KANGAROO FLAT REGION OF THE NORTHERN ADELAIDE PLAINS PWA

GROUNDWATER LEVEL AND SALINITY STATUS REPORT

2011

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SUMMARY 2011

The Kangaroo Flat region encompasses an area of 65 km^2 within the north-eastern corner of the Northern Adelaide Plains Prescribed Wells Area (PWA), 42 km north-east of Adelaide. Groundwater use in the region was restricted in 2000 and was prescribed in 2004 as an addition to the Northern Adelaide Plains PWA under the *Natural Resources Management Act 2004*. The Kangaroo Flat region will be included in the Water Allocation Plan for the Adelaide Plains to provide for the sustainable management of the groundwater resources.

An assessment of the capacity of the groundwater resource in the Kangaroo Flat region was recently carried out to help determine the licensed allocations and consequently the area has been reported on separately from the Northern Adelaide Plains PWA.

Groundwater extractions in the Kangaroo Flat region occur from the well-cemented limestone of the lower Port Willunga Formation (T2 aquifer). Groundwater recharge to the T2 aquifer is thought to occur by lateral inflow from fractured aquifers of the Mount Lofty Ranges at the eastern boundary of the region.

Metered extraction data from the T2 aquifer have been recorded since the 1999–2000 irrigation season. These data indicates variable annual extraction volumes with an overall increase between the 1999–2000 and 2006–07 irrigations seasons. Since 2008–09 there has been a steady decrease in extraction, with the extraction in 2010–11 totalling 1010 ML, which is a decrease of 32% from the previous irrigation season. This is probably due to continued above average rainfall in recent years.

Groundwater levels in observation wells in close proximity to irrigation wells show seasonal fluctuations of up to 20 m. Between 2008 and 2010, it seems there was a change in the pumping regime to an earlier and more prolonged irrigation season, which may have reduced the maximum level of recovery of the pressure levels even though the seasonal drawdown reduced. The maximum recovered pressure level in observation wells MUW029 and MUW030 appears to have recovered this year. If future assessment of this resource reveals a continuation of the previously observed steady decline, it could have significant implications to the salinity of the T2 aquifer because the overall head difference between the T2 aquifer and the overlying more saline Q4 aquifer is increasing.

Irrigation wells with multiple salinity readings over the past 30 years indicate an increase in salinity with rates of increase varying from 5 to 25 mg/L/y. Up until 2008, the rising trend reached a maximum of 40 mg/L/y, but between 2008 and 2010 when the pumping regime appears to have changed, the trend from five irrigation wells has increased dramatically to over 130 mg/L/y. More recent sampling has shown a stabilisation or decrease in salinity trends in response to the decrease in extraction and the reduction in head difference between the Q4 and T2 aquifers.

Several irrigation wells have already exceeded the limit for vegetable irrigation of 1500 mg/L.

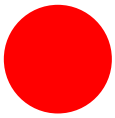
ASSESSMENT OF STATUS

The Kangaroo Flat region of the Northern Adelaide Plains PWA has been assigned a status of red "Degradation of the resource compromising present use within the short term" based on current trends. This status is supported by:

- a previous gradual decline in recovered winter water levels between 2006 and 2010 has stabilised, but the overall head difference between the T2 aquifer and the overlying Q4 aquifer is still significant, with potential for downward leakage of saline groundwater
- previous increasing trends in groundwater salinity levels of up to 130 mg/L/y have stabilised or are decreasing, however four irrigation wells have salinities exceeding the recognised limit for vegetable irrigation of 1500 mg/L.

The current extraction regime will maintain downward leakage of saline groundwater that will cause continuing degradation of the resource. Although the trends for 2011 are positive, they may only be temporary and a change in the beneficial use of the groundwater resource away from the irrigation of vegetables within five years is still possible.

STATUS 2011



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 Kangaroo Flat region encompasses an area of 65 km^2 within the north-eastern corner of the Northern Adelaide Plains PWA, 42 km north-east of Adelaide (Fig. 1). Groundwater use in the region was restricted in 2000 and was prescribed in 2004 as an addition to the Northern Adelaide Plains PWA under the *Natural Resources Management Act 2004*. The Kangaroo Flat region will be included in the Water Allocation Plan for the Adelaide Plains to provide for the sustainable management of the groundwater resources.

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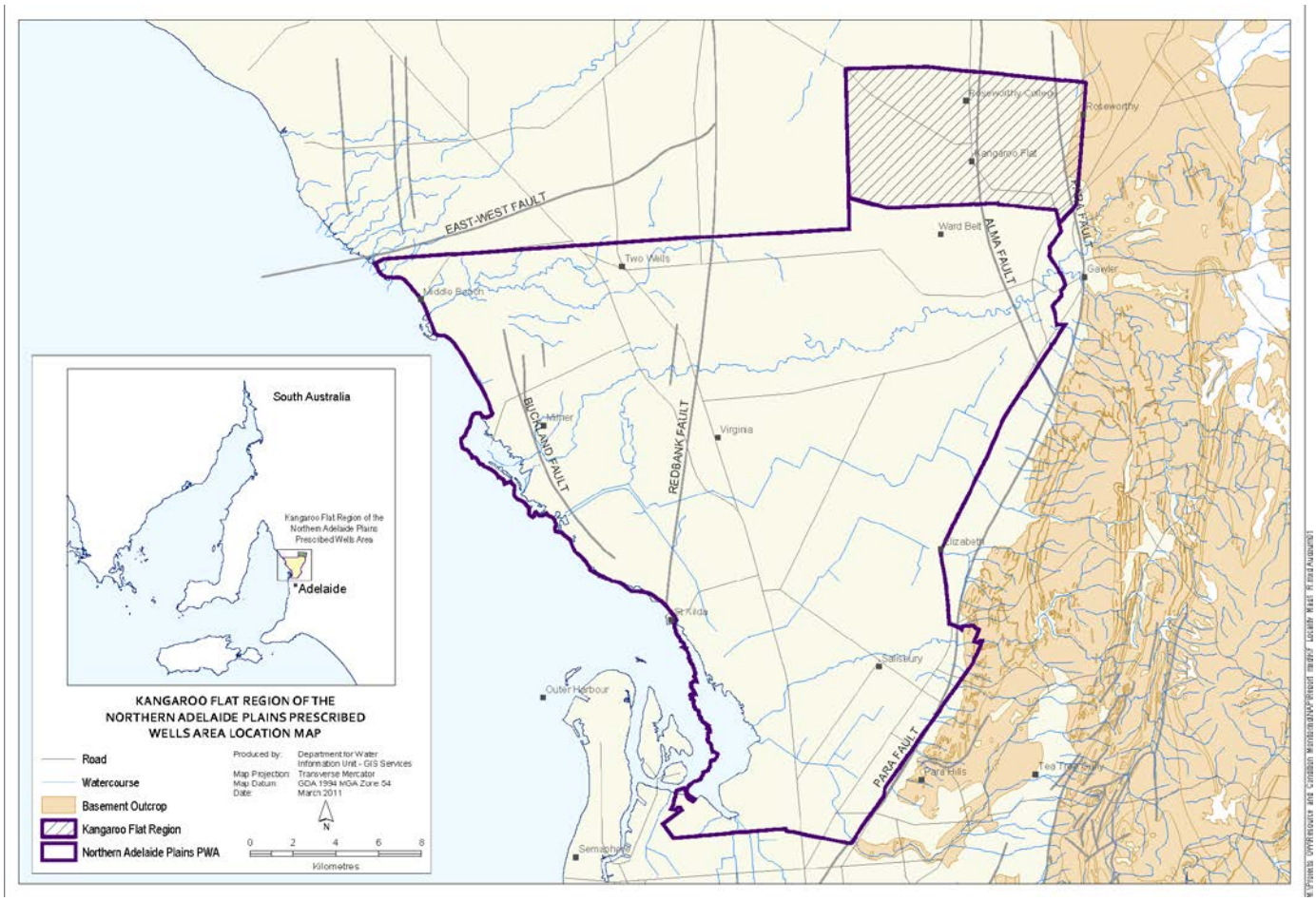

Figure 1. Location of the Kangaroo Flat region of the Northern Adelaide Plains PWA

HYDROGEOLOGY

The Kangaroo Flat region of the Northern Adelaide Plains PWA lies just to the north of the Adelaide Metropolitan Area and comprises Quaternary and Tertiary sedimentary aquifers of the St Vincent Basin. The stratigraphy within the study area has been well defined by numerous well logs. The sedimentary sequence includes Quaternary and Tertiary sediments that extend to a depth of about 600 m below the ground surface. These sediments can be broadly divided into four regional hydrogeologic units (Fig. 2).

Hindmarsh Clay

The Hindmarsh Clay aquitard has a thickness of 30–50 m and consists primarily of clays with layers of silt and sand which may be several metres thick and form minor aquifers. It acts as a confining layer.

Q4 Aquifer

The Q4 Aquifer (also called Carisbrooke Sand Aquifer) directly underlies the Hindmarsh Clay. The aquifer consists of fine to medium-grained, poorly consolidated sand and silt about 10 m in thickness. Salinity is believed to range from 3000 to 5000 mg/L.

Munno Para Clay

The Munno Para Clay is the semi-confining layer separating the Q4 aquifer from the underlying T2 Tertiary aquifer. It is a thin aquitard consisting of weathered clayey Quaternary-Tertiary sediments. The limited thickness and semi-confining nature of the aquitard allows for downward leakage of the saline Q4 groundwater into the highly-pumped T2 aquifer.

T2 Aquifer

The T2 aquifer, which underlies the Munno Para Clay confining layer, occurs throughout the entire Kangaroo Flat region and consists of well-cemented limestone of the lower Port Willunga Formation.

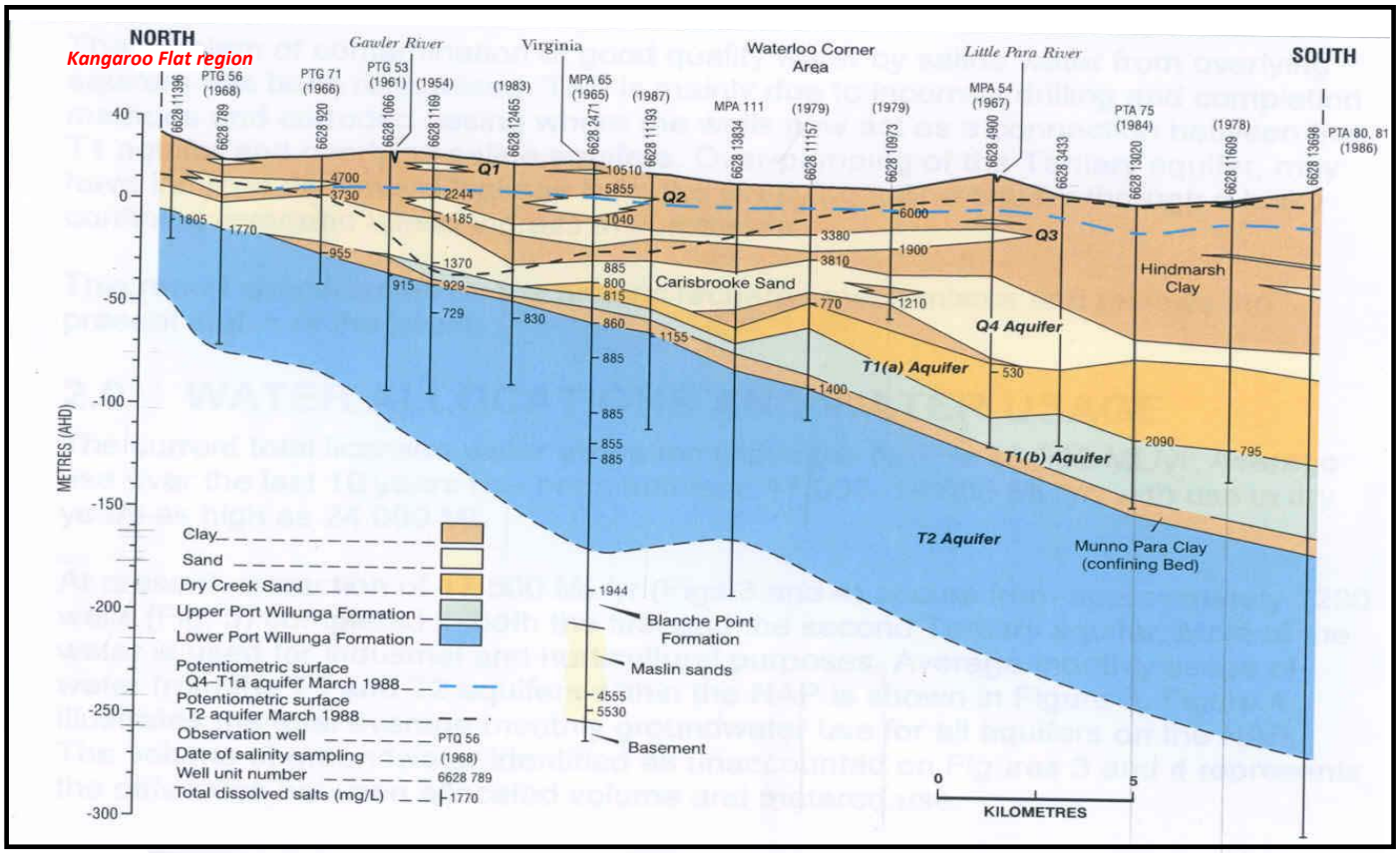

Figure 2. Diagrammatic north-south cross-section of the NAP PWA

For further information, see:

http://www.waterconnect.sa.gov.au/BusinessUnits/InformationUnit/Technical%20Publications/dwlbc_technote_KFlat1.pdf

GROUNDWATER FLOW AND SALINITY

Groundwater recharge to the T2 aquifer is thought to occur by lateral inflow from fractured aquifers of the Mt Lofty Ranges at the eastern boundary of the region. Groundwater outflow from the aquifer system occurs through extraction from irrigation and domestic wells and discharge beneath the Northern Adelaide Plains region to Gulf St Vincent.

Groundwater flow within the Kangaroo Flat region is toward the south-west and is dominated by irrigation extractions in the central NAP PWA and the associated cone of depression in the T2 aquifer centred on Virginia. There is a localised cone of depression in the south-west corner of the Kangaroo Flat region caused by concentrated pumping (Fig. 3).

Groundwater salinity in the T2 aquifer increases toward the margins of the St Vincent Basin to the north-east and east. Values range from 1400 to over 3000 mg/L, with higher values associated with areas of large seasonal drawdowns caused by pumping.

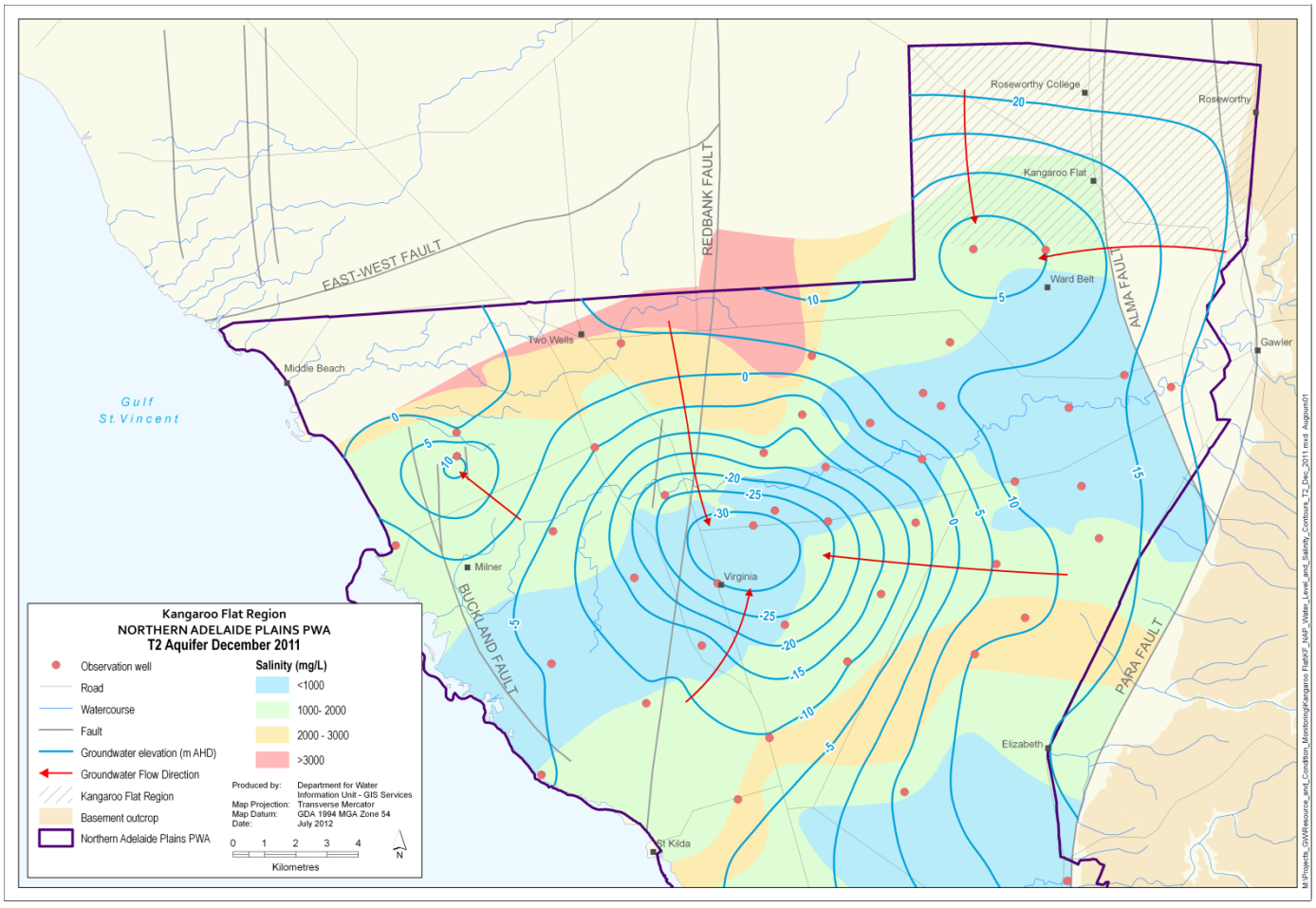

Figure 3. **Salinity distribution and regional groundwater flow direction (2011) for the T2 aquifer in the Northern Adelaide Plains PWA**

GROUNDWATER DEPENDENT ECOSYSTEMS

Whilst groundwater dependent ecosystems (GDEs) have not been used in the assessment of the status of the groundwater resource, it is important to note the presence and ecological characteristics of the GDEs found in the Kangaroo Flat region. 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.

The Kangaroo Flat region is dominated by agricultural land use, with little evidence of the original landscape remaining. There are no watercourses or wetlands evident within the region.

While the Quaternary aquifer is sufficiently shallow (<10 m below surface) to support vegetation with a dependence on groundwater in some areas of the region, this vegetation no longer exists in the current landscape. Elevated salinity levels in the Quaternary aquifer also act to preclude many species of plants which may potentially be able to utilise this water.

Other possible GDEs in the Kangaroo Flat region include stygofauna.

RAINFALL

Rainfall is a very important part of the groundwater balance because it is a source of recharge of aquifers.

The Kangaroo Flat region experiences a Mediterranean climate which is characterised by hot, dry summers and cool to cold winters. The rainfall station located at Gawler (station 23078; Fig. 7) was selected as representative of the rainfall pattern throughout the area. Rainfall is winter dominant, with an annual average rainfall of 468 mm.

The cumulative deviation from mean annual 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.

The Gawler station shows generally above average rainfall prior to 1975, with mostly below average rainfall since then, especially following the 2006 drought (Fig. 4).

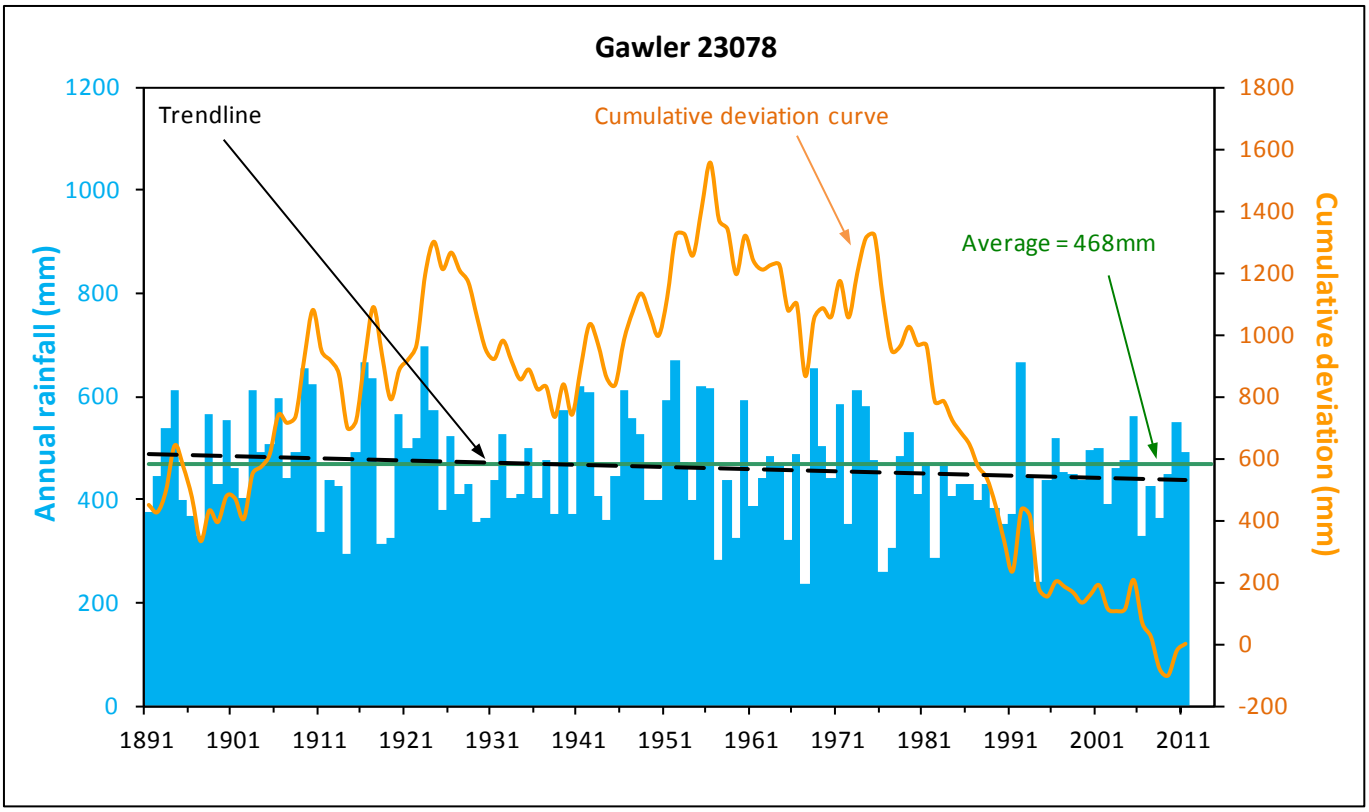

Figure 4. **Annual rainfall and cumulative deviation for mean annual rainfall for Gawler**

GROUNDWATER USE

Metered extraction data from the T2 aquifer are available since the 1999–2000 irrigation season (Fig. 5). There has been a steady overall increase in extraction over the last ten years until 2008–09. Extraction for 2010–11 totalled 1010 ML, which is a decrease of 32% from the previous irrigation season. This reduction is probably due to the recent above average rainfall and the increase in groundwater salinities. Due to the presence of mains water and highly variable groundwater salinities, stock and domestic extractions are thought to be minimal. Potatoes received by far the greatest volume of extracted groundwater with 769 ML, followed by almonds with 144 ML and olives with 97 ML (Fig. 6).

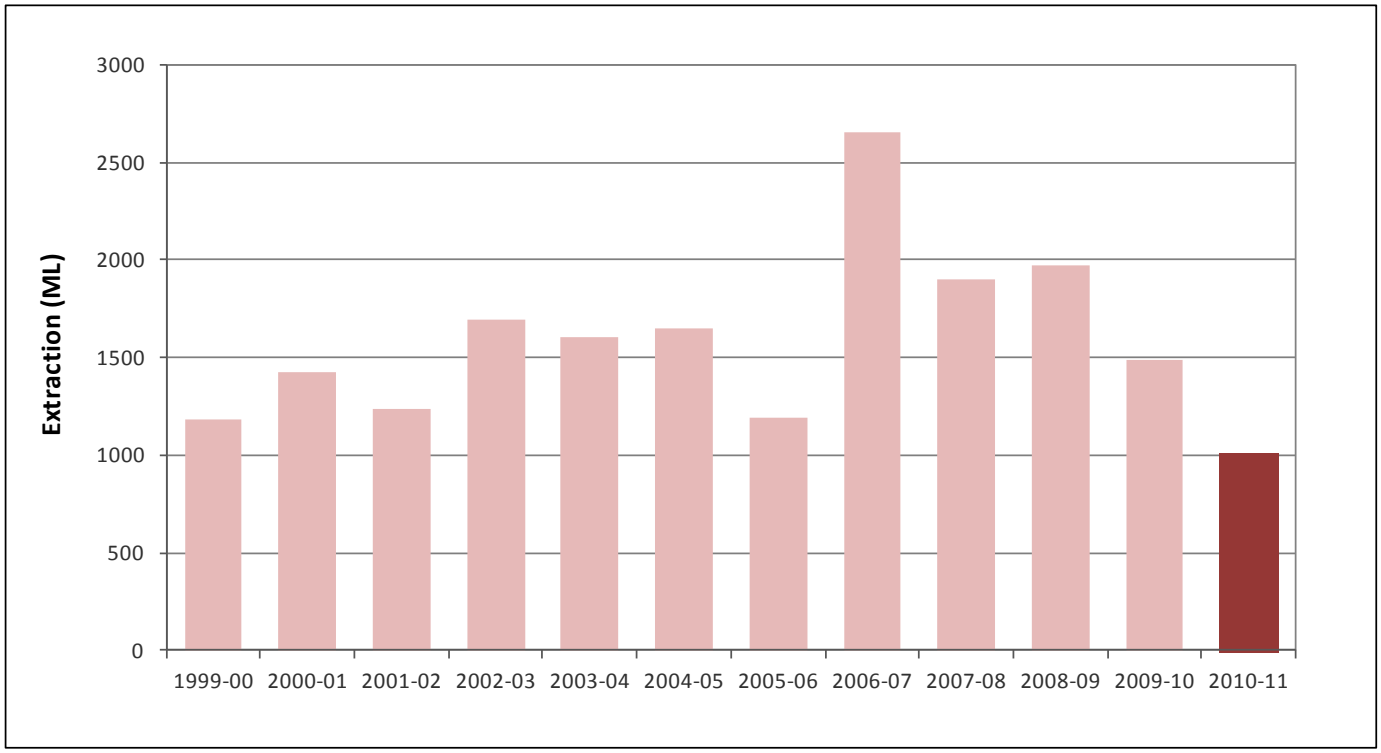

Figure 5. **Historical groundwater use in the Kangaroo Flat region**

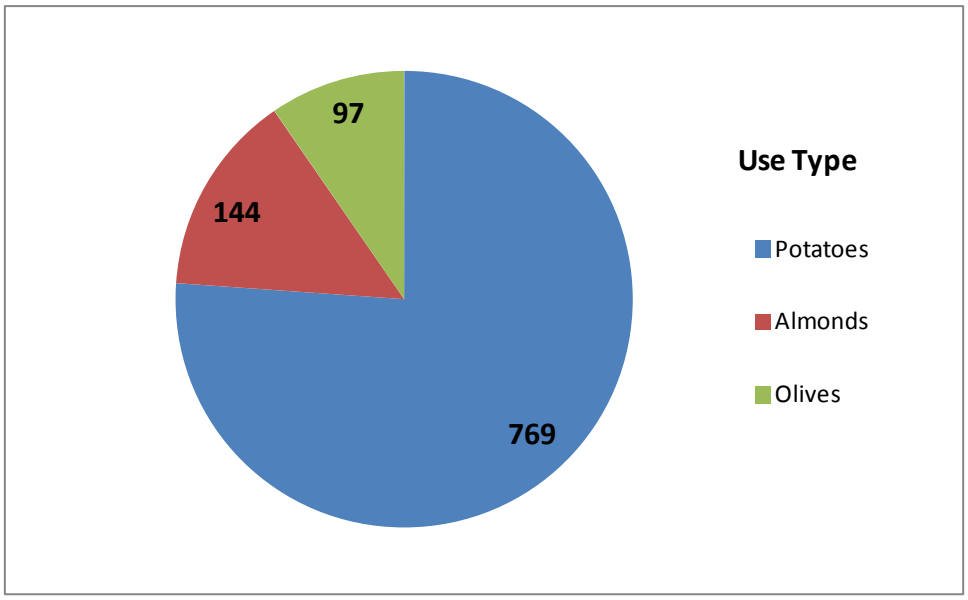

Figure 6. **Groundwater volumes extracted per type of use for the 2010–11 season (ML)**

WATER LEVEL NETWORK

Although groundwater monitoring in the Northern Adelaide Plains PWA had been carried out since the mid 1970s, none of the observation wells were located in the Kangaroo Flat area. Following concerns about the increase in irrigation in the area, three new observation wells were drilled and completed in the T2 aquifer within the Kangaroo Flat region in late 2000 (Fig. 7). As part of ongoing investigations, an additional three observation wells were drilled in 2010, two of which are completed in the Quaternary (Q4) aquifer and one into the deeper Tertiary (T3) aquifer. Quarterly monitoring has continued since their construction.

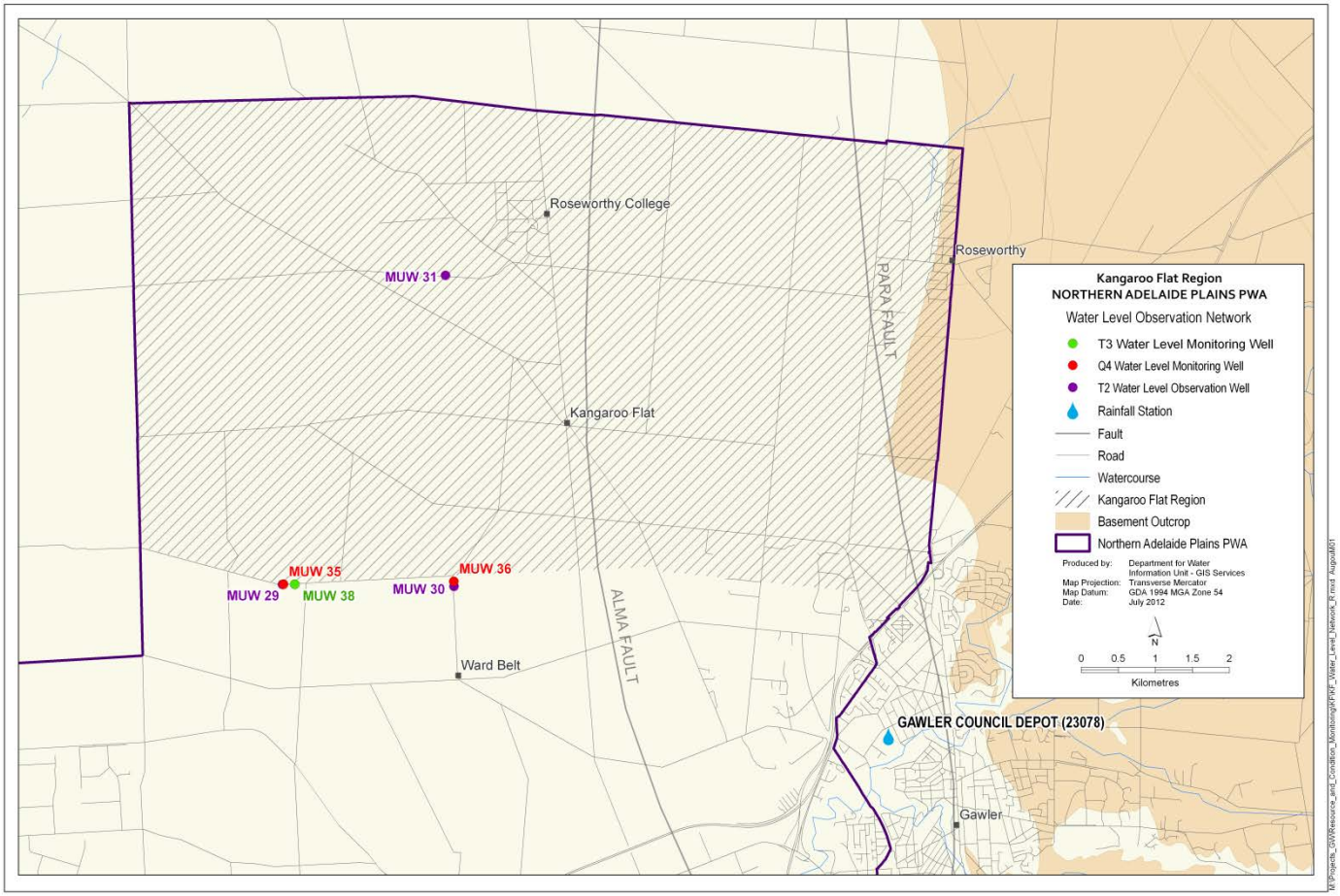

Figure 7. **Location of groundwater level observation wells in the Kangaroo Flat region**

SALINITY NETWORK

Until 2008, there was no regular salinity monitoring carried out in the Kangaroo Flat region. However, in February 2008, most licensed extraction wells were sampled for salinity and have since been sampled on a random basis (Fig. 8).

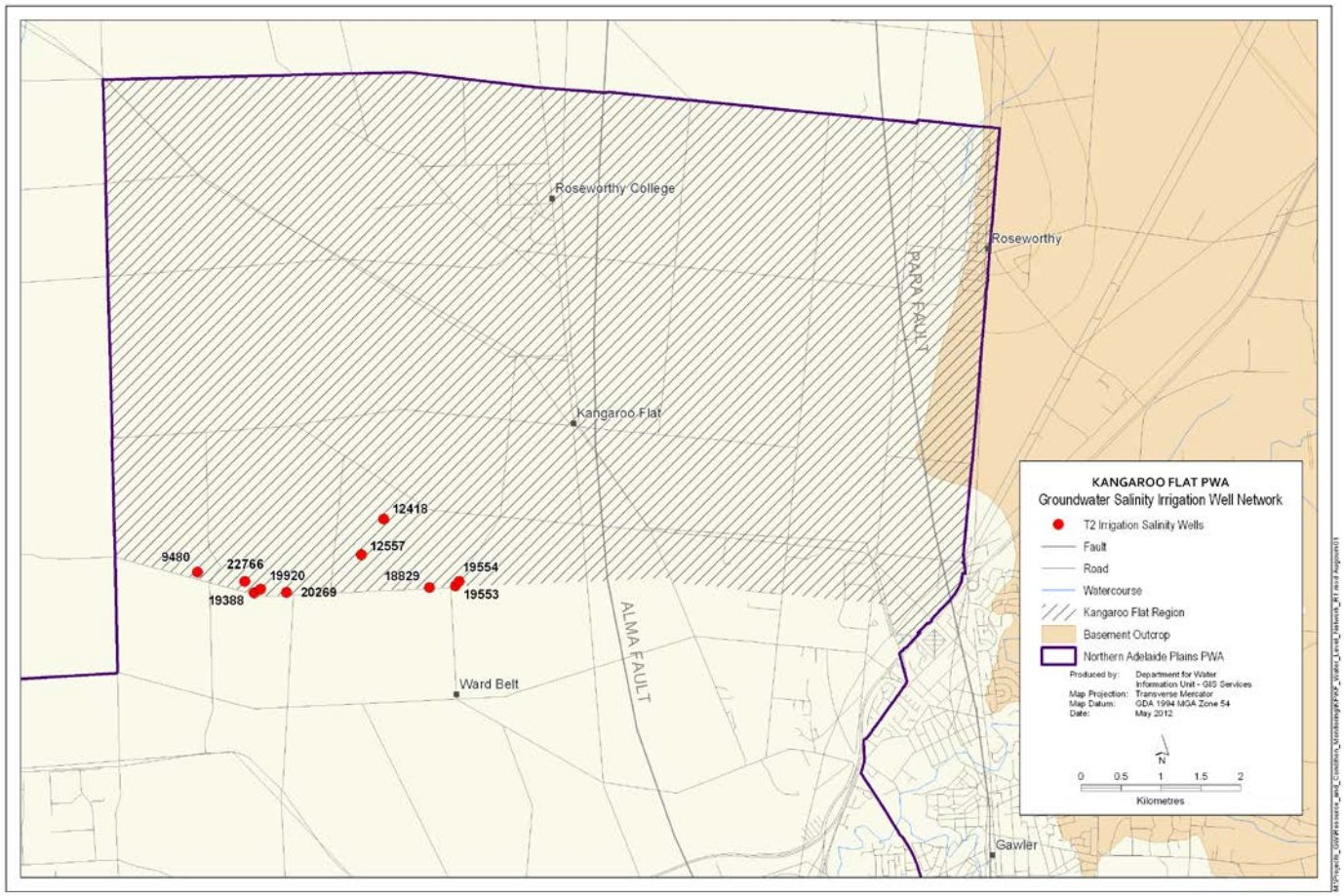

Figure 8. Location of groundwater irrigation wells sampled for salinity in Kangaroo Flat region

GROUNDWATER LEVEL TRENDS

The observation wells completed in the T2 aquifer within the Kangaroo Flat region, MUW029, 030 and 031, were completed in 2000 after the increase in irrigation occurred in 1998. Well MUW029 is located within 250 m of three production wells and not surprisingly, shows the greatest seasonal drawdown of 15–20 m (Fig. 9). Well MUW030 is located within 450 m of four production wells and displays a seasonal drawdown of 10–15 m. Observation well MUW031 is located three kilometres from the nearest extraction well and displays small seasonal variations and a gradual decline of about 0.15 m/y (Fig. 9), indicating that the cone of depression is slowly widening even though it appears relatively stable (to slightly decreasing) at the centre of the cone of depression where most extractions occur (i.e. trends displayed by MUW029 and 030) (Figs. 3 & 9).

Up until 2008, well groundwater levels indicate that Wells MUW029 and 030 reached a form of equilibrium and that they are more likely to reflect the magnitude and timing of local pumping rather than regional trends. Between 2008 and 2010, it seems that a change in the pumping regime to an earlier and more prolonged irrigation season reduced the maximum level of recovery, even though the seasonal drawdown reduced.

In comparison to this period, the decline in the maximum recovered water level during winter of 2011, in wells MUW029 and MUW030, appears to have marginally improved. However the steady gradual decline in MUW031 appears to have continued.

Continued monitoring and assessment of this resource is required. The steady decline in recovered water levels displayed by MUW031, may have important salinity implications if there is an increasing head difference between the T2 aquifer and the overlying Q4 aquifer which would give increase the potential for downward leakage of more saline groundwater (Fig. 9). Wells MUW035 (near 029) and 036 (near 030) were constructed in July 2010 in the Q4 aquifer, and the Initial trends displayed in Fig. 9 indicate that the hydraulic head difference between Q4 and T2 aquifers is generally neglible in the areas of concentrated extraction, with the water levels in both aquifers observed to be almost identical suggesting that they are in close hydraulic connection. As there are minimal or no confining layers between the aquifers in the Kangaroo Flat region (Fig. 2), the water levels in the upper aquifer respond rapidly to pumping from the lower one and there is likely to be some lateral movement of more saline water into the areas of concentrated extraction.

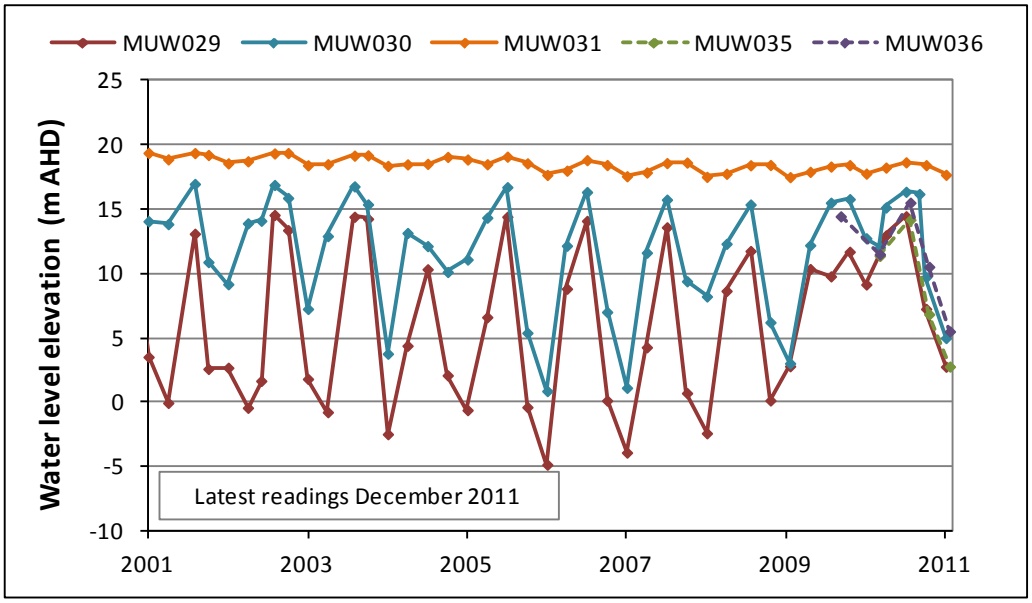

Figure 9. **Groundwater level trends for wells in or near the Kangaroo Flat region**

GROUNDWATER SALINITY TRENDS

Irrigation wells with multiple salinity readings over the past 30 years indicate an overall increase in salinity with rates of increase varying from 5 to 25 mg/L/y (Fig. 10). However, a lack of salinity monitoring in the past makes interpretation of any groundwater salinity trends difficult.

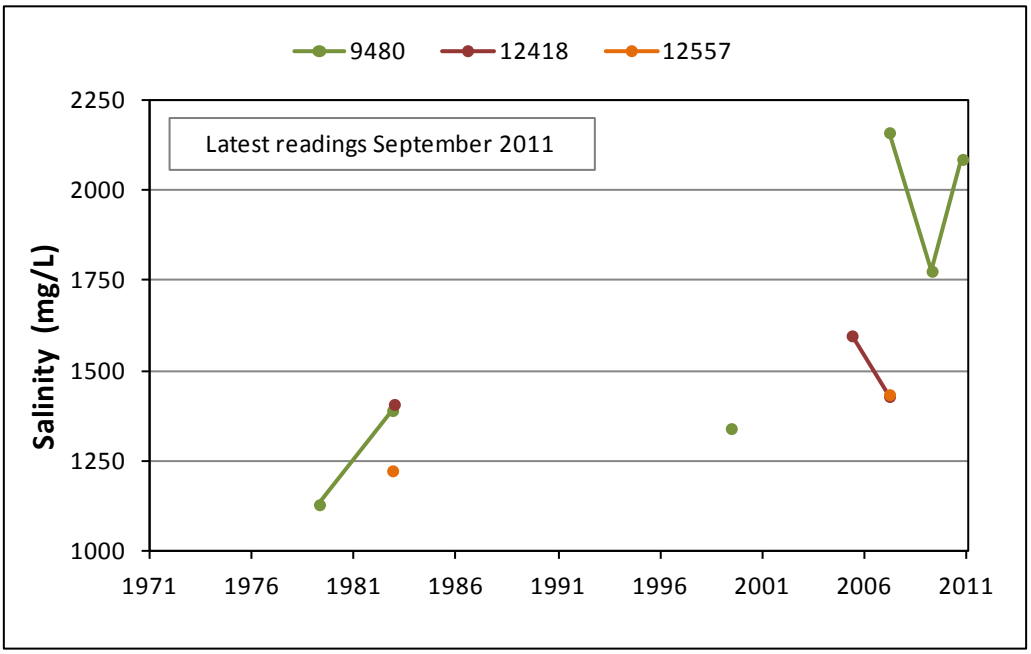

Figure 10. Historical groundwater salinity trends in the Kangaroo Flat region

Between 1998 and 2008, the rising trend reached a maximum of 40 mg/L/y. From 2008 to 2010, salinity trends in five T2 irrigation wells in the Kangaroo Flat region averaged more than 130 mg/L/y over which period the pumping regime appears to have changed (Fig. 11). More recent sampling has shown a stabilisation or decrease in salinity trends in response to the decrease in extraction and the reduction in saline inflows from the Q4 aquifer.

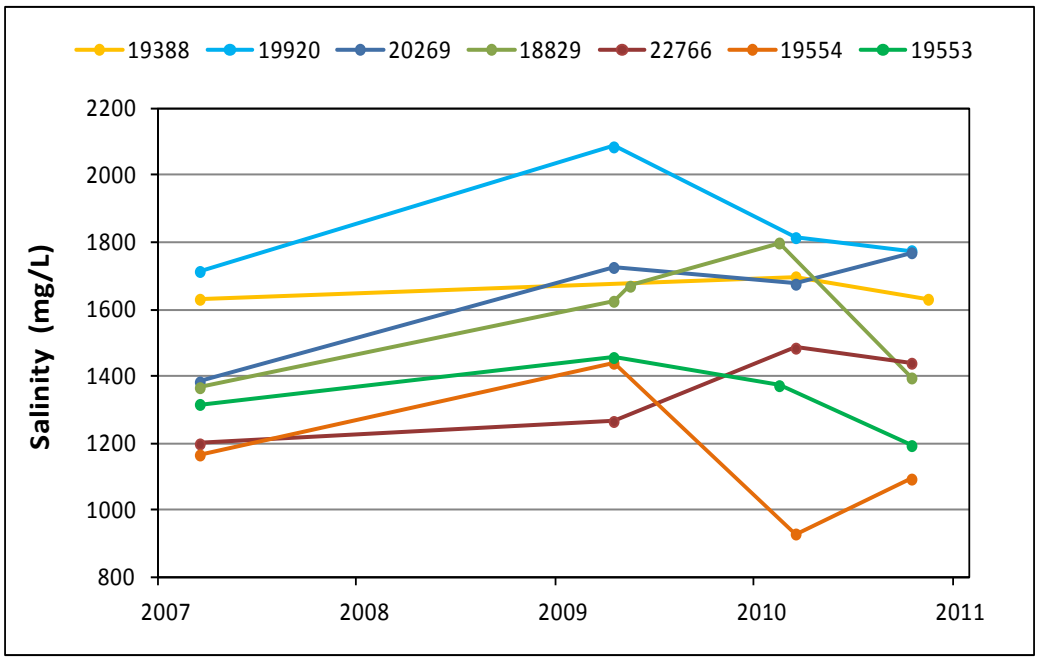

Figure 11. Groundwater salinity trends in the Kangaroo Flat region