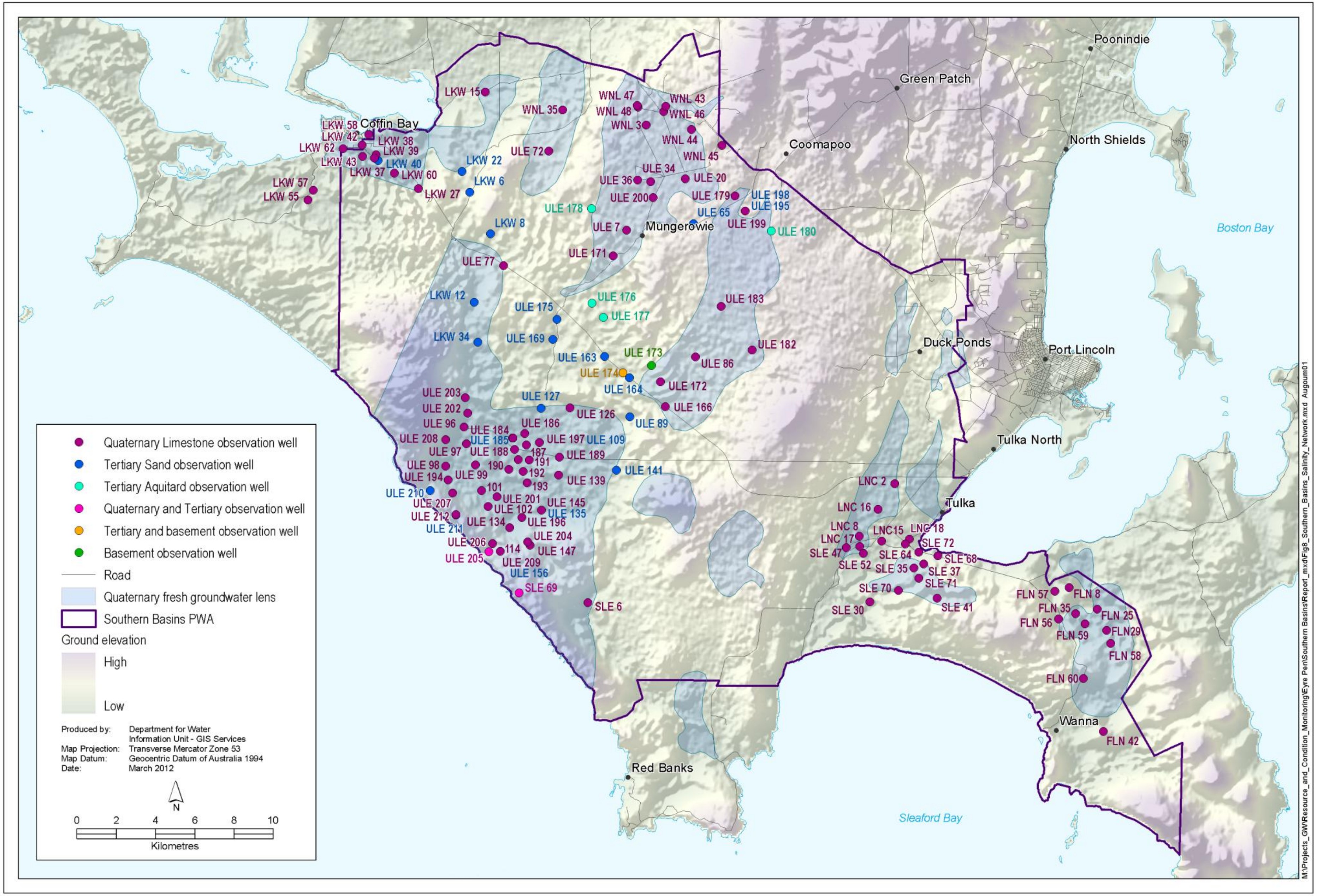

Figure 8. Location of groundwater salinity observation wells in the Southern Basins PWA as at 5 April 2012

GROUNDWATER TRENDS

In the Southern Basins PWA, there are several groundwater basins within the Quaternary Limestone aquifer. Within these basins, there are several lenses with salinities of less than 1000 mg/L (Fig. 1). The extent of these lenses may otherwise cover most of the recognised basin area (e.g. Uley South and Uley Wanilla) or in some cases, only part of a basin that may contain groundwater of generally higher salinity (e.g. Lincoln Basin). The extent of the lenses may also change over time depending on long-term trends in rainfall and therefore recharge. The lenses have been used for extraction to varying degrees and trends from groundwater monitoring data for the lenses labelled in Figure 9 will be discussed in turn. No monitoring data are available for the other lenses.

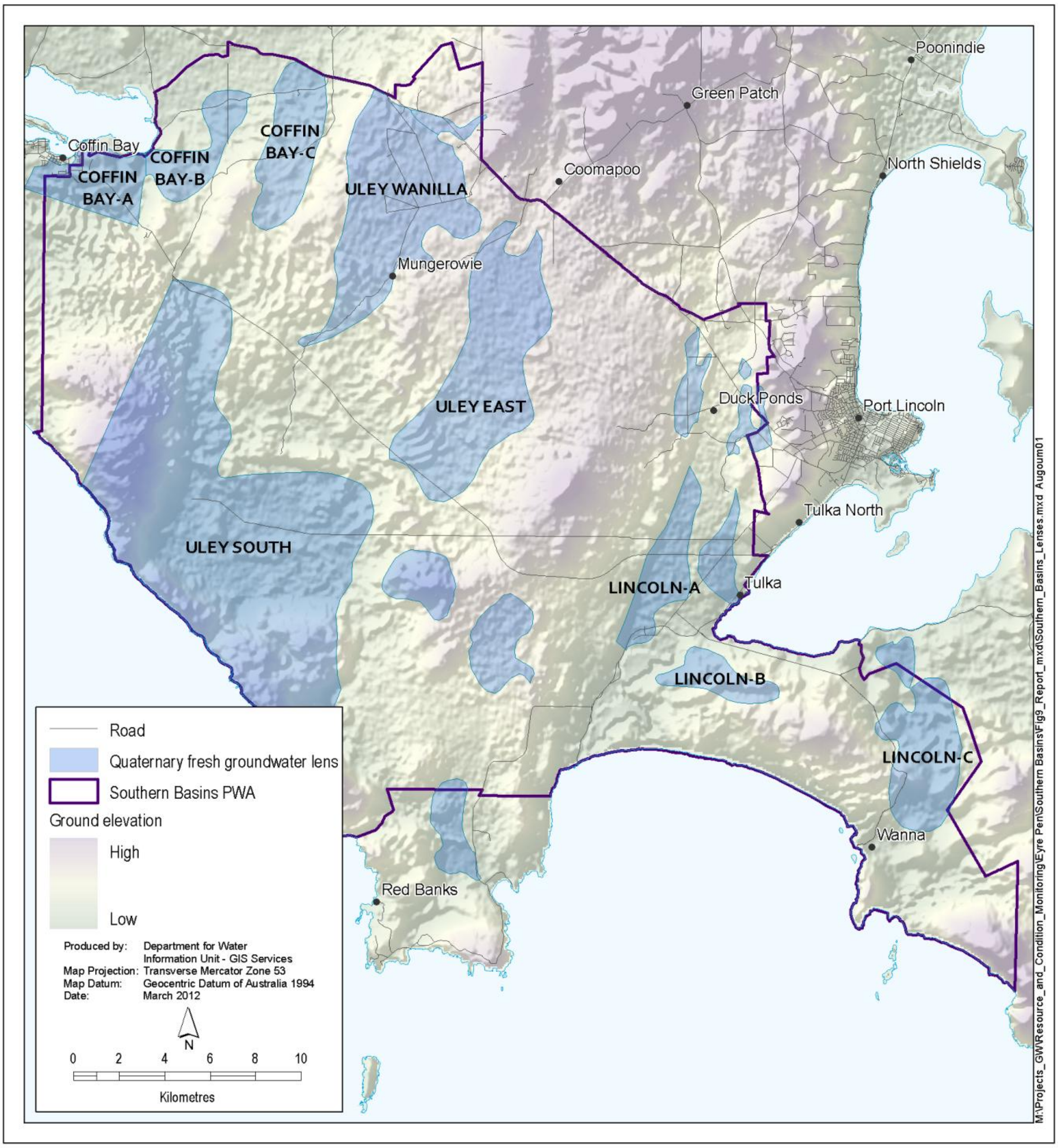

Figure 9. **Location of Quaternary fresh groundwater lenses in the Southern Basins PWA in which groundwater monitoring occurs**

ULEY SOUTH LENS

The Uley South lens is a robust groundwater resource that has provided the majority of the reticulated water supply for Eyre Peninsula, excluding Whyalla, since 1976. The total volume extracted in 2010–11 was 4940 ML, which represents a decrease of 15% from the previous water-use year (Fig. 10). Licences for the use of prescribed groundwater were first issued in 2001–02. In order to match demand with the available allocations a number of strategies were adopted including the introduction of Level 2 water restrictions. SA Water and the Department's predecessors agreed to a strategy of temporarily allocating additional water from the Uley South lens. From the 2002–03 financial year onwards, this additional water was approved on the condition that any additional allocation was 'paid back' in subsequent years. All approved additional extraction from the Uley South lens was 'paid back' in the 2007–08 year and extractions have been consistently lower than the allocation limit since then. A *Notice of Authorisation to Take Water for Public Supply,* according to section 128 (1) of the *Natural Resources Management Act 2004,* authorised SA Water to take an additional 361.2 ML in both 2004–05 and 2005–06 and 500 ML in the 2006–07 water-use year.

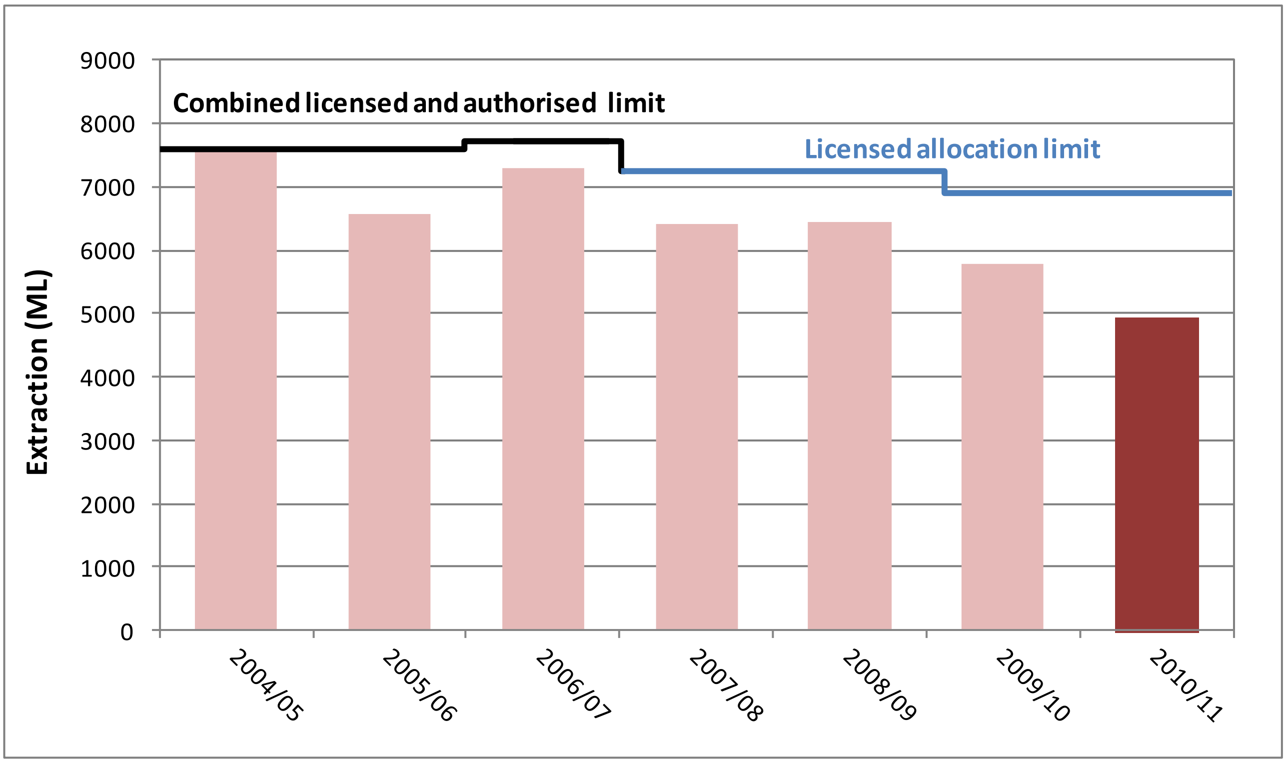

Figure 10. Historic licensed groundwater use and licensed allocation limit, including approved additional authorisations for the Uley South lens in the Southern Basins PWA

WATER LEVEL TRENDS

Trends in groundwater levels are observed using wells with a representative distribution throughout the lens to avoid the direct effect of pumping from SA Water production wellfields. Within the Uley South lens there is a close relationship between the groundwater levels and the cumulative deviation from the average annual rainfall from the Westmere rainfall station (Fig. 11). Monitoring records reveal a long-term decline of nearly two metres in groundwater levels since 1992, which coincides with the trend of below-average rainfall recorded at the Westmere rainfall station. Above-average rainfall since 2009 has led to a rise in groundwater levels throughout the lens, although current groundwater levels remain lower than those recorded before 1992.

From December 2010 to December 2011, rises in groundwater levels were observed in the majority of wells throughout the lens (Fig. 12).

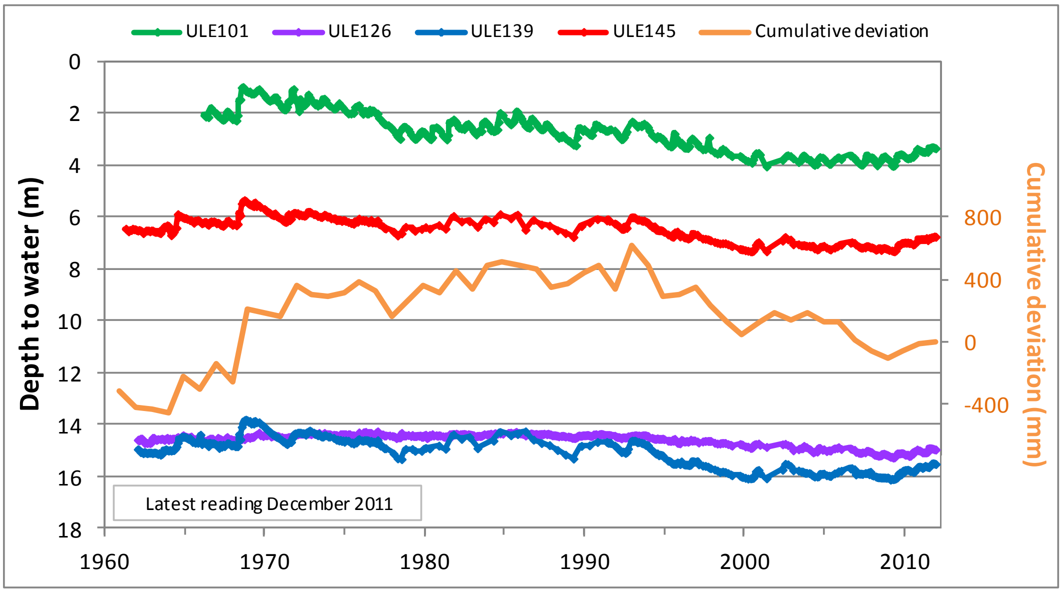

Figure 11. Groundwater level trends for the Uley South lens in the Southern Basins PWA (cumulative deviation for the Westmere rainfall station is plotted on the right-hand axis)

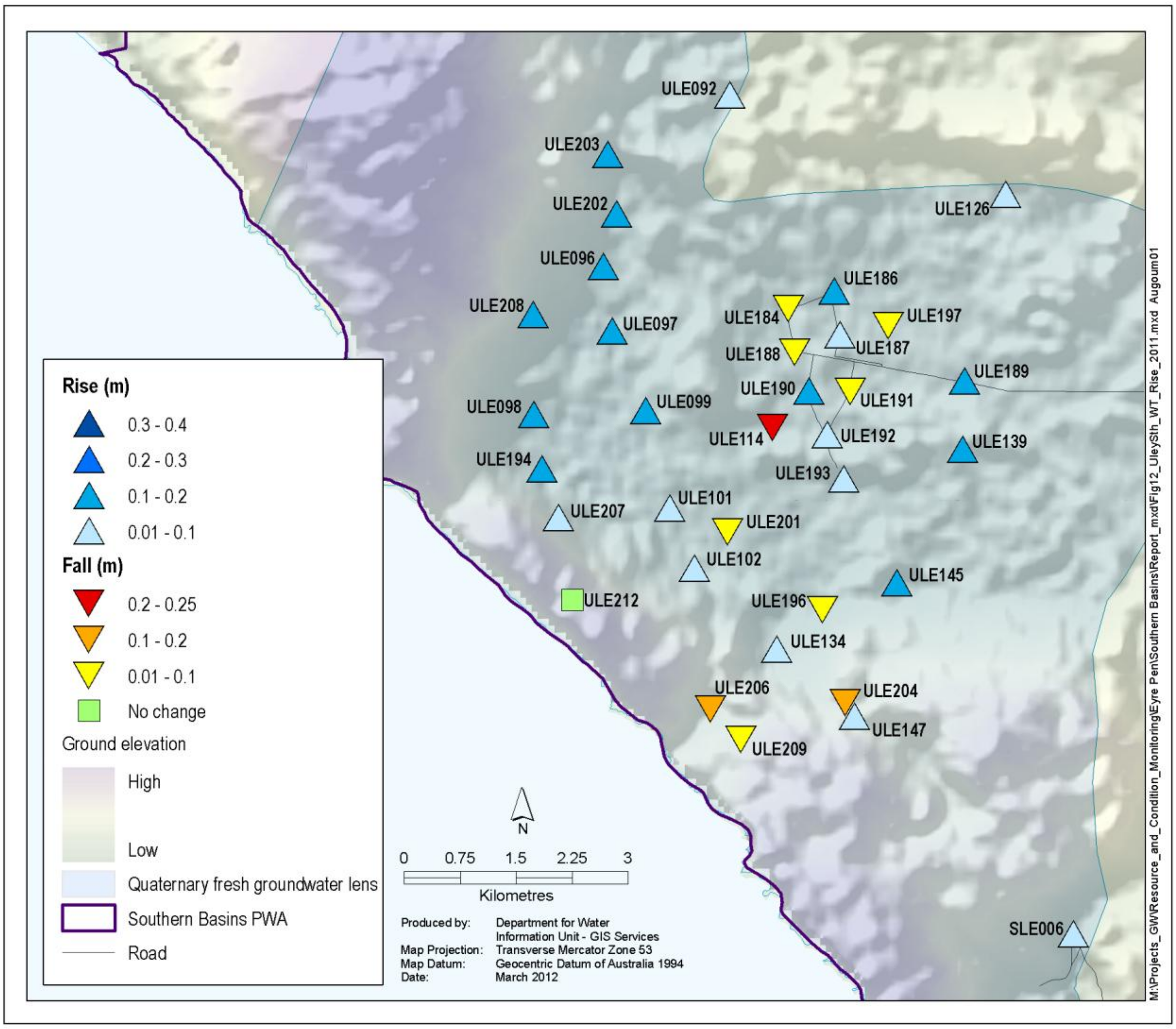

Figure 12. Overall 12-month change in watertable elevation for Uley South lens (December 2010 to December 2011)

SALINITY TRENDS

Long-term salinity trends are presented for both observation wells (Fig. 16) and SA Water production wells (Fig. 13).

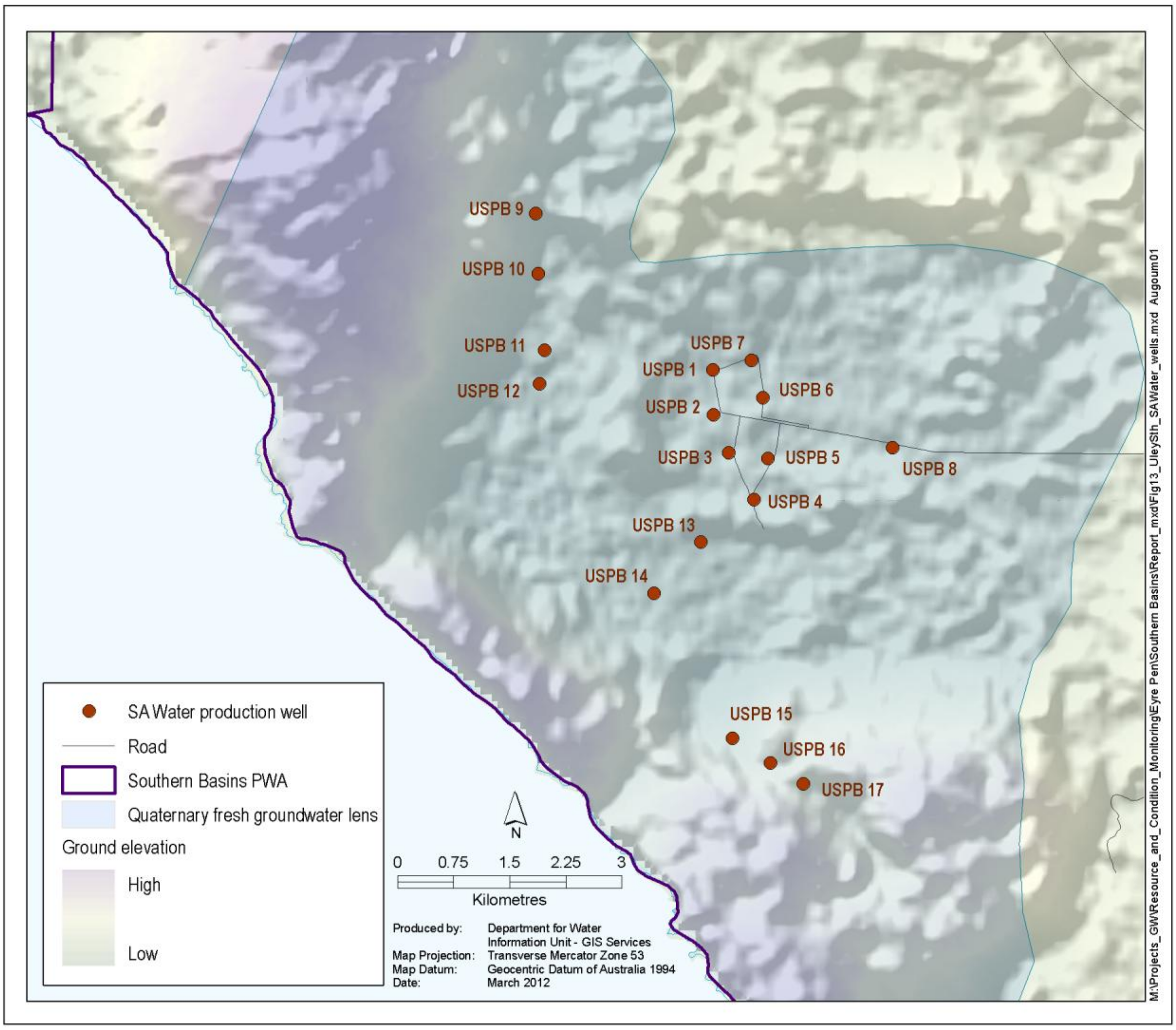

Figure 13. Location of SA Water production wells in Uley South lens

In the central wellfield within the Uley South lens, the SA Water production wells display a variety of long-term trends over the sample record since 1985, ranging from a decrease of 0.6 mg/L/y in supply well USPB 1, to an increase of 2.2 mg/L/y in supply well USPB 2 (Fig. 14). Since 2009, the amplitude of salinity fluctuations has decreased, as has the salinity, reflecting the increased recharge and freshening of the groundwater due to higher rainfall.

Supply well USPB 3 displays an interesting step increase in salinity in 1996 followed by a stable trend, indicating a probable layering within the limestone aquifer. It suggests a shallow lower-salinity layer had been dewatered by the regional lowering of the watertable and subsequently a deeper, slightly more saline layer was contributing most of the supply. However, the salinity in well USPB 3 has been decreasing steadily since July 2010 and may indicate the recovery of the shallow low-salinity layer as a result of increased recharge due to above-average rainfall since 2009.

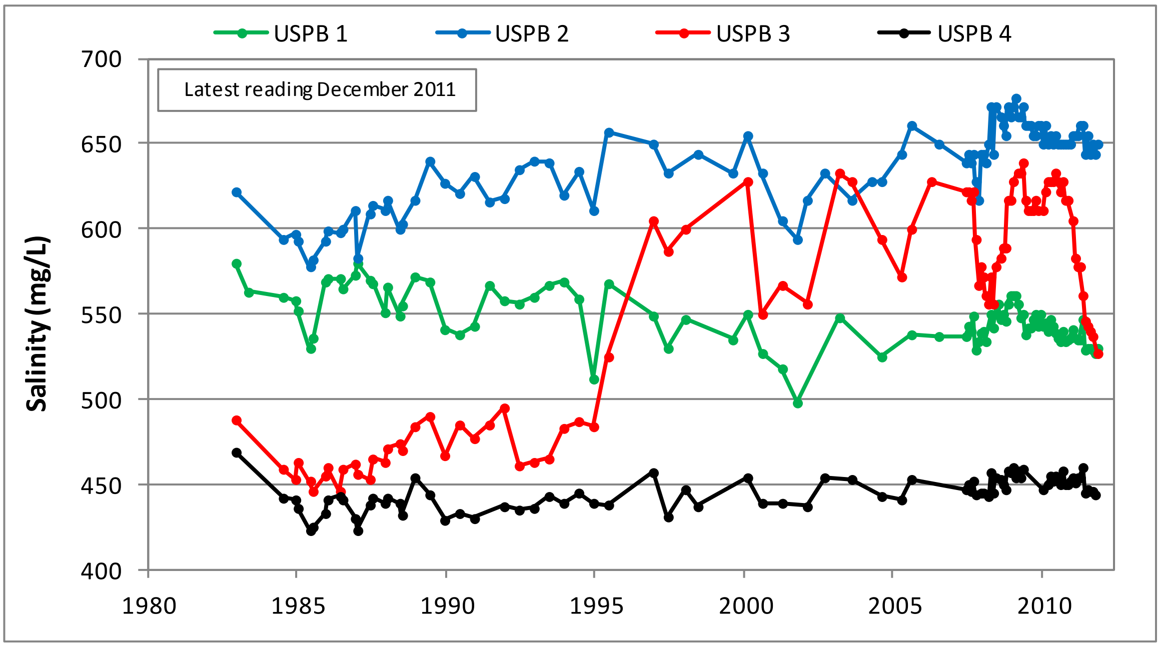

Figure 14. Groundwater salinity trends for the central SA Water wellfield in Uley South Basin

In the southern and north-western SA Water wellfields, data have been collected regularly for a much shorter time period. From 2007 to early 2009, the wells display an overall trend of increasing salinity (Fig. 15). Salinity was quite stable from early 2009 to early 2011 in response to above-average rainfall, with decreases of between 11 and 14 mg/L since April 2011.

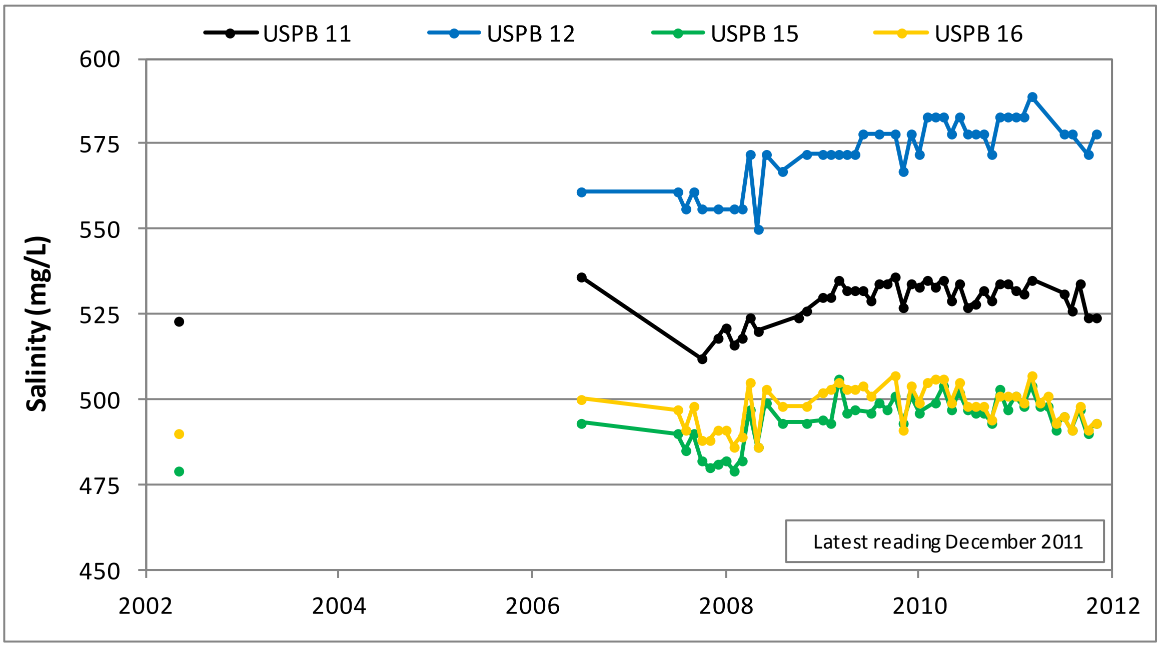

Figure 15. Groundwater salinity trends for the southern and north-western SA Water wellfields in Uley South Basin

Observation wells located some distance away from the wellfields display varying trends (Fig. 16). Salinity in observation well ULE099 has increased by 6 mg/L/y since 1992, in observation well ULE126 the overall increase is 1 mg/L/y. This may be due to the generally below-average rainfall received over this time period. These two wells recorded a drop in salinity in 2010 that may have been caused by the above-average rainfall in 2009 and 2010. The remaining three observation wells have not had a salinity measurement taken since 2009. Observation well ULE101 recorded a decreasing trend of approximately 4 mg/L/y since 1992 and ULE197 recorded a decreasing trend of 1.3 mg/L/y since 1991. Observation well ULE194 reveals a step increase similar to that exhibited by production well USPB 3 in Figure 14, which suggests a shallow lower-salinity layer had been dewatered by the regional lowering of the watertable and subsequently a deeper, slightly more saline layer was contributing most of the supply.

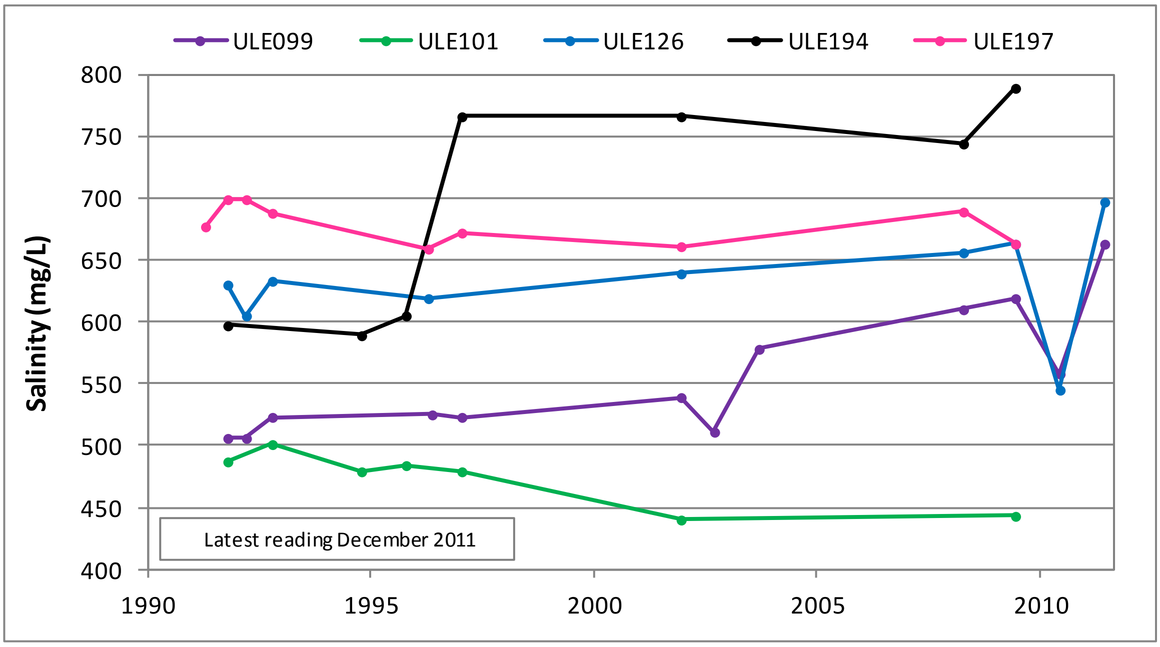

Figure 16. Groundwater salinity trends for observation wells in the Uley South Basin located at a distance from SA Water production wellfields

ULEY WANILLA LENS

In 1949, the Uley Wanilla lens was the first groundwater lens to be developed to augment the Tod River Reservoir. Extractions from Uley Wanilla have decreased steadily since 1993 in response to falling groundwater levels. The total volume extracted in 2010–11 was 121 ML which represents a decrease of 9% from the previous year (Fig. 17). The apparent overuse in 2004–05 was offset against reduced extractions in other lenses for the same period and was consistent with the relevant water licence.

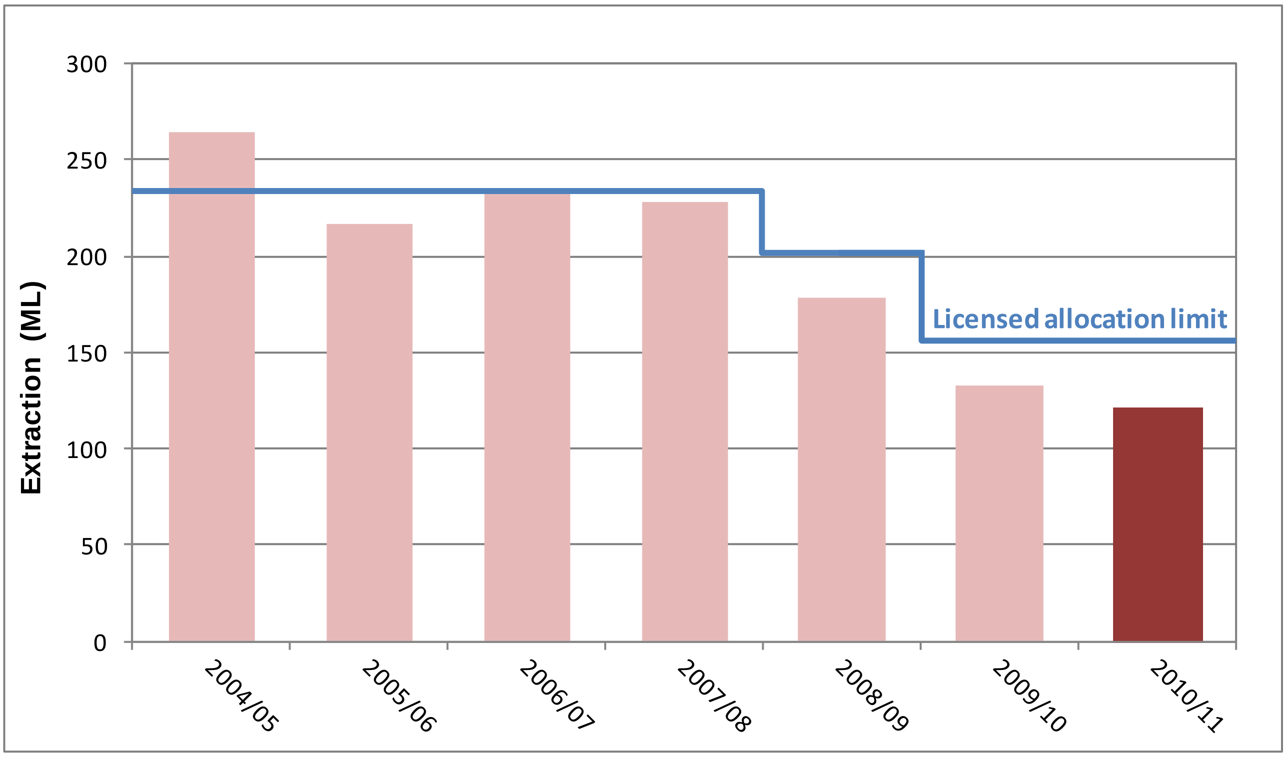

Figure 17. Historic licensed groundwater use and licensed allocation limit for the Uley Wanilla lens in the Southern Basins PWA

WATER LEVEL TRENDS

Observation wells from various parts of the Uley Wanilla lens reveal a close relationship to rainfall when plotted against the cumulative deviation from the average annual rainfall at the Big Swamp rainfall station (Fig. 18). Since records began, the overall long-term trend in water levels has declined at an average rate of about 0.1 m/y in the northern and central areas of the lens and 0.2 m/y in the south of the lens. Since 1985 there has been an overall decline in groundwater levels of up to five metres. This decline in groundwater levels precedes the long-term trend of below-average rainfall by about seven years and may be caused by a combination of high historical extractions between 1987 and 1994, the interception of recharge and direct use of groundwater by vegetation and the steep watertable gradients that promote lateral groundwater flow to the south.

Most wells display a rise in groundwater levels in response to the above-average rainfall received since 2009, but are still well below pre-1985 levels. Across the lens, groundwater levels in December 2011 are up to 0.2 m higher than those recorded in December 2010, with the exception of WNL045 which is located to the east of the currently defined lens (Fig. 19).

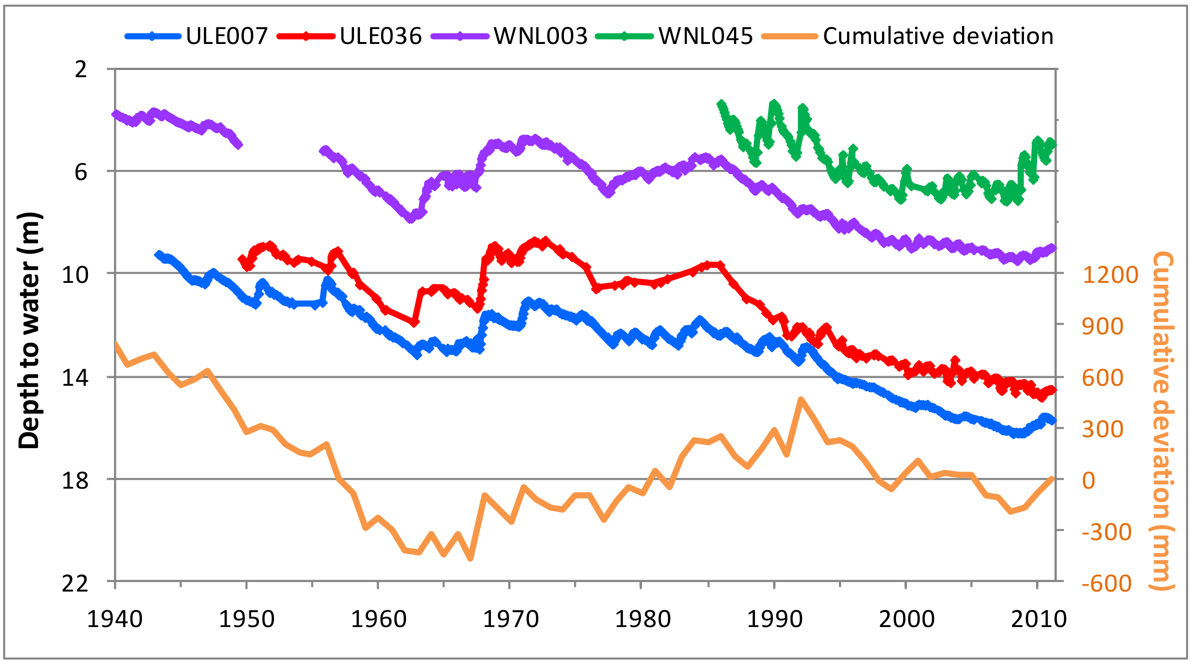

Figure 18. Groundwater level trends for Uley Wanilla lens in the Southern Basins PWA (cumulative deviation for the Big Swamp rainfall station is plotted on the right-hand axis)

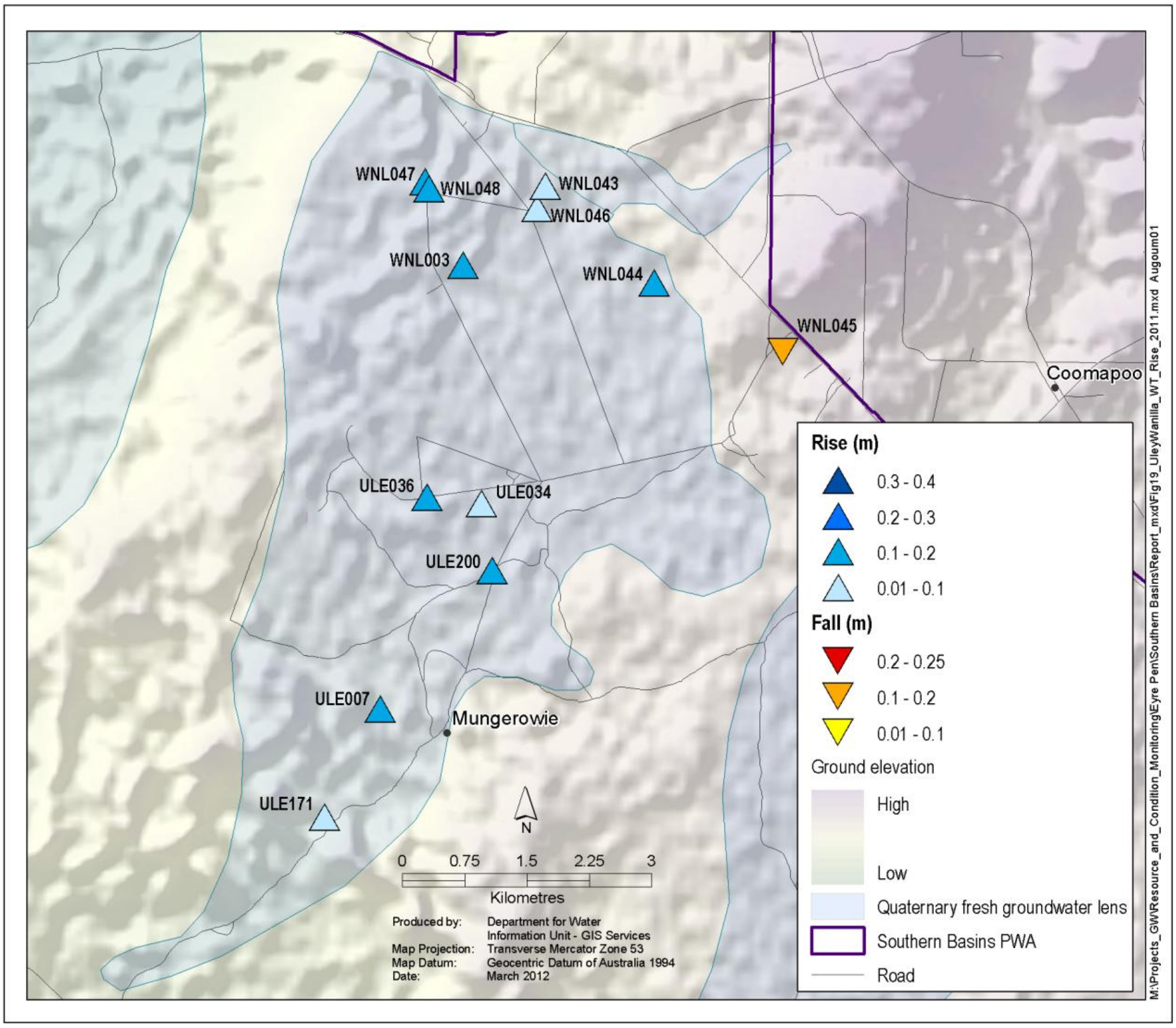

Figure 19. Overall 12-month change in watertable elevation for Uley Wanilla lens (December 2010 to December 2011)

SALINITY TRENDS

Results from SA Water production wells located in the Uley Wanilla lens (Fig. 20) show a gradual long-term rise in salinity since 1985 (Fig. 21). In production well UWPB 5 this has averaged 3 mg/L/y, whilst in well UWPB 6 it is 6 mg/L/y. Some of the supply wells (e.g. UWPB 6) show a marked seasonal variation in salinity which may indicate freshening by recharge from winter rainfall.

Observation well ULE171 is located in the south of the lens and indicates relatively stable salinity levels with an overall long-term increase of 0.2 mg/L/y. In the centre of the lens, the salinity of well ULE200 has increased at an overall long-term rate of 2.2 mg/L/y. Although well WNL043, located in the north of the lens, has seen a marked increase in salinity with an overall long-term rise of nearly 11 mg/L/y, the latest salinity measurement taken in 2009 is lower than the previous measurement taken in 1997.

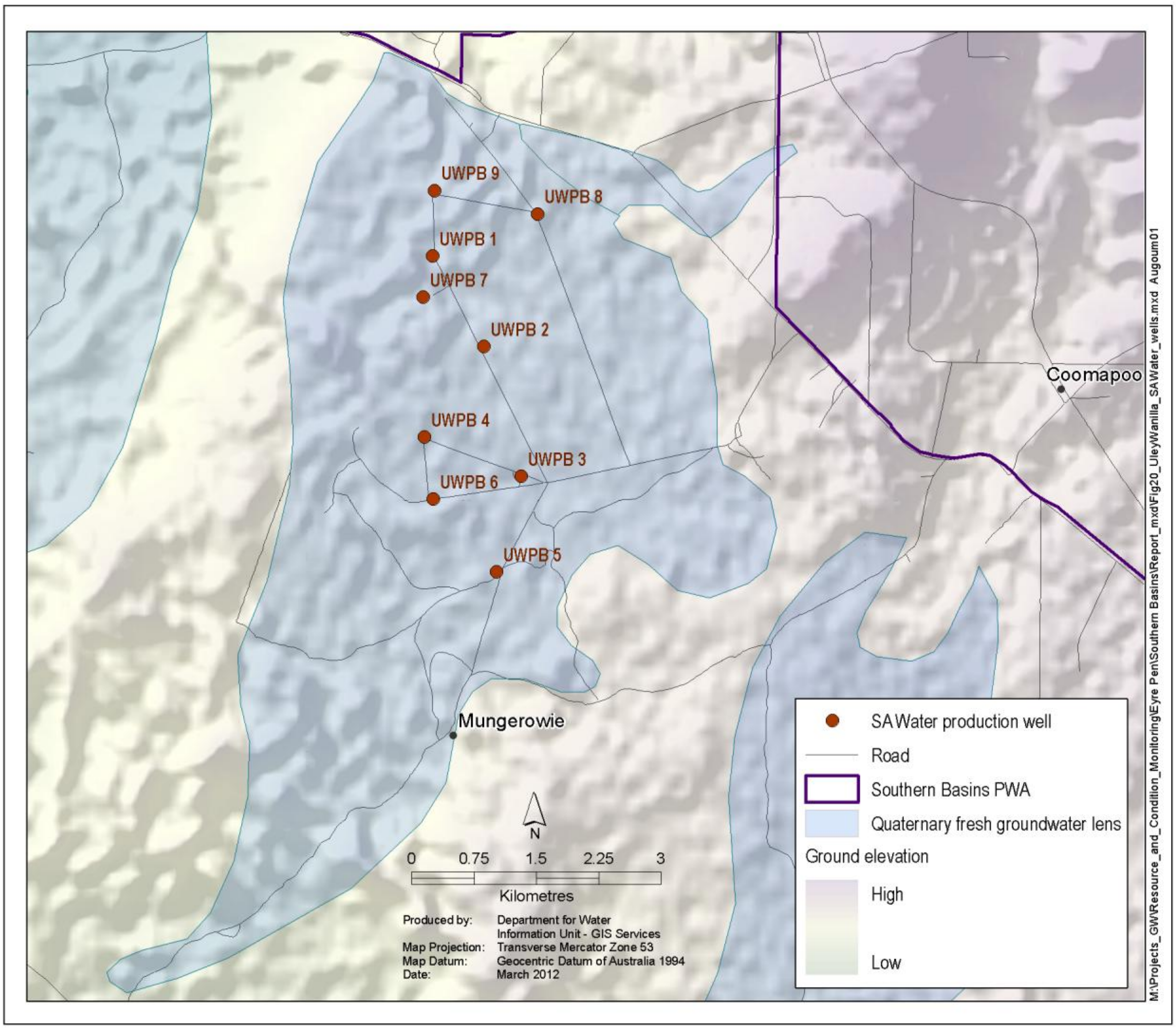

Figure 20. Location of SA Water production wells in Uley Wanilla lens

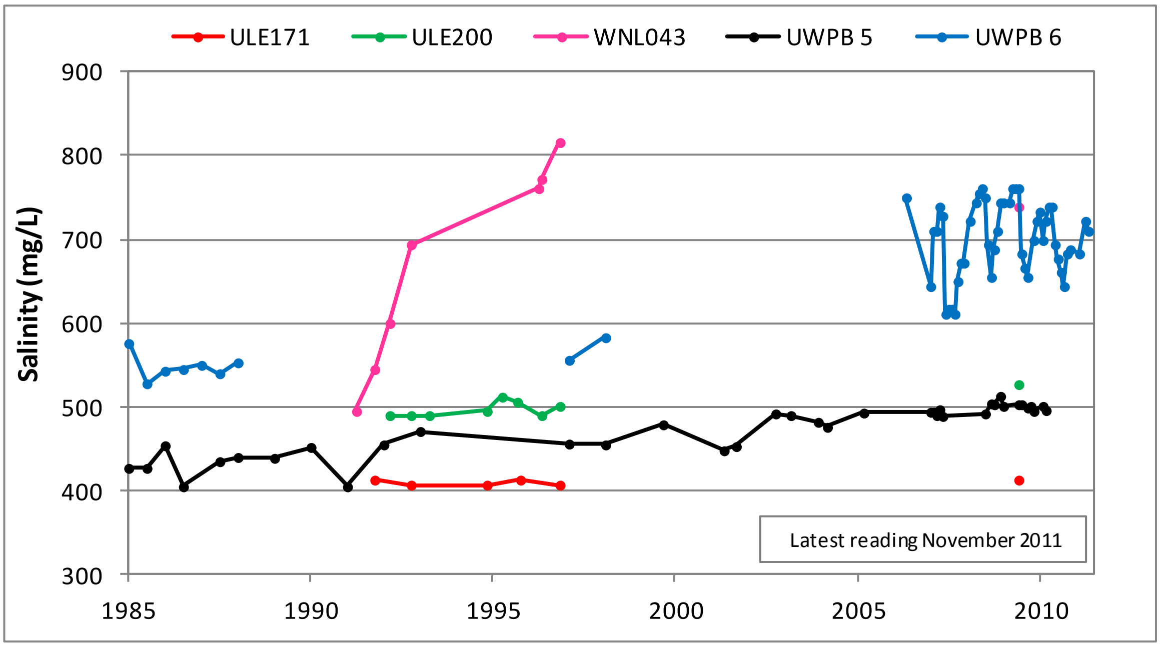

Figure 21. Groundwater salinity trends for Uley Wanilla lens in the Southern Basins PWA

ULEY EAST LENS

No licensed groundwater extractions are taken from the Uley East lens, which varies in areal extent depending on the elevation of the watertable.

WATER LEVEL TRENDS

The majority of observation wells in the Uley East lens reveal a close relationship to rainfall when plotted against the cumulative deviation from the average annual rainfall at the Big Swamp rainfall station (Fig. 22). This relationship can be seen clearly in observation well ULE179, but is difficult to see at the presented scale in observation well ULE086. Observation well ULE183, which is located in the centre of the lens, appears independent of rainfall and has recorded a steady decline in the groundwater level of 0.14 m/y since measurements began in 1986. This equates to a total drop of three metres and may indicate vertical leakage to the underlying Tertiary aquifer in the area. In 2011, the aquifer has a saturated thickness of around 10 m at this location.

Above-average rainfall since 2009 has resulted in the sharp rise of the groundwater level in well ULE179. A total rise of 2.6 m has recovered the groundwater level in this well to historical levels. While well ULE086 has experienced seasonal rises in the groundwater level since 1992, there was a steady decline of 0.2 m from December 2010 to December 2011.

Across the lens, the overall yearly change in the watertable elevation was varied with rises of up to 0.3 m and falls of up to 0.2 m (Fig. 23). Variations in water levels such as this are typical when rainfall is close to average. Significant water level rises across the lens are more likely to occur when rainfall is well above average or after intense rainfall events. The rise in water level of 0.3 m in the north of the lens is likely due to infiltration of surface water overflow from the Big Swamp wetland.

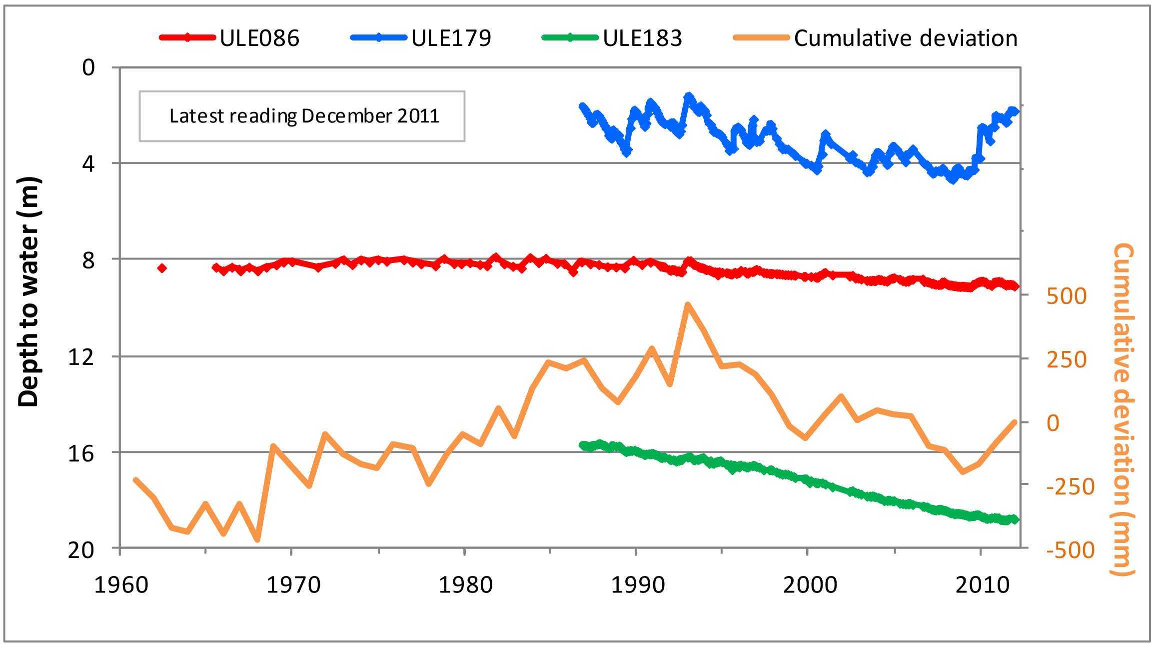

Figure 22. Groundwater level trends for Uley East lens in the Southern Basins PWA (cumulative deviation for the Big Swamp rainfall station is plotted on the right-hand axis)

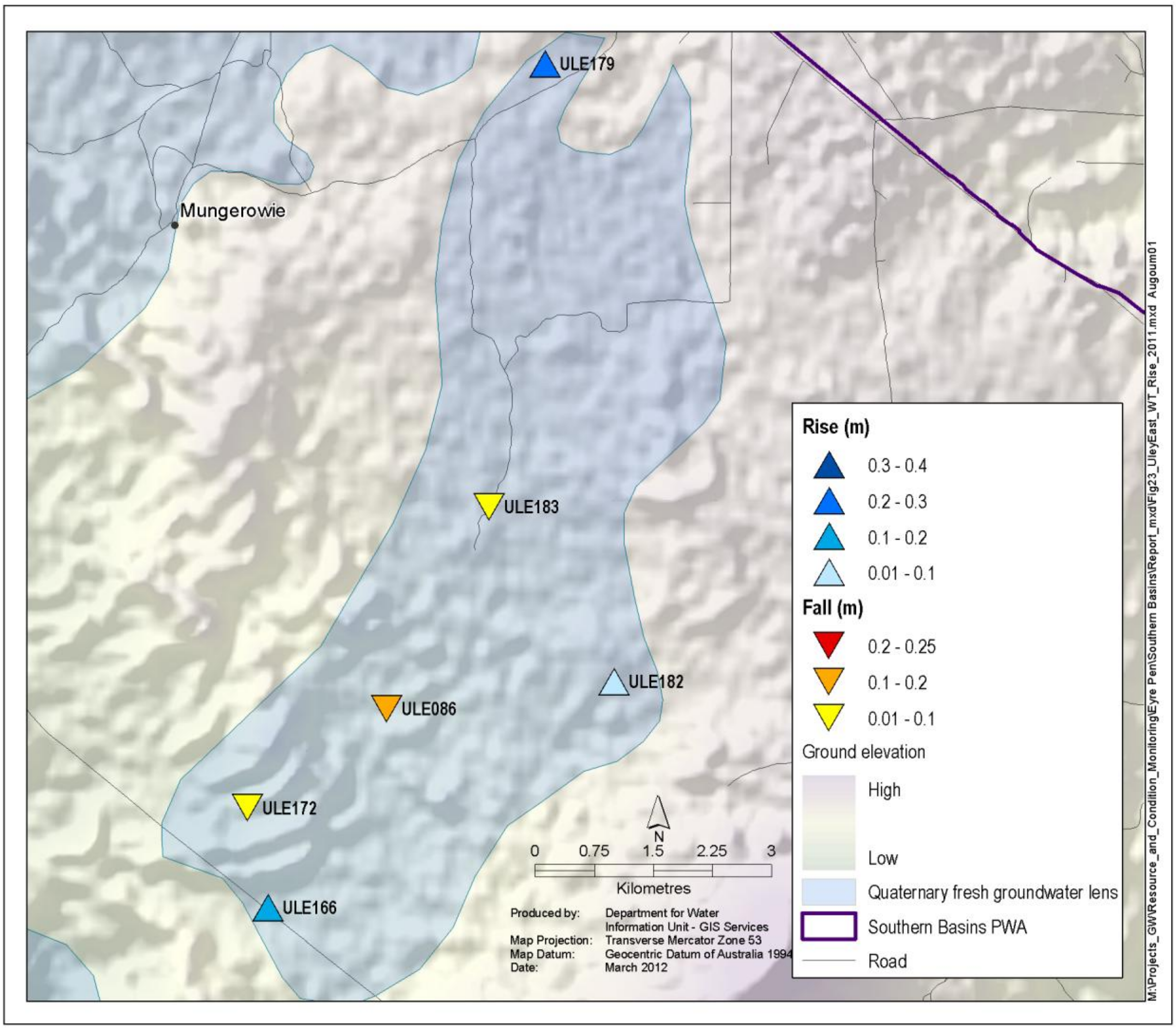

Figure 23. Overall 12-month change in watertable elevation for Uley East lens (December 2010 to December 2011)

SALINITY TRENDS

Within Uley East lens, observation data displays only minor variations (5–11%) in salinity over the years (Fig. 24). Observation well ULE183 in the centre of the lens has recorded an overall decline of 5 mg/L/y, while further south, salinity in well ULE086 has declined by 0.4 mg/L/y. At the south-western margin of the lens, salinity has risen by 3 mg/L/y in well ULE166, which is expected given the direction of groundwater flow through the lens towards this margin. The next salinity readings are scheduled to be taken in 2012.

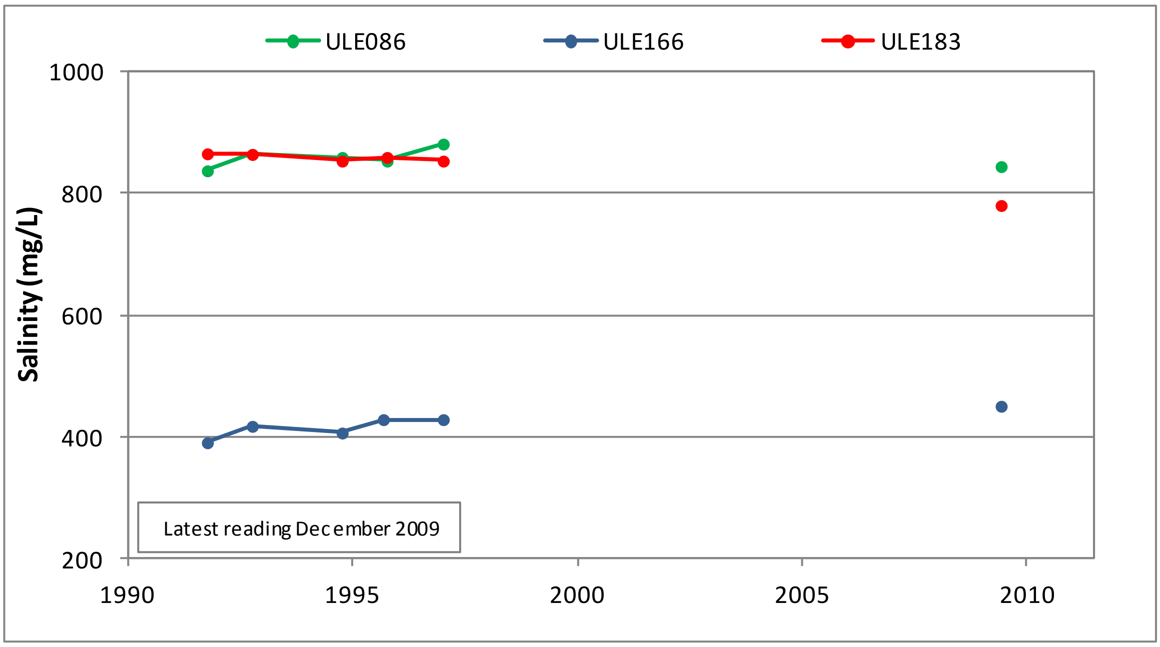

Figure 24. Groundwater salinity trends for Uley East Basin in the Southern Basins PWA

LINCOLN BASIN

SA Water groundwater extractions from three of the five lenses that comprise the Lincoln Basin commenced in 1961. Extraction volumes decreased significantly when the Uley South lens was developed due to its greater capacity and lower salinity. Concerns about increasing salinity due to the up-coning of underlying saline groundwater have resulted in further decreases since 2007–08 (Fig. 25). The total volume extracted by SA Water in 2010–11 was 441 ML, which represents a decrease of 24% from the previous year. Extraction by other licence holders totalled 1 ML, primarily for irrigation.

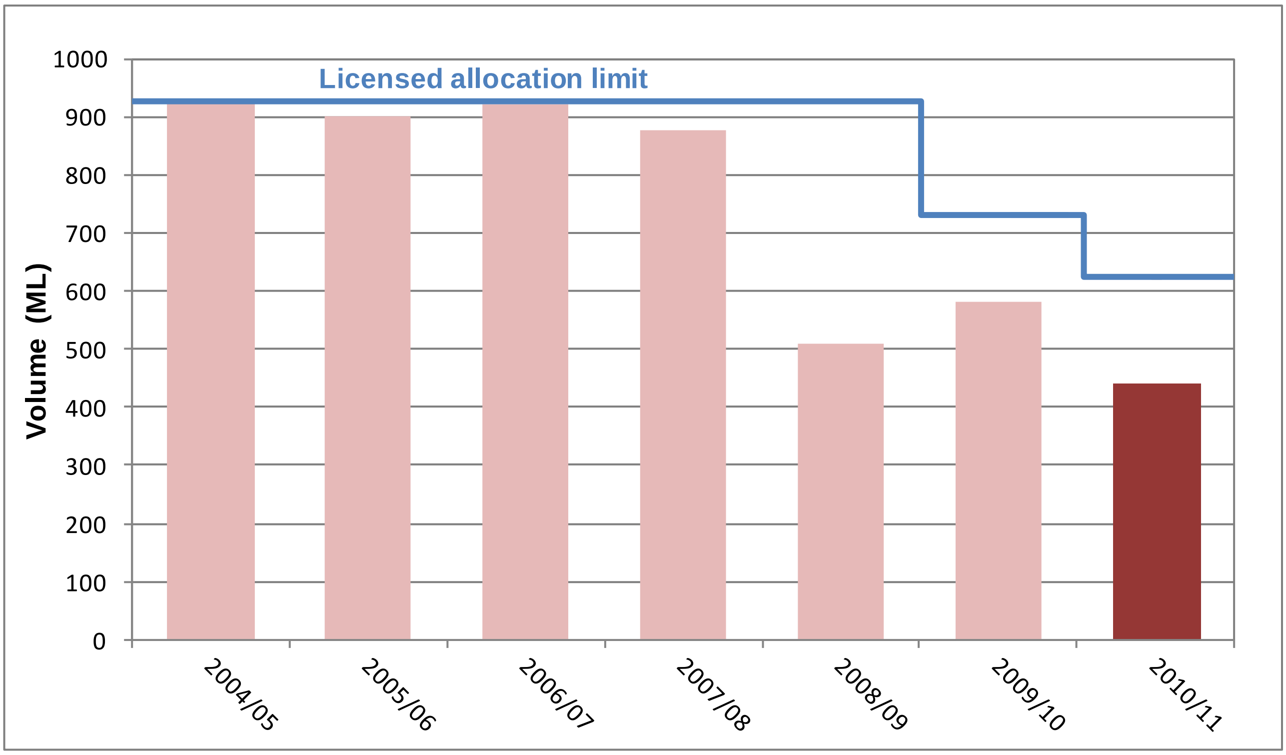

Figure 25. Historic licensed groundwater use and licensed allocation limit for lenses A, B and C of the Lincoln Basin in the Southern Basins PWA

WATER LEVEL TRENDS

Observation wells from three of the lenses that comprise the Lincoln Basin display seasonal fluctuations (Fig. 26). All three lenses reveal similar long-term trends related to rainfall patterns as seen in the other lenses, but variations in water levels are more subdued due to their close proximity to the ocean, which buffers water level responses to changes in recharge. Since 1990, the long-term decline due to below-average rainfall averaged 0.03 m/y.

Above-average rainfall since 2009 has led to an overall rise in groundwater levels but they remain lower than pre-1990 levels. December 2011 levels are slightly higher than those from December 2010, with most observation wells in the Lincoln Basin lenses showing minor rises in water level averaging nearly 0.1 m (Fig. 27).

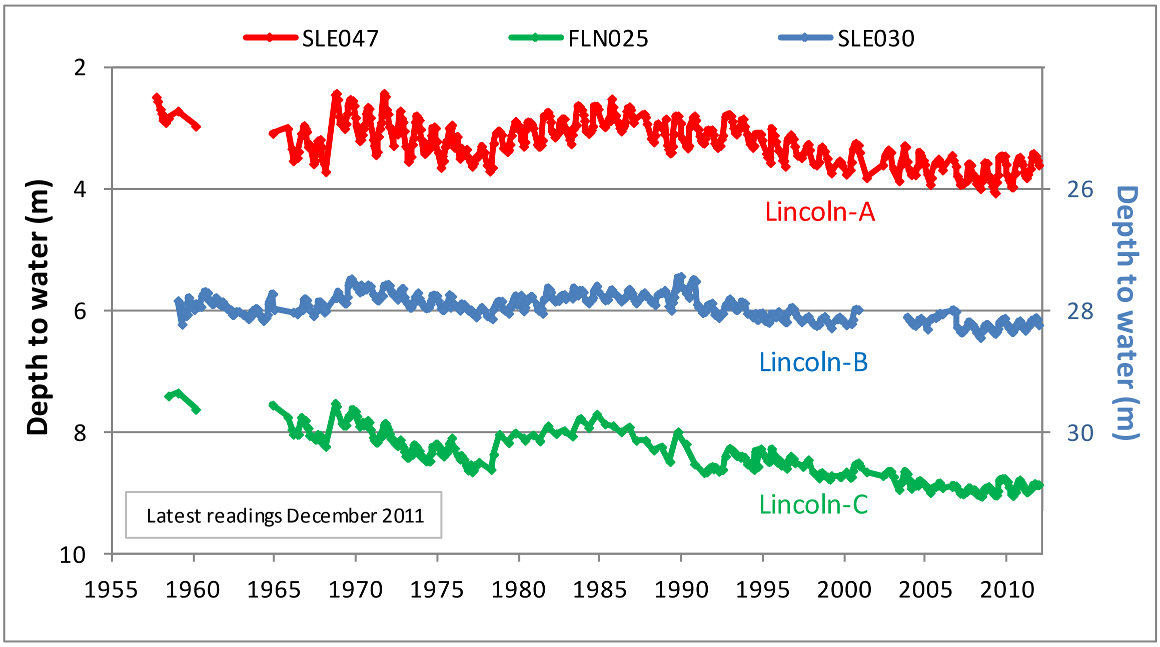

Figure 26. Groundwater level trends for lenses A, B and C of the Lincoln Basin in the Southern Basins PWA (depth to water in well SLE030 in Lincoln-B lens is plotted on the right-hand axis)

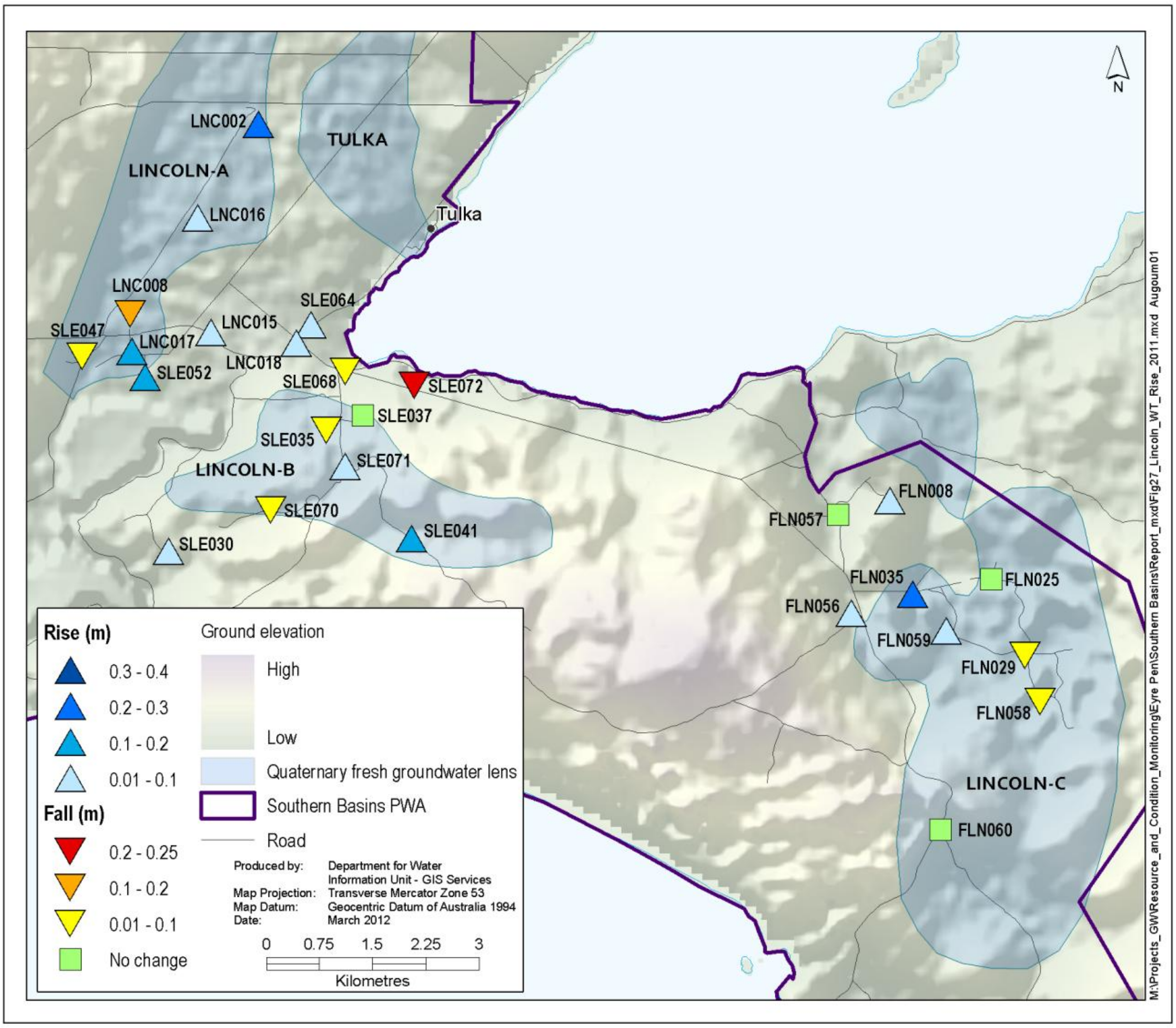

Figure 27. Overall 12-month change in watertable elevation for lenses A, B and C of the Lincoln Basin (December 2010 to December 2011)

SALINITY TRENDS

In the Lincoln-A lens, observation wells and SA Water production wells (Fig. 31) display a rise in salinity of between 3 and 35 mg/L/y since 1990 (Fig. 28). Wells SLE052, LBPB A and LBPB B recorded an overall decrease in salinity during 2011 but it is still higher than historical measurements. Observation well LNC008 recorded an increase in salinity in 2011.

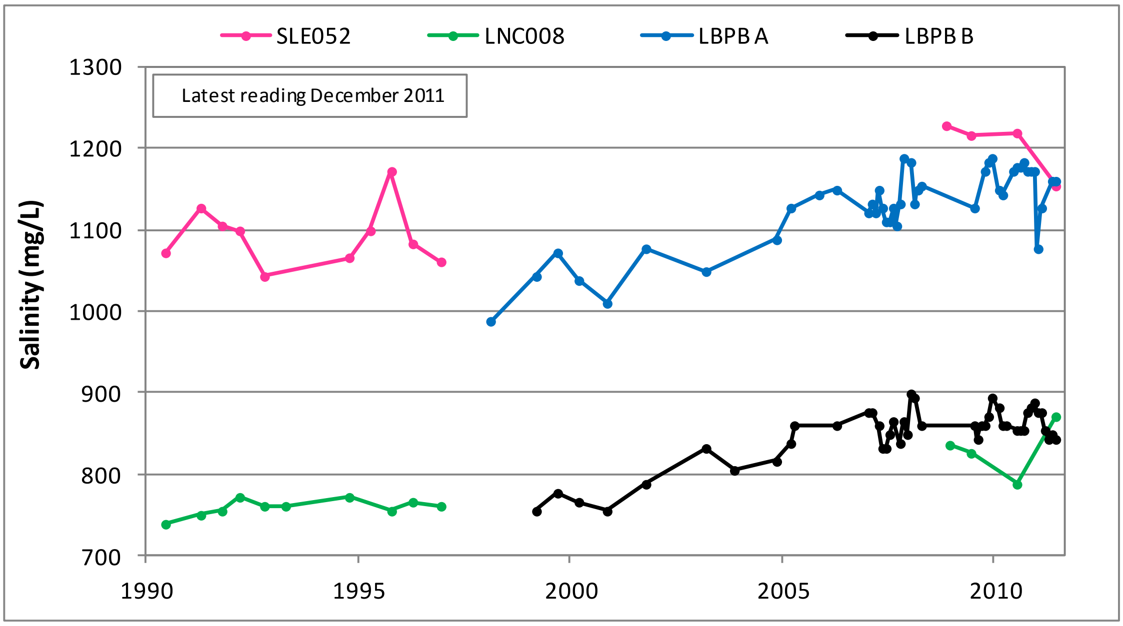

Figure 28. Groundwater salinity trends for the Lincoln-A lens in the Southern Basins PWA

Salinity data from both observation wells and SA Water production wells within the Lincoln-B lens reveal an overall long-term trend of increasing salinity (Fig. 29). The SA Water production well LBPB H reveals large fluctuations in salinity values which are related to extraction rates (fluctuations in salinity coincident with fluctuations in extraction rates). Observation well SLE068 is located about 200 m from the coast and has shown a significant rise in salinity over time. The peak recorded salinity of 12 000 mg/L in 2009 may be due to low groundwater levels causing sampling difficulties and the ingress of saline groundwater. A large drop in salinity was recorded in 2010. Measurements in 2011 reveal a gradual increase in salinity since then.

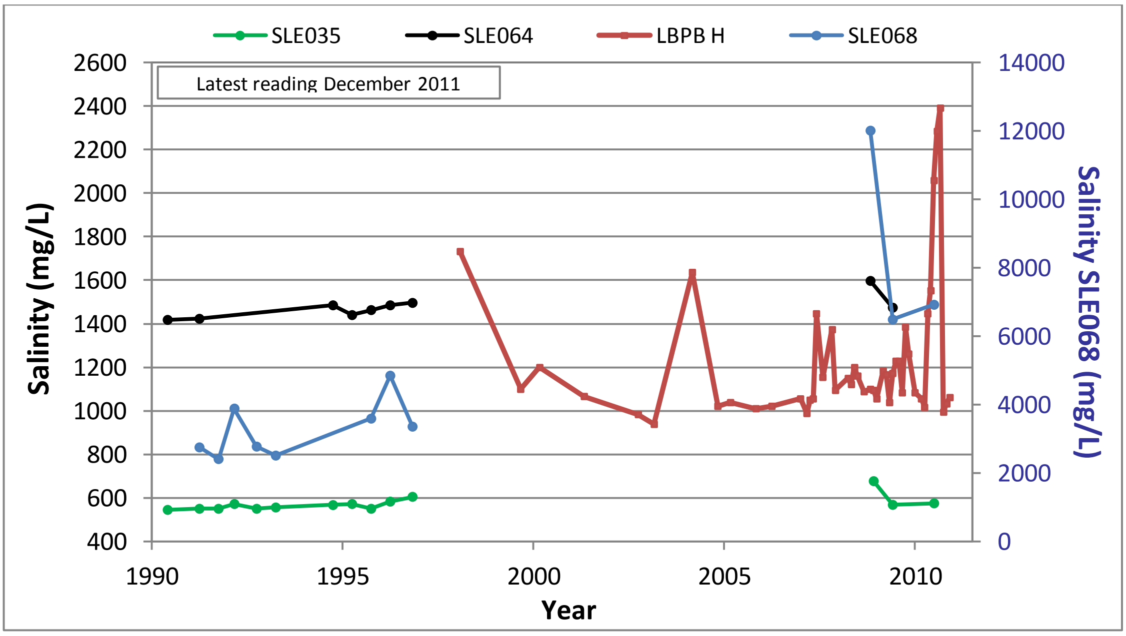

Figure 29. Groundwater salinity trends for the Lincoln-B lens in the Southern Basins PWA

Salinity data from both observation wells and SA Water production wells within the Lincoln-C lens reveal an overall long-term trend of increasing salinity, with the exception of observation well FLN025 (Fig. 30). Salinity levels in production wells LBPB M and LBPB Q have increased at an average rate of 16 mg/L/y and 8 mg/L/y, respectively. Salinities in observation wells FLN035 and FLN056 have increased at an average rate of 11 mg/L/y and 13 mg/L/y, respectively. The salinity in observation well FLN025 displays an overall decline in salinity of 1 mg/L/y. This well is located in an area of cleared vegetation where recharge rates are expected to be higher. The salinity recorded in 2011 in wells FLN035, FLN056 and LBPB Q is higher than that of 2010, while salinity recorded in well LBPB M is marginally lower than that measured in 2010.

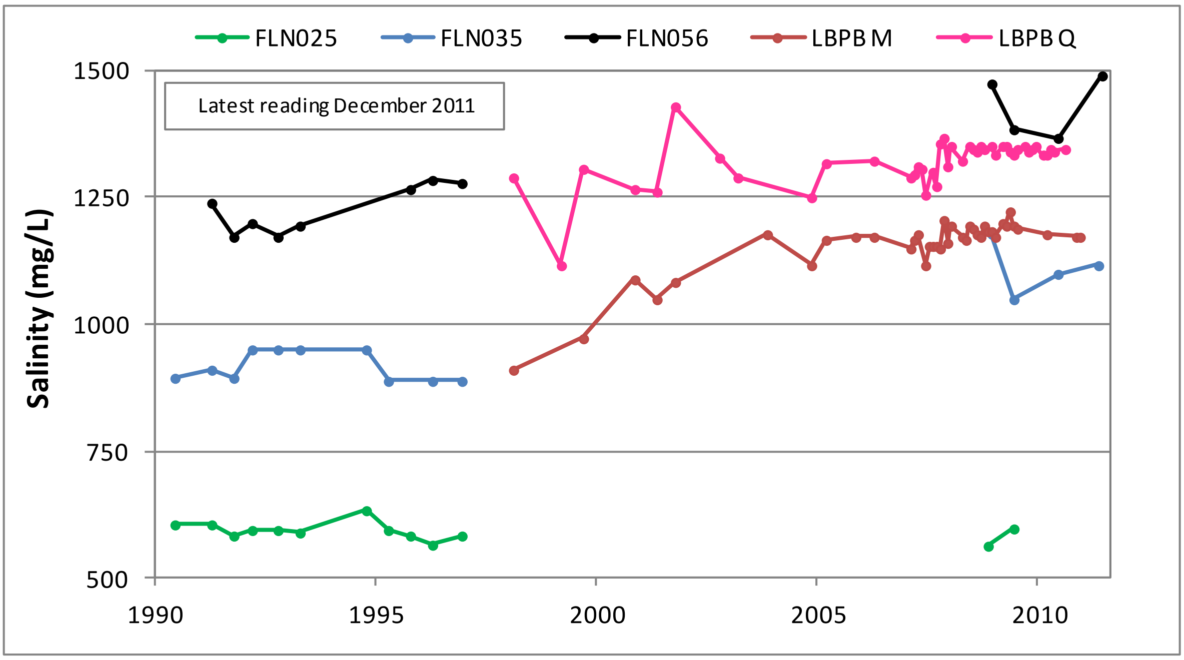

Figure 30. Groundwater salinity trends for the Lincoln-C lens in the Southern Basins PWA

The risk of rising salinity in the Lincoln Basin lenses due to the up-coning of underlying saline groundwater has been recognised for some years and the operation of the wellfields by SA Water has been modified to minimise these risks.

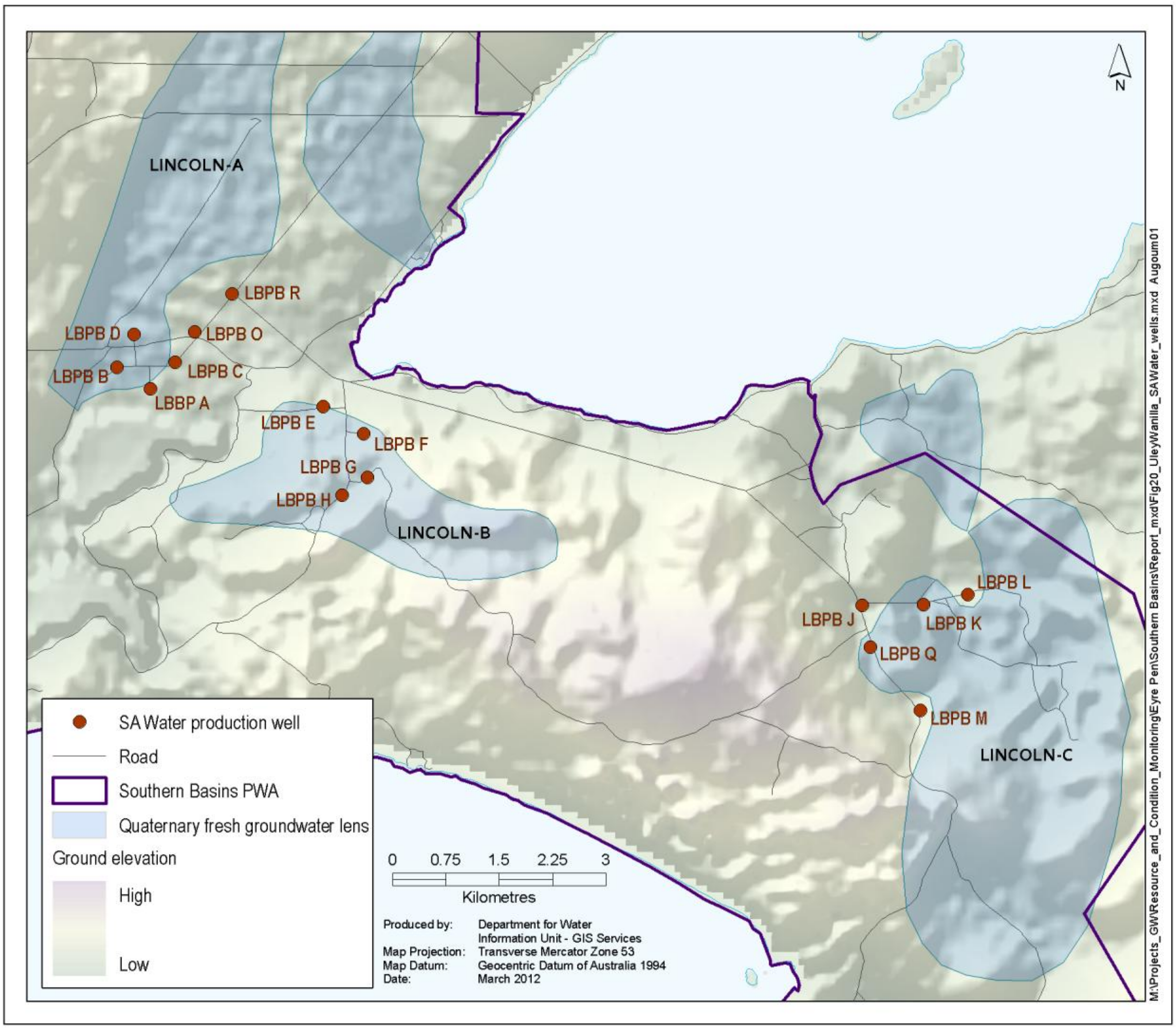

Figure 31. Location of SA Water production wells in the Lincoln Basin

COFFIN BAY BASIN

Groundwater extractions from the Coffin Bay-A lens commenced in 1986 for the reticulated supply of the Coffin Bay township. The rate of extraction was reasonably steady from 2001–02 to 2007–08 (Fig. 32). Since then, groundwater extraction has decreased steadily to the current rate of 103 ML for the 2010–11 water-use year. The majority of groundwater extracted is used for public water supply (83 ML), with 20 ML used to irrigate a golf course.

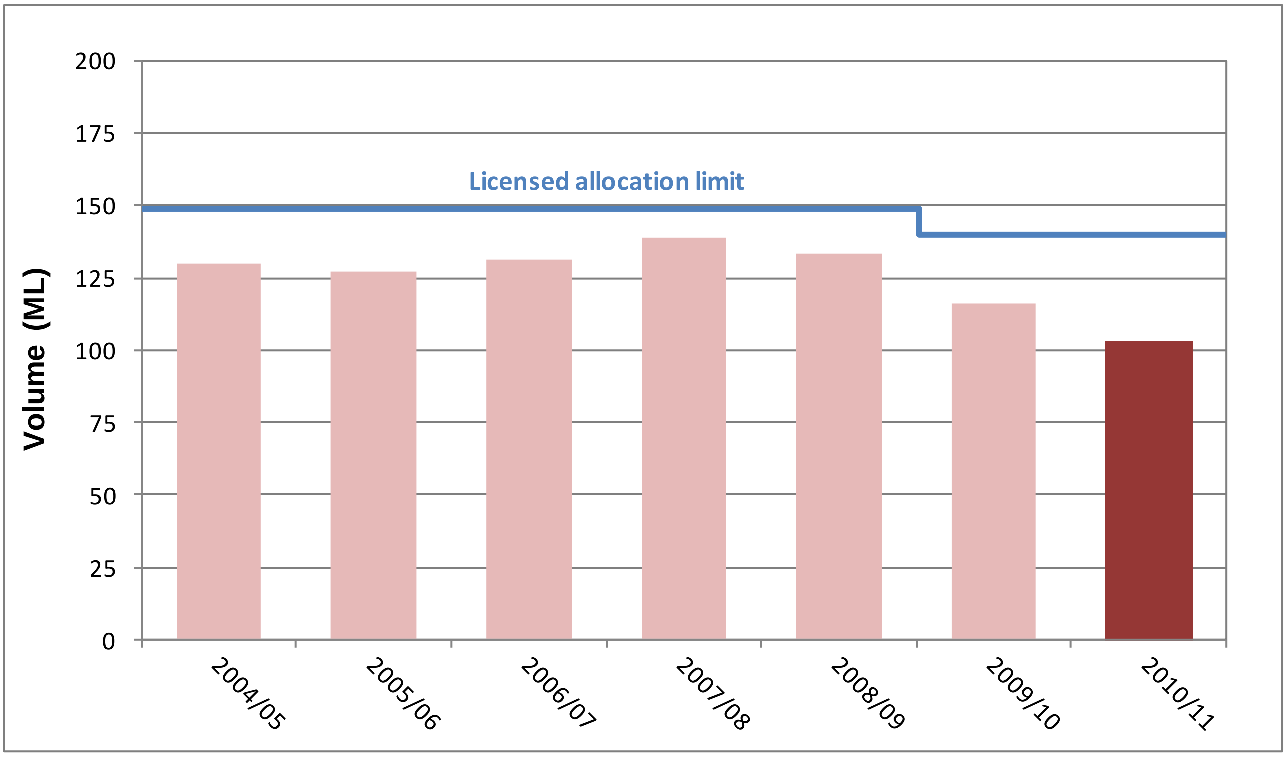

Figure 32. **Historic licensed groundwater use and licensed allocation limit for the Coffin Bay-A lens in the Southern Basins PWA**

WATER LEVEL TRENDS

Long-term water level trends in the Coffin Bay-A lens are very stable with a slight drop in levels recorded over the period of below-average rainfall from 1992 to 2008 (Fig. 33). Lenses that show stable trends with little correlation with the rainfall cumulative deviation are generally in close proximity to the ocean, which buffers water level responses to changes in recharge. Both Coffin Bay-B and Coffin Bay-C lenses have experienced long-term declines in groundwater levels generally up until late 2009 to early 2010.

Above-average rainfall since 2009 has halted these declining trends and resulted in a rise in groundwater levels across the three Coffin Bay lenses (Fig. 34) but most significantly in Coffin Bay C. The rises are smaller near the coast (below 0.1 m), but increase to up to 0.4 m some distance inland.

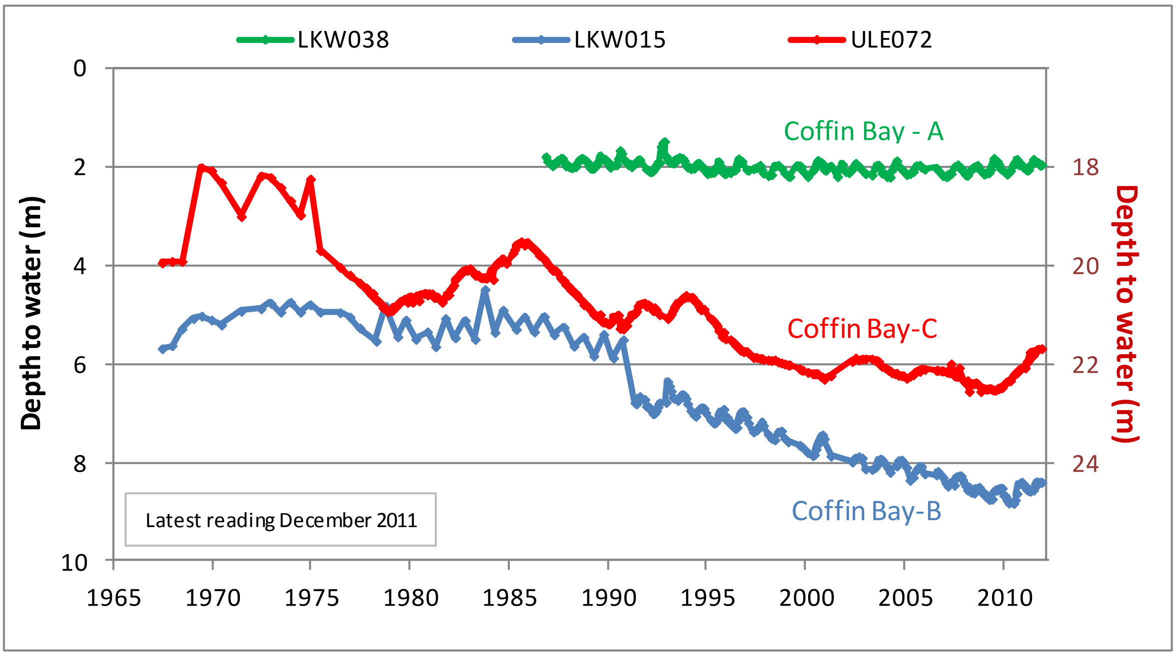

Figure 33. Groundwater level trends for the Coffin Bay Basin lenses in the Southern Basins PWA (the depth to water in well ULE072 in Coffin Bay-C is plotted on the right-hand axis)

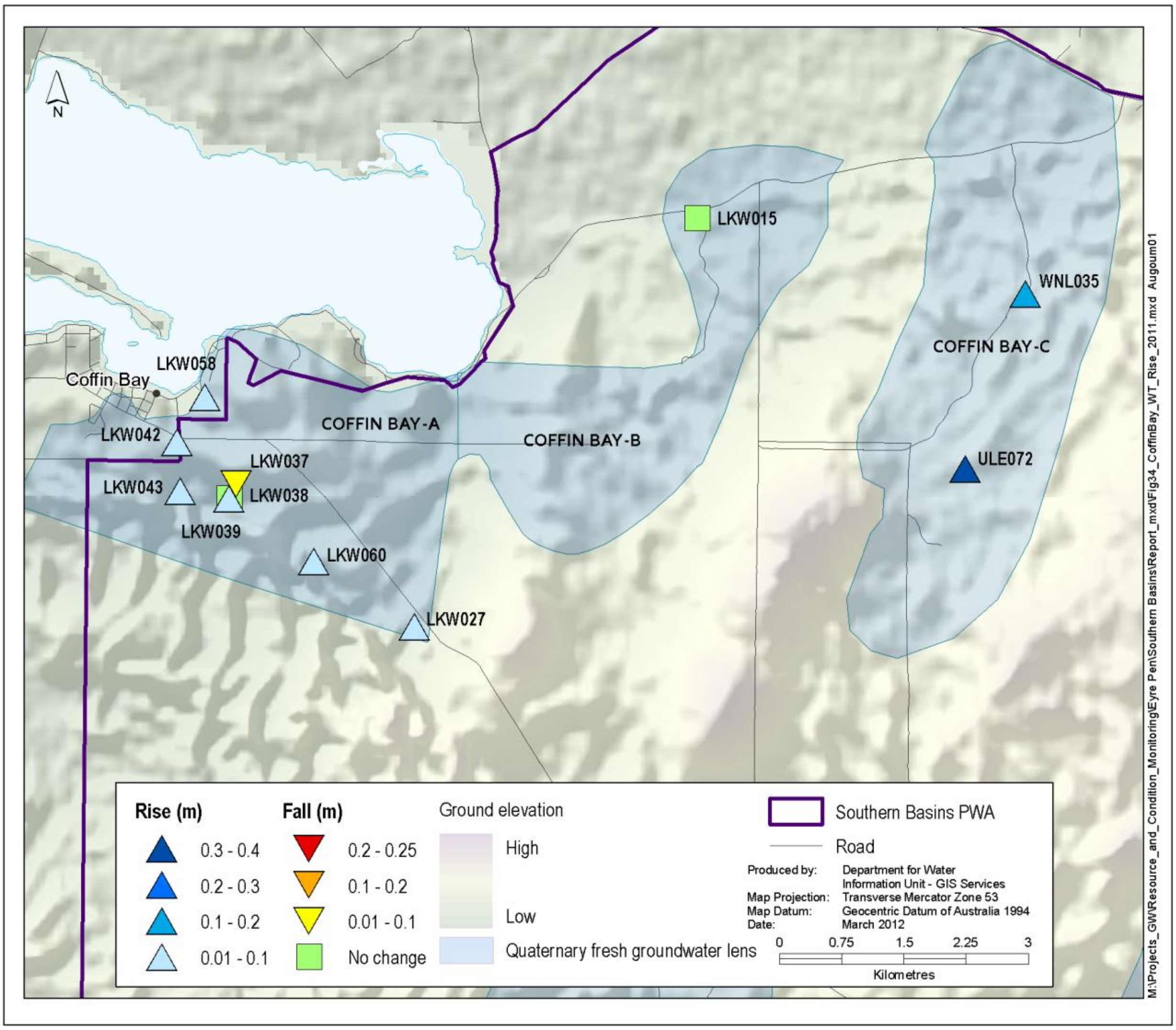

Figure 34. Overall yearly change in watertable elevation for the Coffin Bay Basin lenses from December 2010 to December 2011

SALINITY TRENDS

Town water supply wells located in the Coffin Bay-A lens (Fig. 35) reveal a gradual increase in salinity (Fig. 36). In well CB TWS 2, this has equated to 1.2 mg/L/y and in production well CB TWS 3, it is 3.2 mg/L/y. After an overall increase in salinity in 2007, the salinity of CB TWS 3 stabilised. In 2011, the salinity in both wells decreased but it is still above pre-2007 levels.

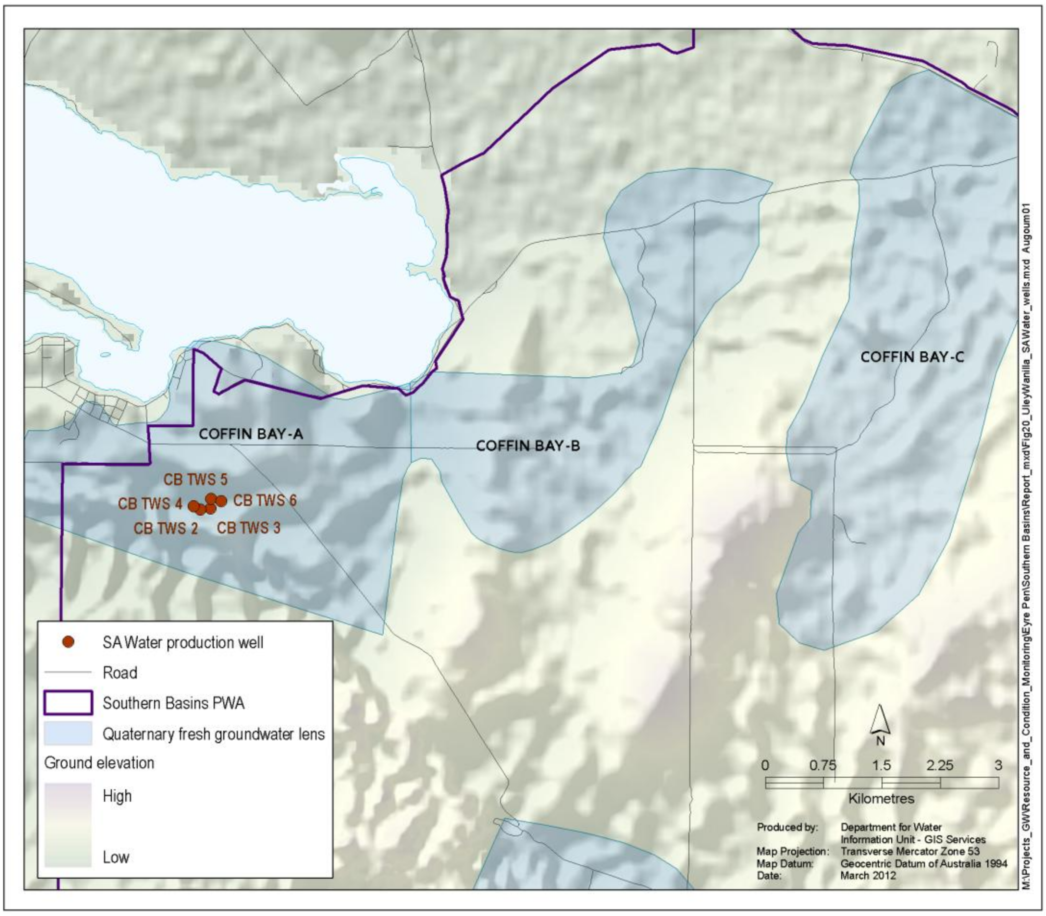

Figure 35. Location of SA Water production wells in the Coffin Bay Basin lenses

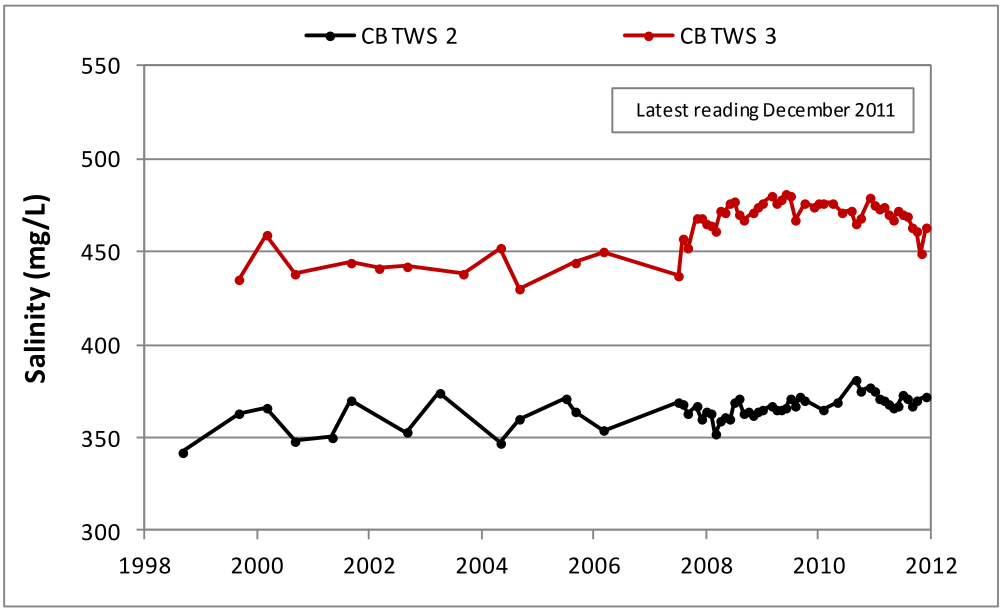

Figure 36. Groundwater salinity trends for Coffin Bay-A lens in the Southern Basins PWA

TERTIARY SAND AQUIFER

There was only minor licensed groundwater extraction from the Tertiary Sand aquifer for 2010–11.

WATER LEVEL TRENDS

Long-term groundwater level trends in the Tertiary Sand aquifer are very similar to those observed in the overlying Quaternary Limestone aquifer. In each lens, Tertiary observation wells display long-term declines due to below-average rainfall since 1992 (Fig. 37). Above-average rainfall since 2009 has resulted in a rise in groundwater levels, but they are still much lower than before 1992. In 2011, groundwater in well ULE065 (Uley Wanilla) has declined and in well LKW034 (Uley South) and well LKW022 (Coffin Bay-B), increases have been minimal.

The similar trends to the Quaternary aquifer indicate a hydraulic connection between the two aquifers in areas where the clay confining layer is thin or absent.

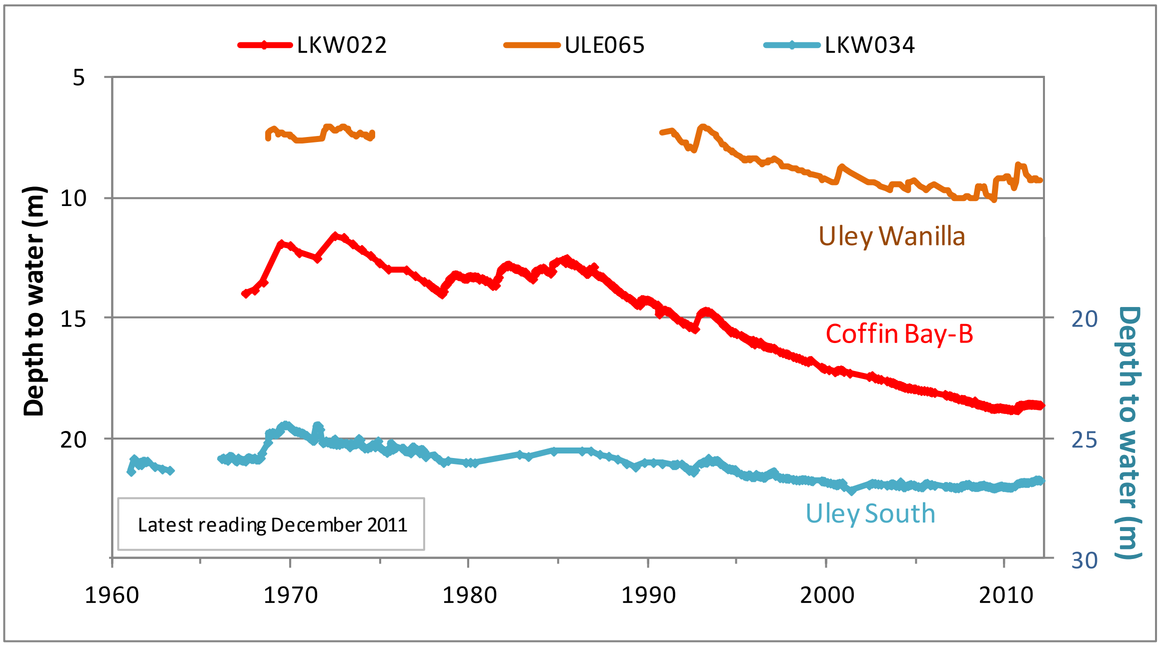

Figure 37. Groundwater level trends for the Tertiary Sand aquifer in the Southern Basins PWA (the depth to water in well LKW034 in Uley South is plotted on the right-hand axis)

SALINITY TRENDS

There is a limited number of observation wells with suitable data for the analysis of long-term groundwater salinity trends in the Tertiary Sand aquifer. However, the available data suggest the salinity in the aquifer is quite stable (Fig. 38). The next salinity measurements are scheduled for 2012.

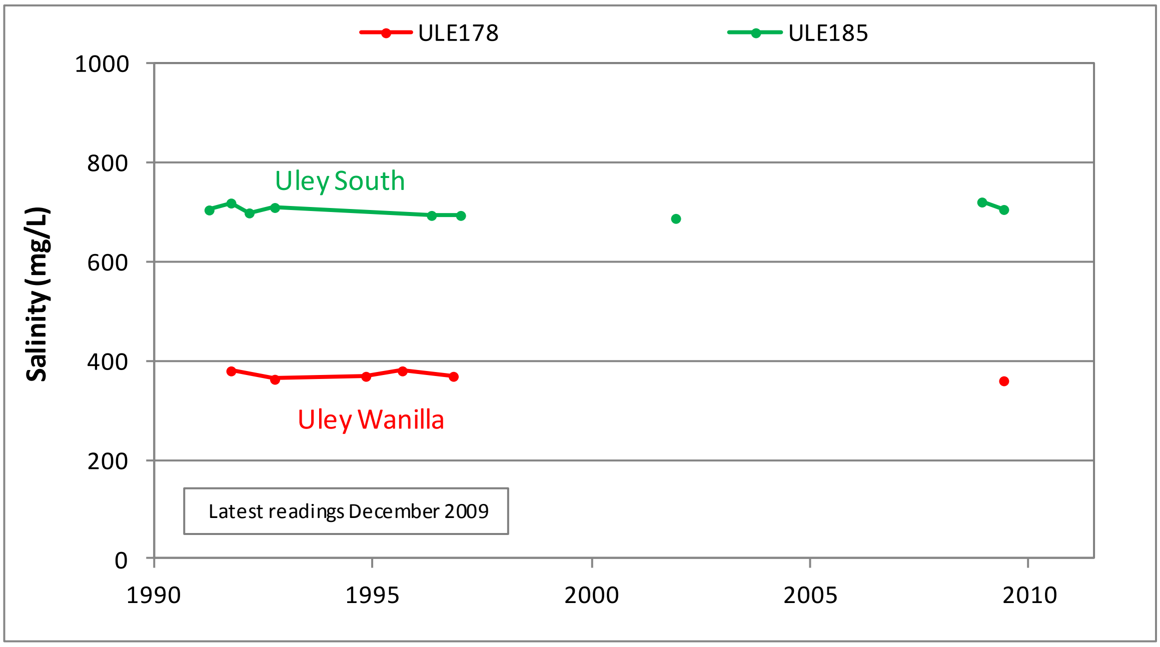

Figure 38. Groundwater salinity trends for the Tertiary Sand aquifer in the Southern Basins PWA