McLAREN VALE PWA

GROUNDWATER LEVEL AND SALINITY STATUS REPORT

2009–10

DEPARTMENT FOR WATER

Government of South Australia
Department for Water

SUMMARY 2009–10

The McLaren Vale PWA is located approximately 35 km south of Adelaide. It is a regional-scale resource for which groundwater has been prescribed under South Australia's *Natural Resources Management Act 2004*. A Water Allocation Plan provides for sustainable management of the water resources.

The McLaren Vale PWA encompasses sedimentary aquifers of Quaternary and Tertiary age within the Willunga Basin and fractured rock aquifers which form the hills to the east of the Willunga Fault and which also crop out to the north. Groundwater occurs in four major aquifers; the Quaternary Aquifer, Port Willunga Formation Aquifer, Maslin Sands Aquifer and Fractured Rock Aquifer. Imported treated effluent from the Christies Beach Wastewater Treatment Plant provides an alternative water source to groundwater via the Willunga Basin Water Company reticulation scheme.

Metered groundwater extractions in the PWA for 2009–10 totalled 3990 ML, which represents a reduction of 20% from the previous year and is well below the extraction limit of 6600 ML. Most of the groundwater extractions (65%) occur from the Port Willunga Formation Aquifer, with 18% pumped from the Maslin Sands Aquifer and 17% from the Fractured Rock Aquifer. Groundwater is used primarily for the irrigation of vines.

Groundwater level trends in the Port Willunga Formation Aquifer have shown widespread declines of up to 3 m since 1993, at a long term average rate of decline of 0.12 m/yr. Since the 2006 drought, the rate of decline is averaging 0.22 m/yr with most observation wells showing a continuing decline, despite extractions from this aquifer being relatively stable or declining. Over this same period, 75% of irrigation wells sampled (139 wells) have shown an increase in groundwater salinity of 13% (an average of 135 mg/L). Despite this aquifer being confined, higher rainfall during 2009–10 has stabilised or reduced salinity levels in about half of these wells; however, 65 wells are continuing to show a rising trend, averaging 48 mg/L/yr.

Groundwater levels in the Maslin Sands Aquifer have been relatively stable since 2000. There have been some declines of up to 1.5 m following the 2006 drought, however recent high rainfall has produced some recovery in water levels. Almost identical increasing salinity trends to the Port Willunga Formation described above have been observed in the Maslin Sands following 2006.

Fractured Rock Aquifer groundwater level trends tend to follow rainfall patterns, especially where the basement rock crops out and receives direct recharge from rainfall. Declines due to below-average rainfall after 2006 have averaged just over one metre and recovery of water levels due to higher rainfall during 2009–10 has been variable. The Fractured Rock Aquifer has also experienced increasing salinity trends very similar to the other aquifers.

Further work is being undertaken to define the causes of these salinity increases. On-going monitoring will help determine if these rises will be persistent and present a threat to the sustainability of the groundwater resource.

The ability to access an alternative water supply through the Willunga Basin Water Company reticulation scheme may reduce the impacts from this rise in salinity.

ASSESSMENT OF STATUS

The McLaren Vale PWA 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:

- a widespread gradual decline in groundwater levels in the Port Willunga Formation aquifer since 1993 that has accelerated since the 2006 drought, despite extractions from this aquifer being relatively stable or declining. However, these declines are not expected to affect access to the resource by groundwater users over the next 10–20 years.
- rising salinity levels in a significant number of irrigation wells completed in all three major aquifers since the 2006 drought.

Further work will be undertaken to define the causes of these salinity increases and on-going monitoring will help determine if the groundwater level declines and salinity rises will be persistent and present a threat to the sustainability of the groundwater resource.

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.

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BACKGROUND

The McLaren Vale PWA is located approximately 35 km south of Adelaide (Fig. 1). It is bound to the north by the Onkaparinga River, to the west by St Vincent Gulf and to the south-east by the Mount Lofty Ranges. It is a regional-scale resource for which groundwater has been prescribed under South Australia's *Natural Resources Management Act 2004*. A Water Allocation Plan provides for sustainable management of the water resource. Imported treated effluent from the Christies Beach Wastewater Treatment Plant provides an alternative water source to groundwater via the Willunga Basin Water Company reticulation scheme.

HYDROGEOLOGY

The McLaren Vale PWA encompasses sedimentary aquifers of Quaternary and Tertiary age within the Willunga Basin and the fractured rock aquifer which forms the hills to the east of the Willunga Fault and which also crops out to the north. The Willunga Basin is a structurally controlled trough bounded in the south-east by the Willunga Fault and to the north by basement outcrop. The depth of the basin increases toward the southeast and reaches a maximum depth of approximately 250 m near the Willunga Fault (Fig. 2). Groundwater occurs in four major aquifers:

- Quaternary Aquifer
- Port Willunga Formation Aquifer
- Maslin Sands Aquifer
- Fractured Rock Aquifer.

Quaternary Aquifer

Sands and interbedded clays form shallow unconfined aquifers which are generally low yielding and provide mostly stock and domestic supplies, with limited extraction for irrigation. Recharge is predominantly derived from local rainfall and runoff provided by streams.

Port Willunga Formation Aquifer

The Port Willunga Formation Aquifer consists of sands and limestones and generally returns high yields. It is unconfined in its northern extent near McLaren Vale and McLaren Flat, but is confined by Quaternary sediments in the south and south-western parts of the PWA. Recharge from rainfall primarily occurs where it is unconfined.

Maslin Sands Aquifer

The Maslin Sands Aquifer directly overlies basement rocks and comprises fine to coarse sands and clays. The aquifer is recharged by rainfall in the north-east of the PWA where it crops out. Elsewhere, the aquifer is confined and separated from the overlying Port Willunga Formation Aquifer by the Blanche Point Formation aquitard which consists of low-permeability marine mudstone and limestone.

Fractured Rock Aquifer

Fractured Rock Aquifers occur in basement rocks (slates, quartzites, shales and limestone) which form ranges to the east of the Willunga Fault and also along the Onkaparinga Gorge. Infiltration of rainfall provides recharge to the aquifer in theses areas. Extractions also occur from these aquifers where they underlie sedimentary aquifers within the Willunga Basin.

For a more detailed description of the hydrogeology of the Willunga Basin, please see:

http://www.waterconnect.sa.gov.au/BusinessUnits/InformationUnit/Technical%20Publications/Willunga_Basin_GW_Resources_1998.pdf

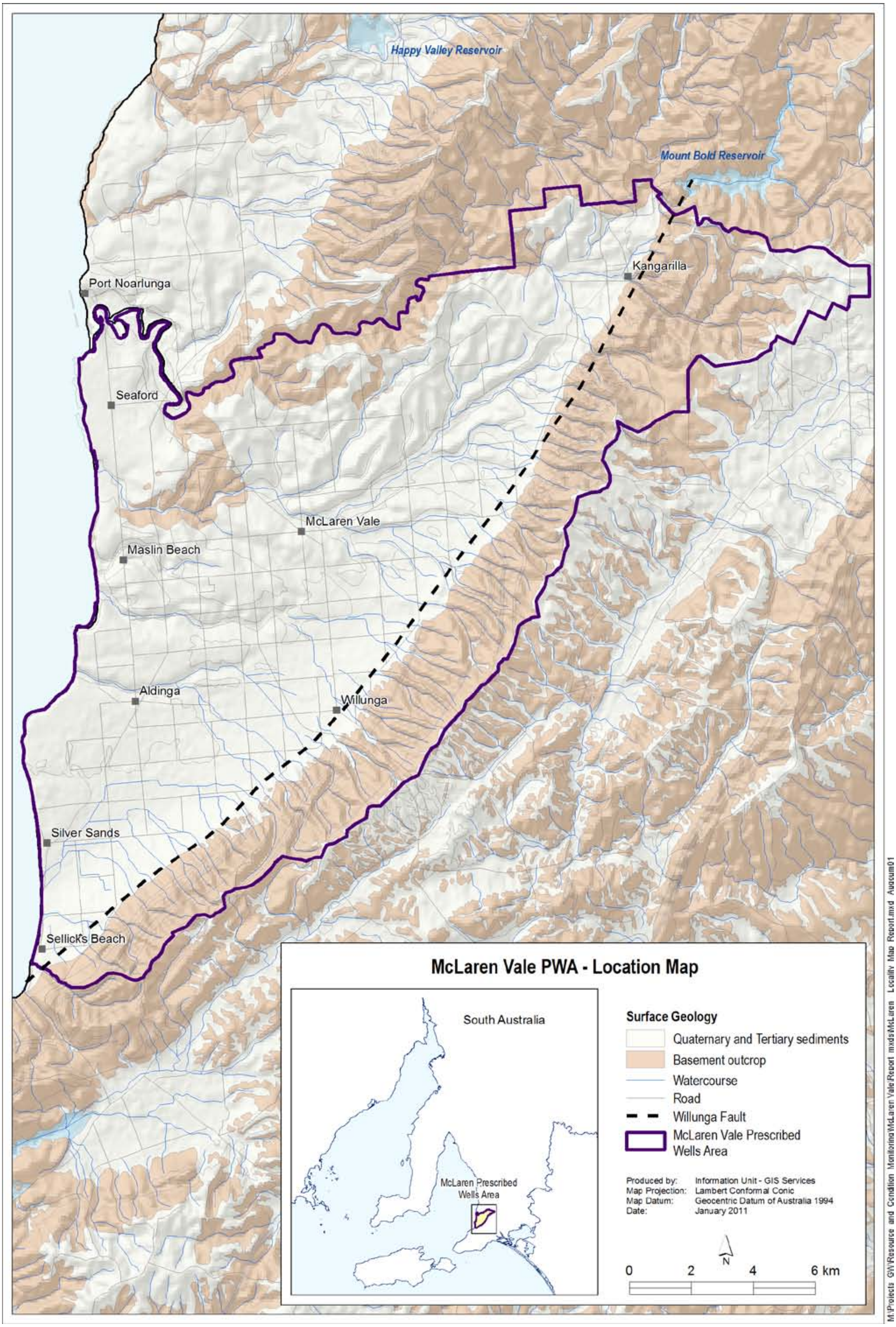

Figure 1. Location of McLaren Vale PWA

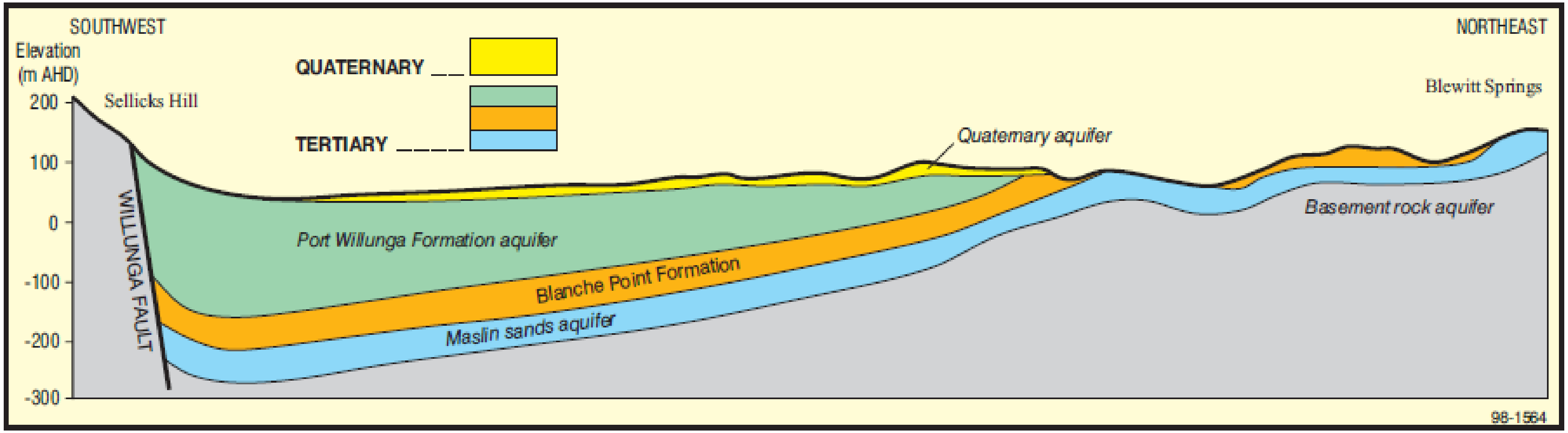

Figure 2. Geological cross-section of the Willunga Embayment in the McLaren Vale PWA

Table 1. Hydrostratigraphy of the McLaren Vale PWA

AGE	STRATIGRAPHY		HYDROSTRATIGRAPHY	
	Unit	**Lithology**	**Unit**	**Description**
Quaternary	Christies Beach Formation	Reddish brown to chocolate-brown fluvial clay, containing lenses of gravel composed mainly of flat-lying pebbles of quartzite.	Aquifers/ aquitards	Confining bed over much of the basin. Thin shallow sandy and gravel unconfined and semi-confined aquifers.
	Ngaltinga Formation	Clayey sand and clay with occasional sandy interbeds and grey to olive-green massive clay.		
	Pirramimma Sandstone	Buff coloured, fine-grained, well-sorted and poorly consolidated sandstone		
	Ochre Cove Formation	Horizontally bedded sequence of alluvial sandstone, gravel and conglomerate		
Tertiary	Port Willunga Formation	Calcarenite, bryozoal, calcrudite, glauconitic, silt and sand	T1 Aquifer	Confined aquifer in southern half of basin; unconfined elsewhere.
	Chinaman Gully Formation	Sand, silt and clay; dark, carbonaceous and pyritic where fresh	Aquitard	Confining bed
	Blanche Point Formation	Glauconitic, calcareous mudstone; spicular chert	Aquitard/ Aquifer	Confining bed over southern half of basin; aquifer to aquitard elsewhere.
	Tortachilla Limestone	Basal ferruginous sand grading to richly fossiliferous limestone	Aquitard	Confining bed
	North and South Maslin Sands	North MS: quartz sand and gravel South MS: marginal marine sand, glauconitic , carbonaceous and pyritic at depth	T2 Aquifer	Confined aquifer over most of basin. Unconfined in northern most part of basin.
Precambrian/ Cambrian		Slates, quartzites, dolomites, tillites, shales and limestone	Fractured Rock Aquifer	Confined or semi-confined aquifer beneath sediments. Unconfined where outcropping in Hills east of the Willunga Fault and along the Onkaparinga Gorge

GROUNDWATER FLOW AND SALINITY

Port Willunga Formation Aquifer

Groundwater within the Port Willunga Formation typically flows from the higher north-eastern part of the basin towards the coast in a south-westerly direction (Fig. 3). The groundwater salinity contours show an increase toward the coast in a south-westerly direction from about 700 mg/L to over 3000 mg/L. In some parts of the basin, the lower portion of the Port Willunga Formation contains lower salinity groundwater than the upper portion.

Maslin Sands Aquifer

The potentiometric surface indicates that groundwater in the Maslin Sands Aquifer flows from the recharge areas in the north-east towards the south-west (Fig. 4). Salinity in the aquifer ranges from below 500 mg/L in the north and increases downgradient towards the coast and along the south-west margin.

Fractured Rock Aquifer

A water level contour map for the Fractured Rock Aquifer was not generated due to the highly variable ground elevations and limited coverage of observation wells. However, groundwater flow within this aquifer generally follows the topography and flows from high points around the basin margin toward the low points within the basin (Fig. 5), with some discharge to the sedimentary aquifers. Beneath the sediments, the flow direction in the Fractured Rock Aquifer turns southwest toward the coast. The salinity distribution in this aquifer is quite variable.

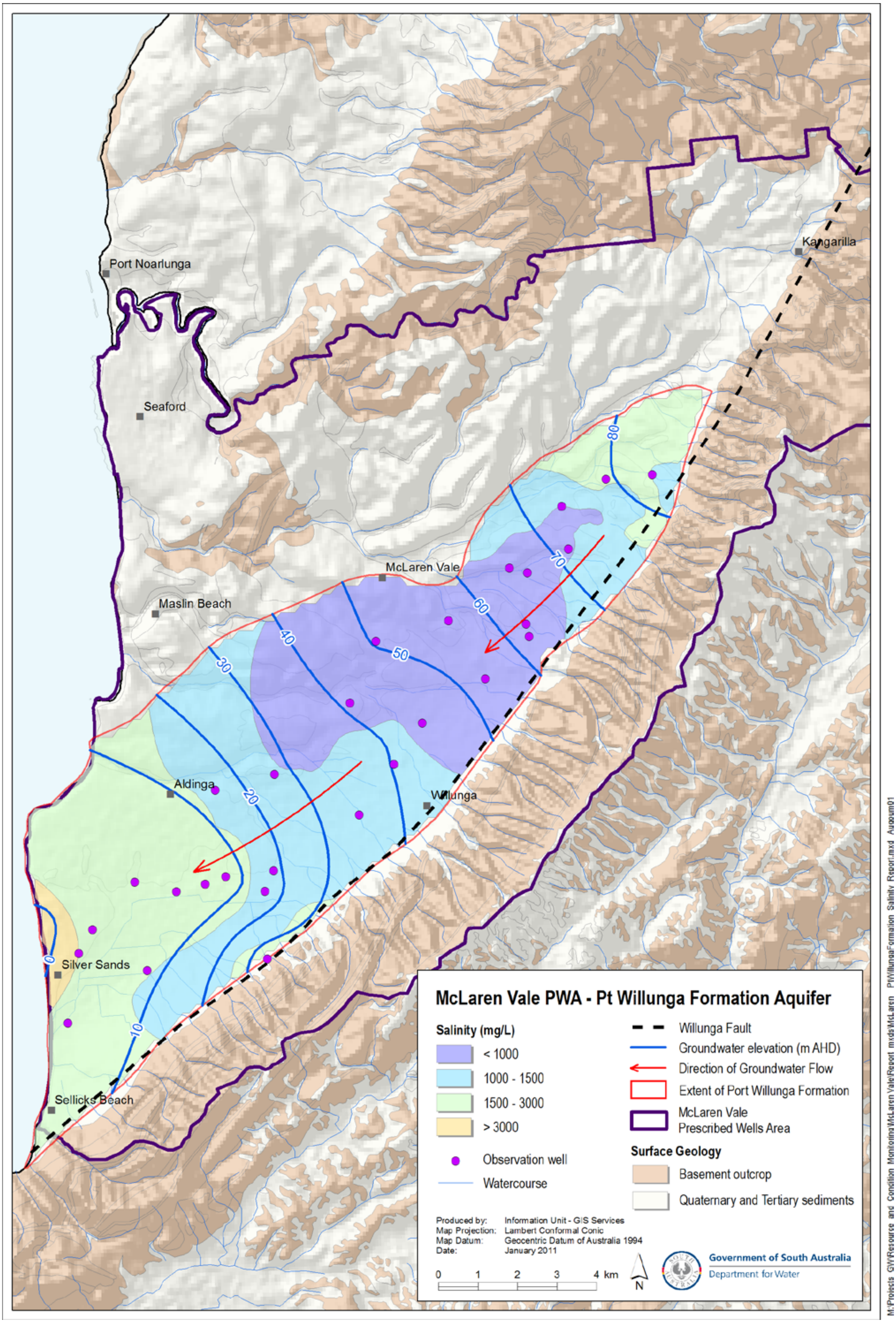

Figure 3. Groundwater flow direction and salinity distribution (2010) of the Port Willunga Formation Aquifer in the McLaren Vale PWA

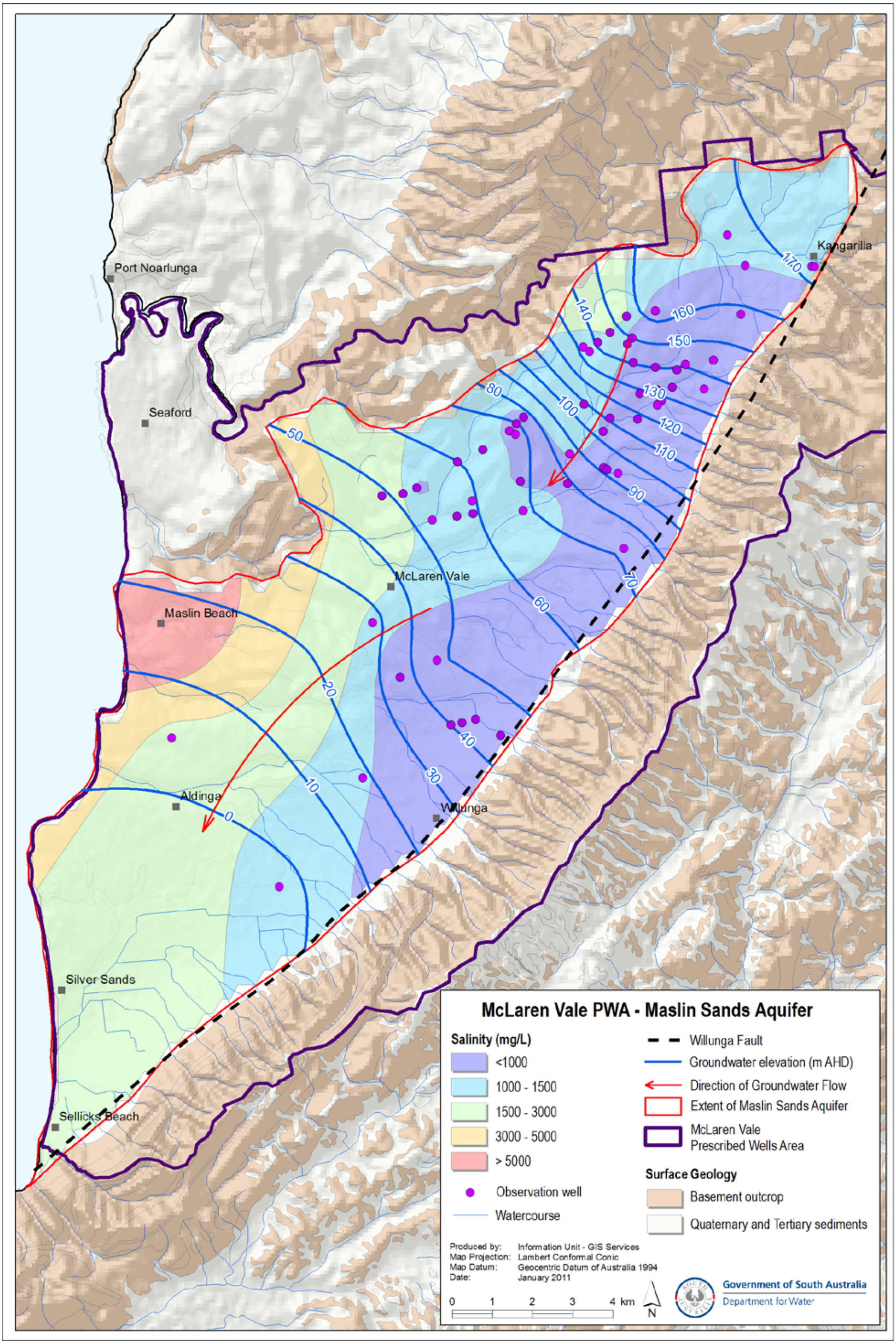

Figure 4. Groundwater flow direction and salinity distribution (2010) of the Maslin Sands Aquifer in the McLaren Vale PWA

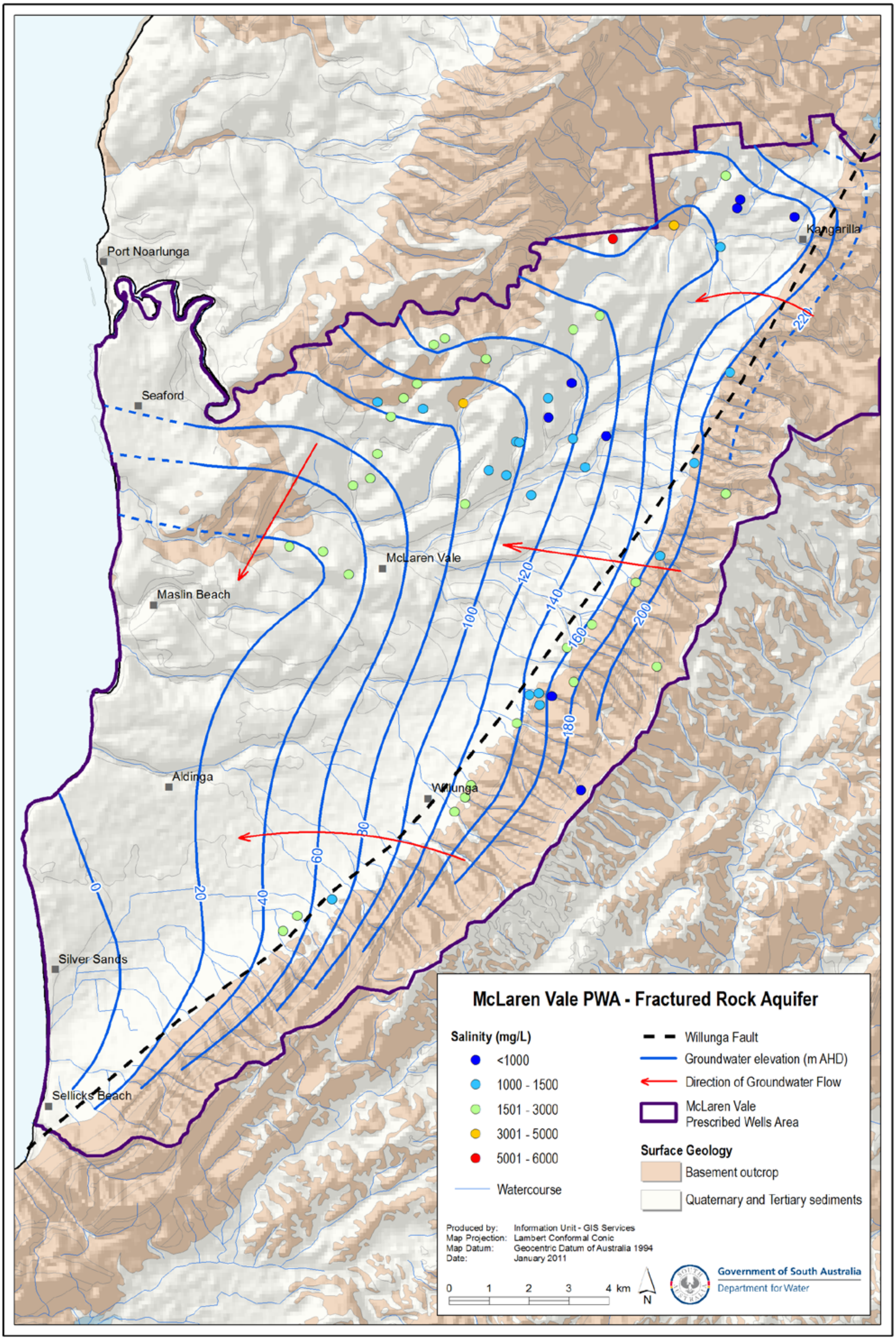

Figure 5. Groundwater flow direction and salinity distribution (2010) of the Fractured Rock Aquifer in the McLaren Vale PWA

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 McLaren Vale PWA. 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.

There are a number of permanent pools within the streams and creeks throughout the McLaren Vale PWA that are particularly concentrated along the Pedler Creek and a tributary of the Onkaparinga River (within the Baker's Gully subcatchment) in the northern part of the PWA. These permanent aquatic habitats are important refugia for aquatic biota. Although there are few specific biotic records for this region, it is anticipated that these habitats support aquatic plants, aquatic macroinvertebrates and fish. These permanent water habitats are expected to be maintained through groundwater baseflow contributions from either the Quaternary, Tertiary or Fractured Rock Aquifers.

There are also a number of wetland habitats within the McLaren Vale PWA, such as Blue Lagoon and the Washpool and groundwater dependent ecosystems such as Aldinga Scrub. These wetlands and the associated vegetation are thought to be supported by a combination of surface water and groundwater (possibly a perched Quaternary aquifer). These wetlands provide important habitat for birds and support a range of aquatic plants.

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 McLaren Vale region is characterised by hot, dry summers and cool to cold, wet winters. Rainfall data is presented for two Bureau of Meteorology stations, Willunga (station 23753) where the long term annual average rainfall is 648 mm, and Mt Bold Reservoir (station 23753) with a higher annual average of 766 mm (Figs. 6 & 7). 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.

Willunga has experienced an extended period of below average rainfall since 1975, with the exception of wet years in 1992–93, 2000 and 2006 (Fig. 6).

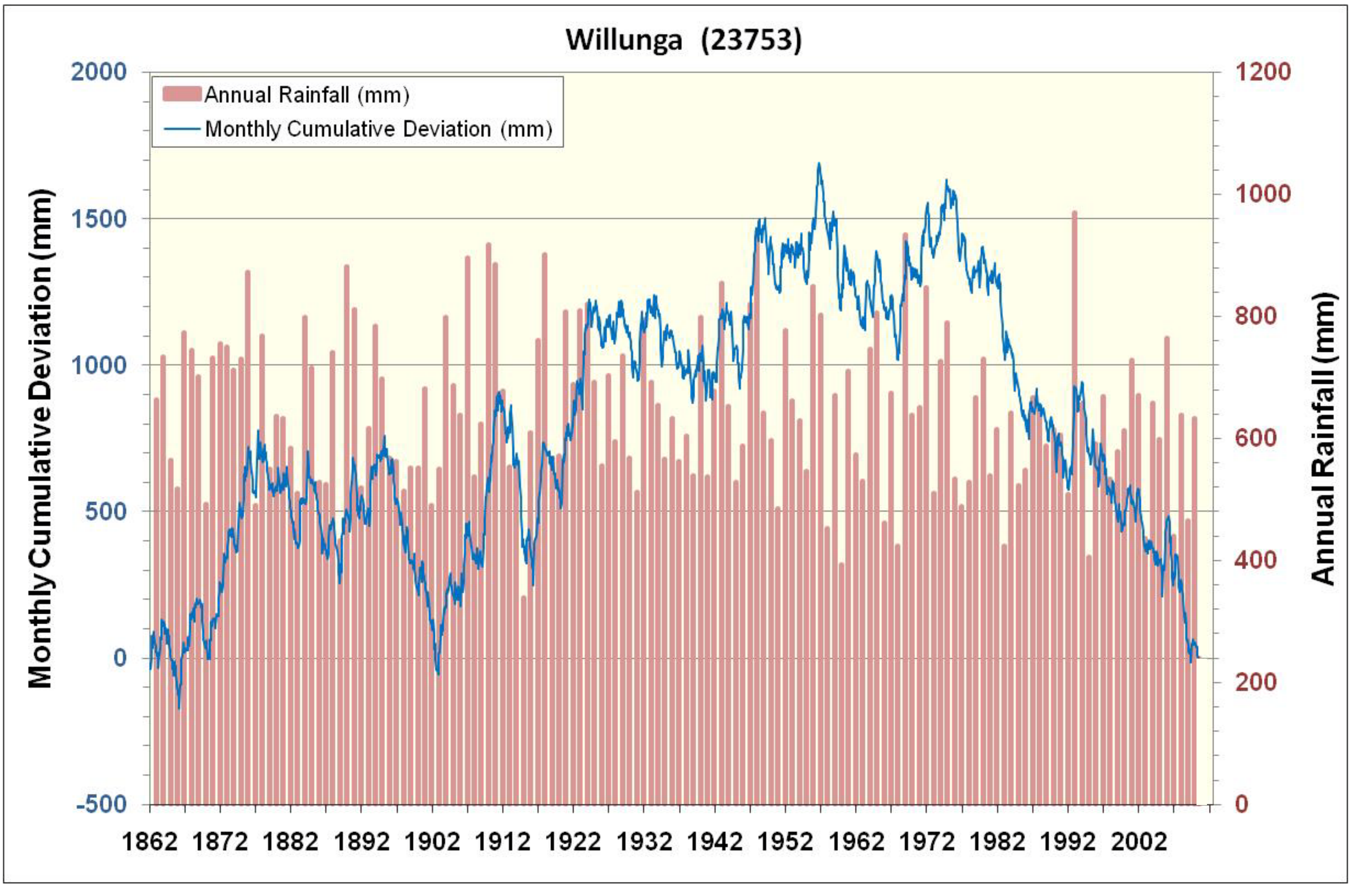

Figure 6. **Monthly rainfall and cumulative deviation from mean monthly rainfall at Willunga in the McLaren Vale PWA**

Mt Bold has a shorter rainfall record and experiences higher rainfall due to its higher elevation and topographic influence from the Mount Lofty Ranges (Fig. 7). The cumulative deviation from mean monthly rainfall also has a different trend to that at Willunga, with generally above-average rainfall from 1970 until 2006. This trend is likely to have a direct impact on unconfined aquifers which receive direct recharge from rainfall.

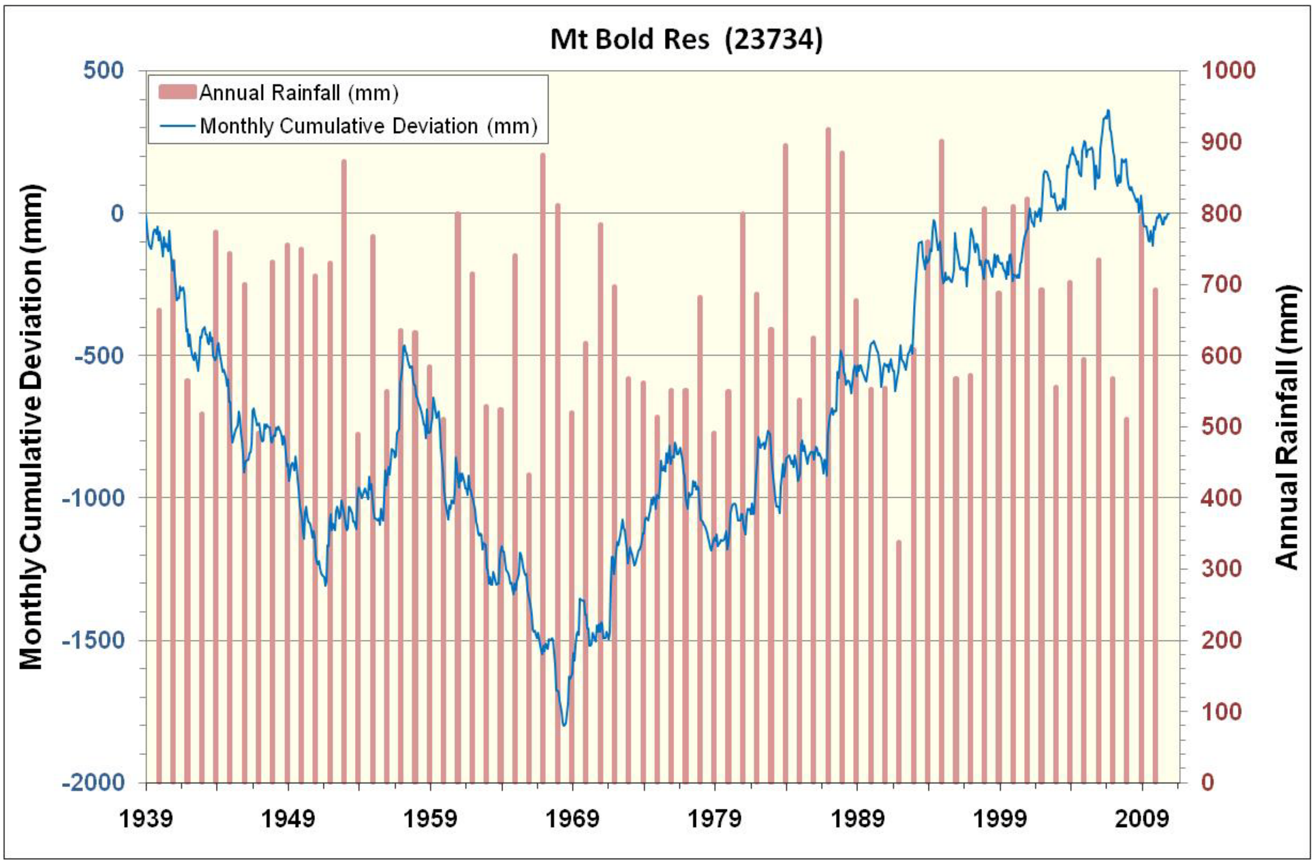

Figure 7. Monthly rainfall and cumulative deviation from mean monthly rainfall at Mount Bold in the McLaren Vale PWA

GROUNDWATER USE

Groundwater extractions (excluding stock and domestic use) in the McLaren Vale PWA for 2009–10 totalled 3990 ML, which represents a reduction of 20% from the previous year and is well below the extraction limit of 6600 ML (Fig. 8). This reduction is probably due to above-average rainfall. Most of the groundwater extractions (65%) occur from the Port Willunga Formation Aquifer (PWF), with 18% pumped from the Maslin Sands Aquifer (MSA) and 17% from the Fractured Rock Aquifer (FRA) whilst the remainder is extracted from the Quaternary and Blanche Point Formation aquifers (Fig. 9). Groundwater is used primarily for the irrigation of vines.

The spatial distribution of extractions from licensed wells within the McLaren Vale PWA is presented in Figure 10. The view is toward the east, 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.

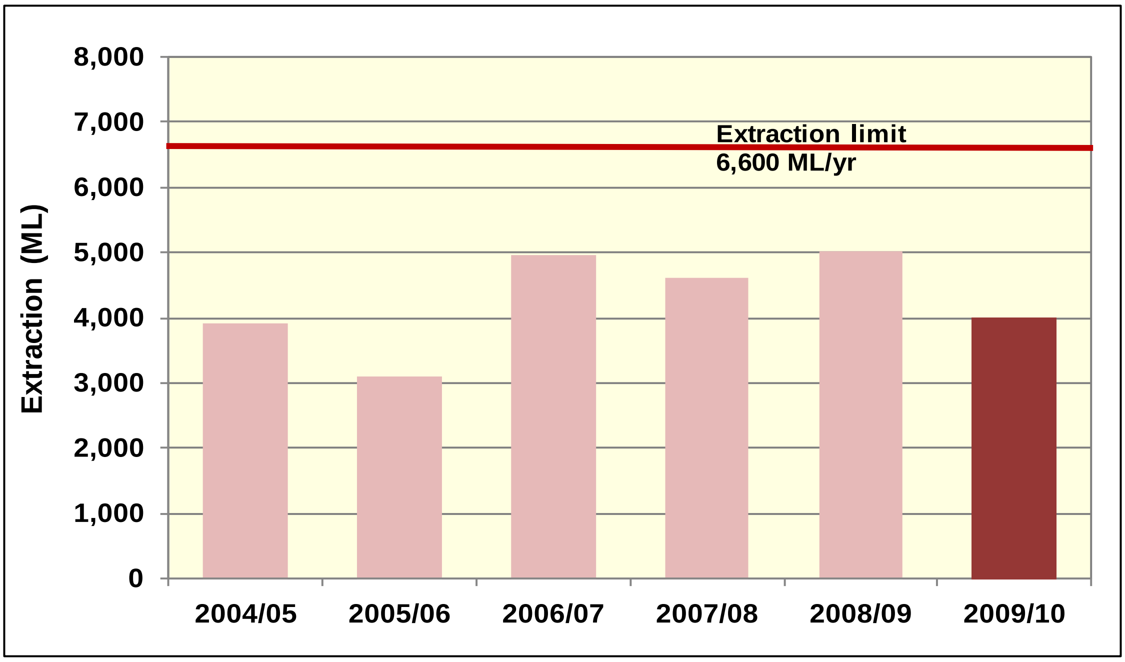

Figure 8. Historic licensed groundwater use in the McLaren Vale PWA

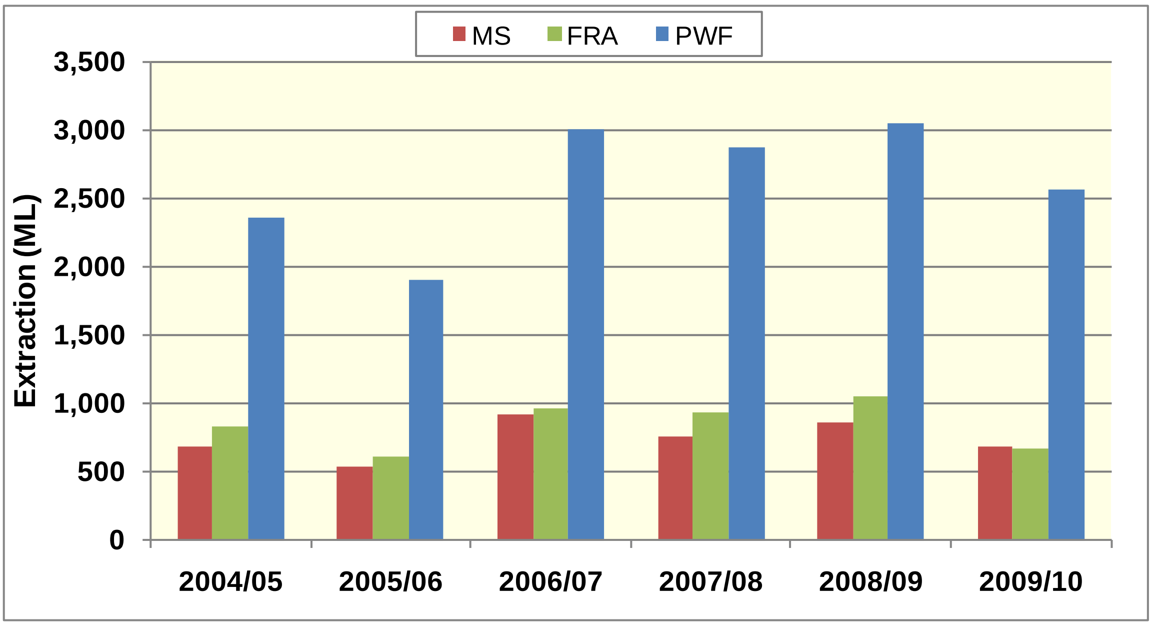

Figure 9. Historic licensed groundwater use by aquifer type for the McLaren Vale PWA

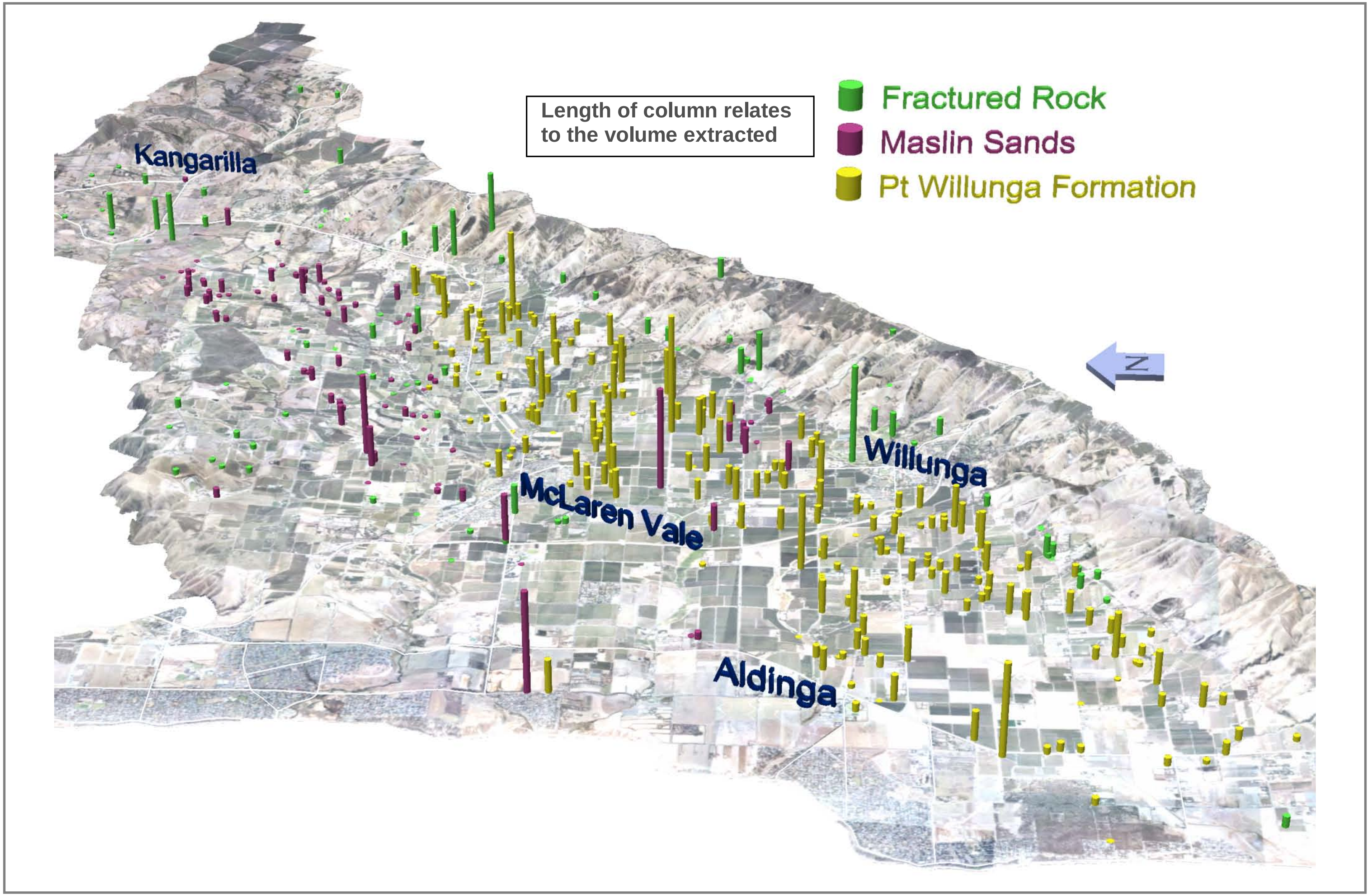

Figure 10. Spatial distribution of licensed groundwater extraction from each well during the 2009–10 irrigation season in the McLaren Vale PWA

GROUNDWATER OBSERVATION NETWORKS

The Willunga observation network was established within the McLaren Vale PWA in the 1970s in response to a marked increase in the use of groundwater for irrigation purposes at that time. Both groundwater levels and salinity are monitored.

WATER LEVEL NETWORK

Groundwater levels are monitored on a monthly basis at 122 wells (Fig. 11). Table 2 details the number of wells monitoring each aquifer.

Table 2. Groundwater level observation network

Aquifer	Number of wells
Quaternary	31
Port Willunga Formation	28
Blanche Point Formation	6
Maslin Sands	25
Fractured rock aquifer	32

SALINITY NETWORK

The groundwater salinity observation network for the McLaren Vale PWA contains a total of 64 observation wells monitored for salinity on an approximately annual basis (Table 3; Fig. 12). In addition to these long-term monitoring wells, samples from 350 irrigation wells have been tested since 2007.

Table 3. Groundwater salinity observation network

Aquifer	Number of wells
Quaternary	10
Port Willunga Formation	13
Blanche Point Formation	6
Maslin Sands	16
Fractured rock aquifer	19

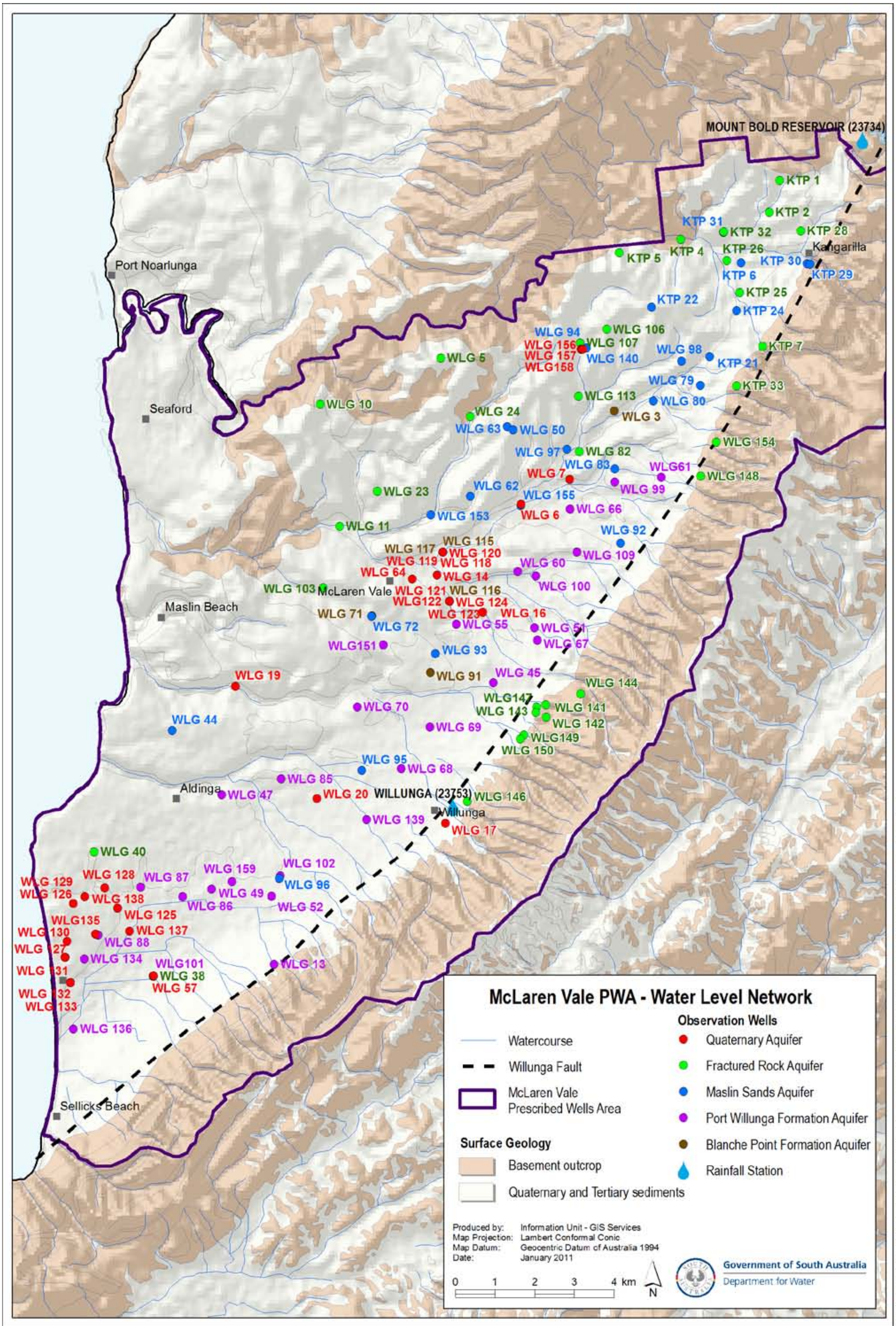

Figure 11. Location of groundwater level observation wells in the McLaren Vale PWA

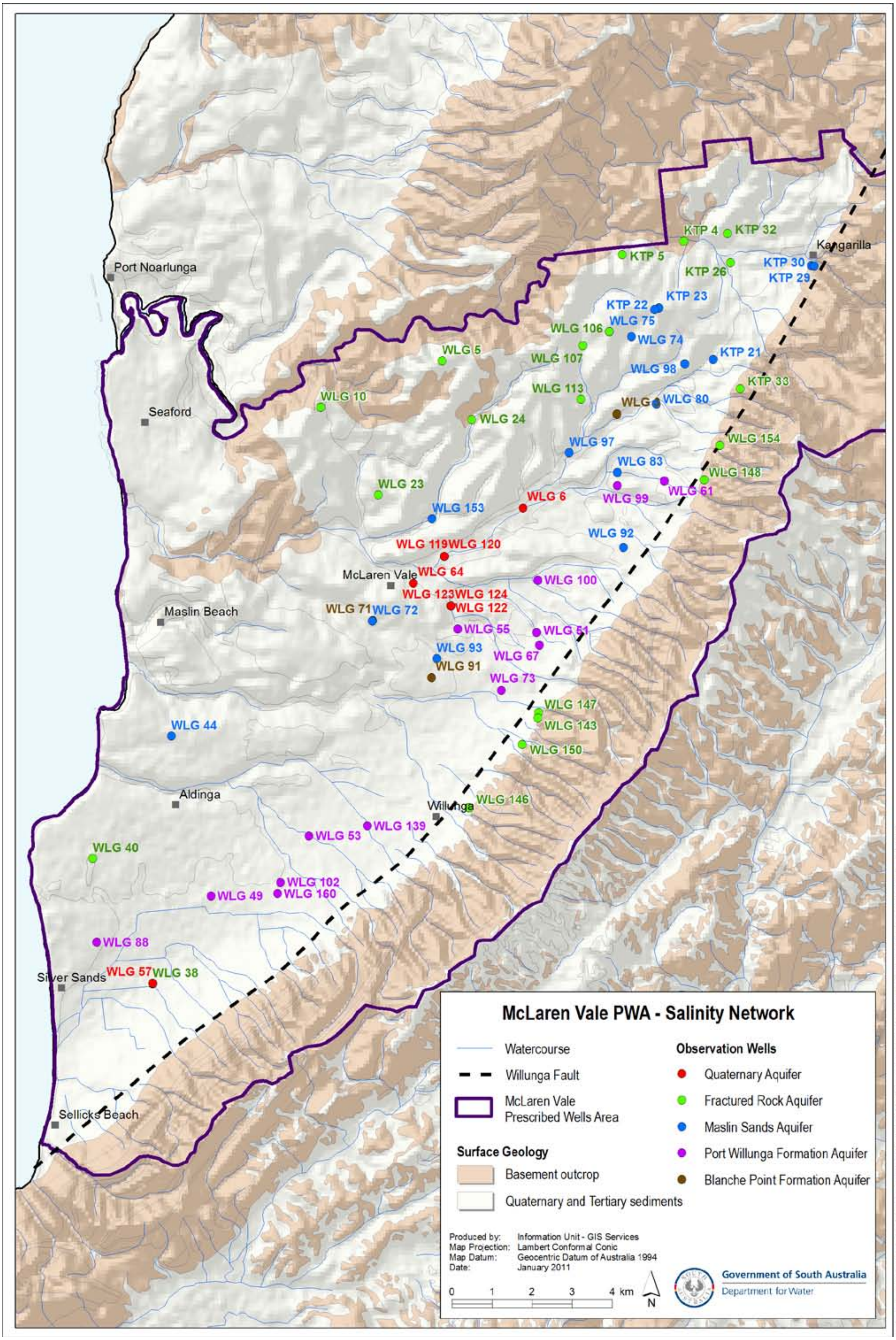

Figure 12. Location of groundwater salinity observation wells in the McLaren Vale PWA

GROUNDWATER LEVEL TRENDS

Trends in groundwater levels have been examined for the three major aquifers of the McLaren Vale PWA; the Port Willunga Formation Aquifer, the Maslin Sands Aquifer and the Fractured Rock Aquifer.

PORT WILLUNGA FORMATION

The Port Willunga Formation limestone aquifer provides most of the extractions in the McLaren Vale PWA. Hydrographs show a seasonal variation in groundwater levels due to pumping (Fig. 13; well WLG061 in green relates to the secondary axis on the right). Widespread declines of up to 5 m have been observed since 1993 at a long term average rate of 0.12 m/yr. Higher rainfall in 2000 and 2005 temporarily halted the decline but since the 2006 drought, the rate of decline is averaging 0.22 m/yr with most observation wells showing a continuing decline despite average rainfall during 2009–10.

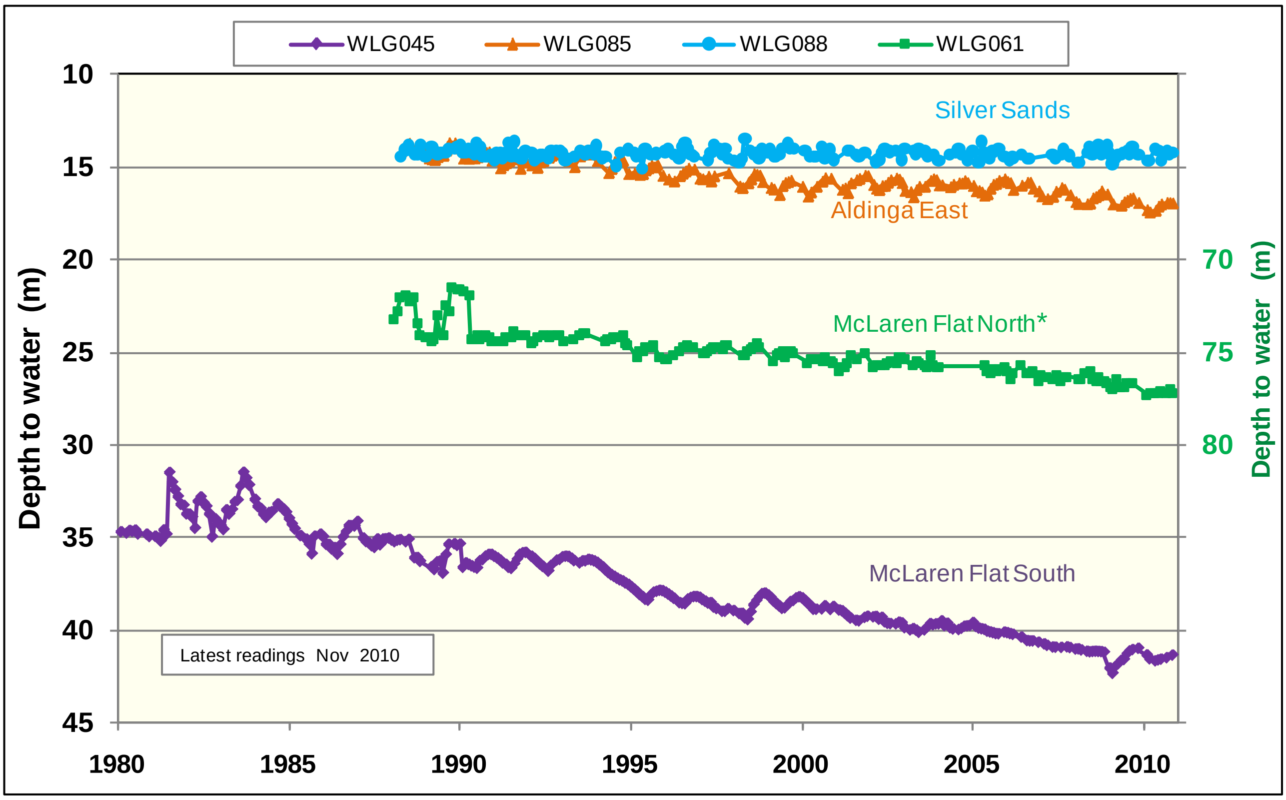

Figure 13. Groundwater level trends for the Port Willunga Formation Aquifer in the McLaren Vale PWA

*Depth to water (m) refers to secondary axis on the right hand side of the graph

Although the Port Willunga Formation is a confined aquifer, the observed groundwater levels largely follow the rainfall trends which show the close relationship between levels in WLG068 and the cumulative deviation from mean monthly rainfall recorded at Willunga (Fig. 14). Following the wet period in 1992–93, groundwater levels have reflected the long interval of below-average rainfall that has occurred since then.

An exception to this trend can be seen by well WLG088 which shows stable groundwater levels and is representative of other wells located toward the coast where the Port Willunga Formation aquifer discharges and where there is little pumping.

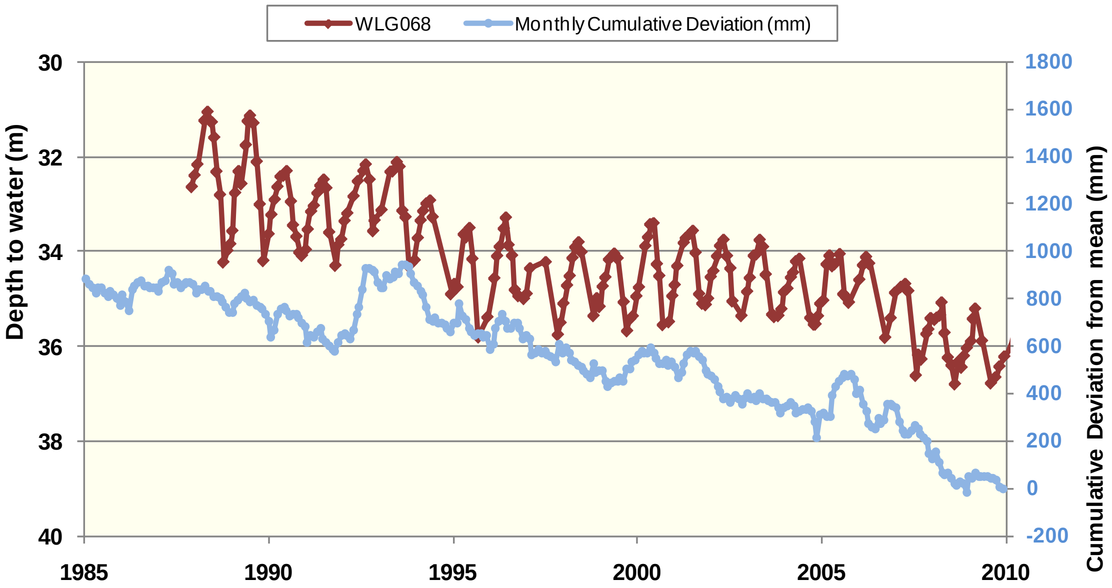

Figure 14. Comparison of rainfall deviation from the mean and groundwater level trends of the PWF Aquifer in the McLaren Vale PWA

MASLIN SANDS

Trends observed in the Maslin Sands unconfined aquifer, which occurs in the north-eastern part of the PWA in the Kangarilla area, are different to those observed in the confined Maslin Sands aquifer located further south. There is very little seasonal variation due to much lower extraction levels and groundwater levels have been relatively stable after 2000 (Fig. 15). There have been some declines of up to 1.5 m following the 2006 drought; however the wetter 2010 year has produced some recovery in groundwater levels. The Maslin Sands groundwater level response is different to that in the Port Willunga Formation aquifer because the Maslin Sands levels are responding to a different rainfall pattern, which is influenced by the topography of the Mount Lofty Ranges as shown in the rainfall data for Mt Bold station (Fig. 7). There is a close relationship between groundwater levels in KTP030 and the cumulative deviation from mean monthly rainfall recorded at Mt Bold (Fig. 16).

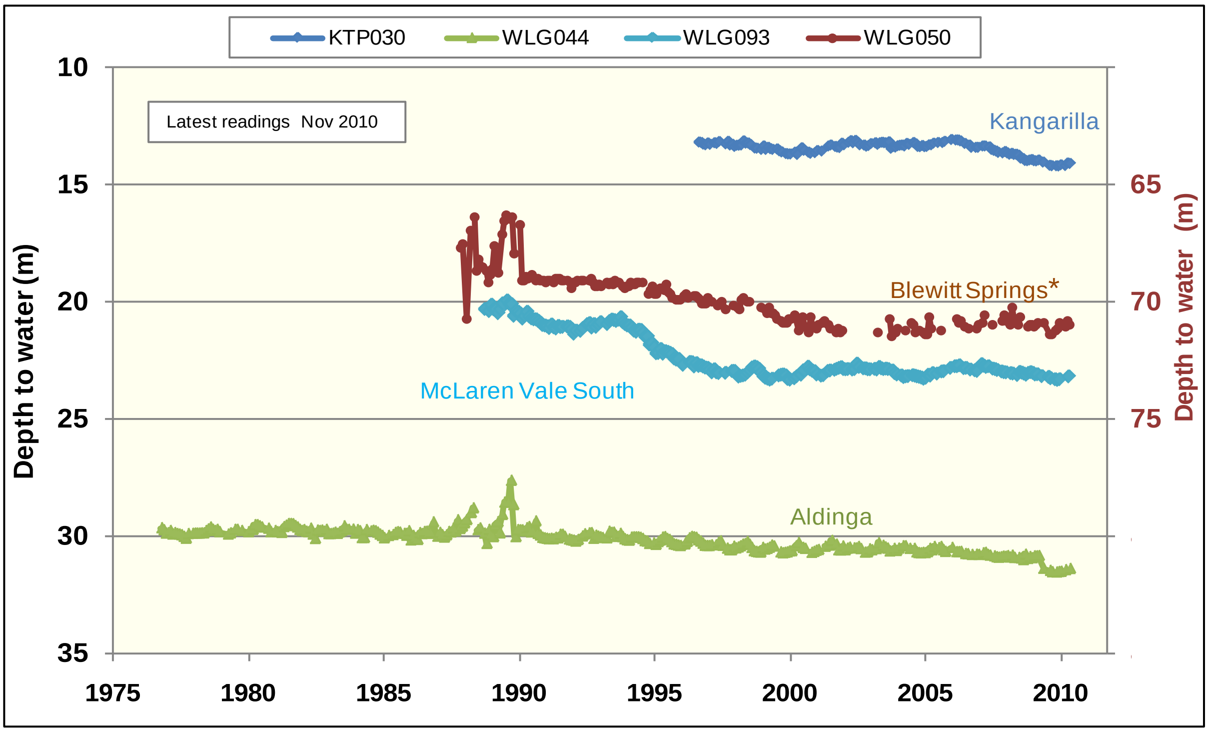

Figure 15. Groundwater level trends for the Maslin Sands Aquifer in the McLaren Vale PWA

*Depth to water (m) refers to secondary axis on the right hand side of the graph

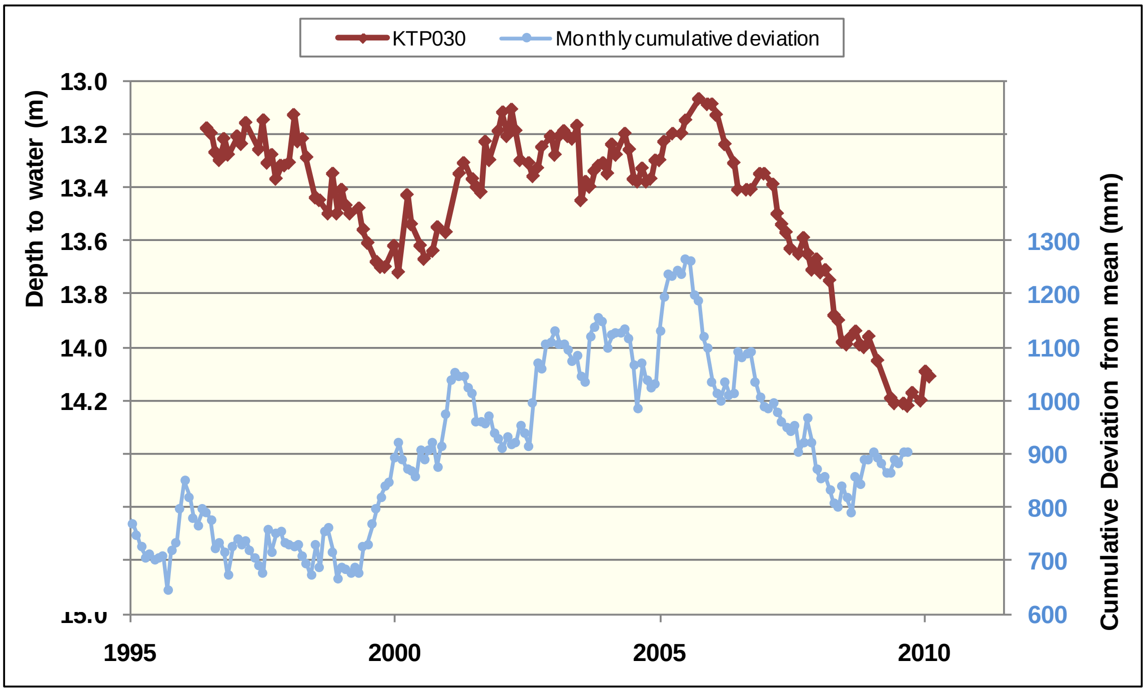

Figure 16. Comparison of rainfall deviation from the mean and groundwater level trends of the Maslin Sands Aquifer in the McLaren Vale PWA

FRACTURED ROCK

Trends in the Fractured Rock Aquifer tend to follow rainfall patterns, especially where the basement rock crops out and receives direct recharge from rainfall (Fig. 17). The low volume of extractions from the Fractured Rock Aquifer would not significantly affect the water level trends. Declines due to below-average rainfall after 2006 averaged just over a metre, with larger declines in lower rainfall areas along the northern boundary of the PWA. Recovery of groundwater levels due to higher rainfall during 2009–10 has been variable. Trends for the Onkaparinga River observation well WLG005 in green relate to the secondary axis on the right of Figure 17.

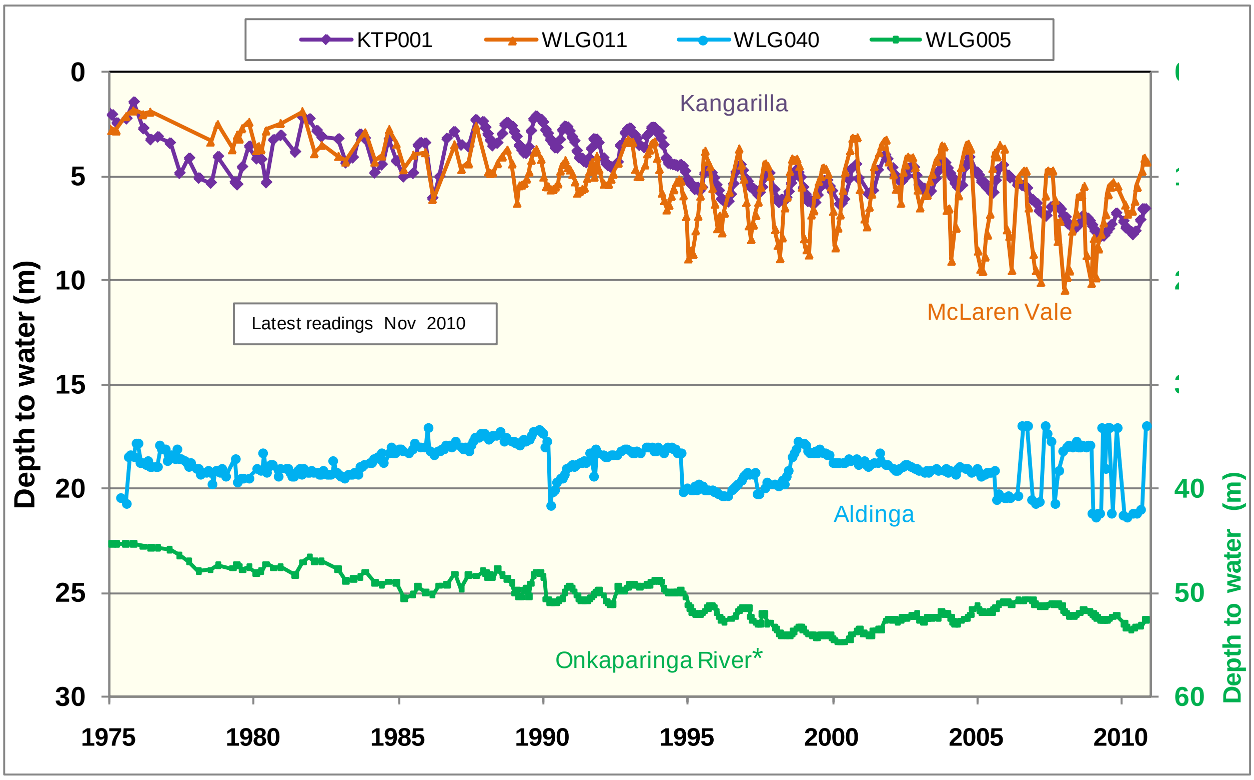

Figure 17. Groundwater levels trends of the Fractured Rock Aquifer in the McLaren Vale PWA

* Depth to water (m) refers to secondary axis on the right hand side of the graph

GROUNDWATER SALINITY TRENDS

Groundwater salinity trends have been analysed for the three major aquifers in the PWA. In all aquifers, there appears to be a broad correlation with rainfall patterns similar to that observed in water level trends. The decreasing trend in groundwater salinity from 1996 to 2006 coincides with above-average rainfall recorded at Mt Bold and rising groundwater levels, while the increasing salinity trend after 2006 is due to below-average rainfall and the resultant reduction in recharge which would normally freshen the groundwater resource. This rise in groundwater salinity could become critical in areas where 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 Willunga Basin Water Company reticulation scheme may reduce the impact of these rises in salinity.

PORT WILLUNGA FORMATION

Despite being a confined aquifer, the Port Willunga Formation follows the general groundwater salinity trends described above (Fig. 18), with rainfall trends shown in light blue. A total of 182 irrigation wells have been sampled since 2007. Of these, 139 wells (75%) have shown an increase in salinity since 2007 averaging 135 mg/L (or 13% of total dissolved solids (TDS)), with some increases exceeding 500 mg/L. Fortunately, about half of the wells that showed an increase have responded to the higher rainfall in 2009 and 2010 with rising trends stabilising or actually decreasing. However, 65 wells are continuing to show a rising trend averaging 48 mg/L/yr.

Long-term trends over a period greater than 20 years were analysed by examining groundwater salinity sample results taken at the time of drilling of irrigation wells. It is recognised that these samples may not always be considered representative. Of the 182 irrigation wells, 140 had such long-term data available. Of these, 77 wells (55%) showed current groundwater salinities that average about 300 mg/L higher than those recorded 20–25 years ago. Interestingly, 38 wells show a decrease in salinity over the long term.

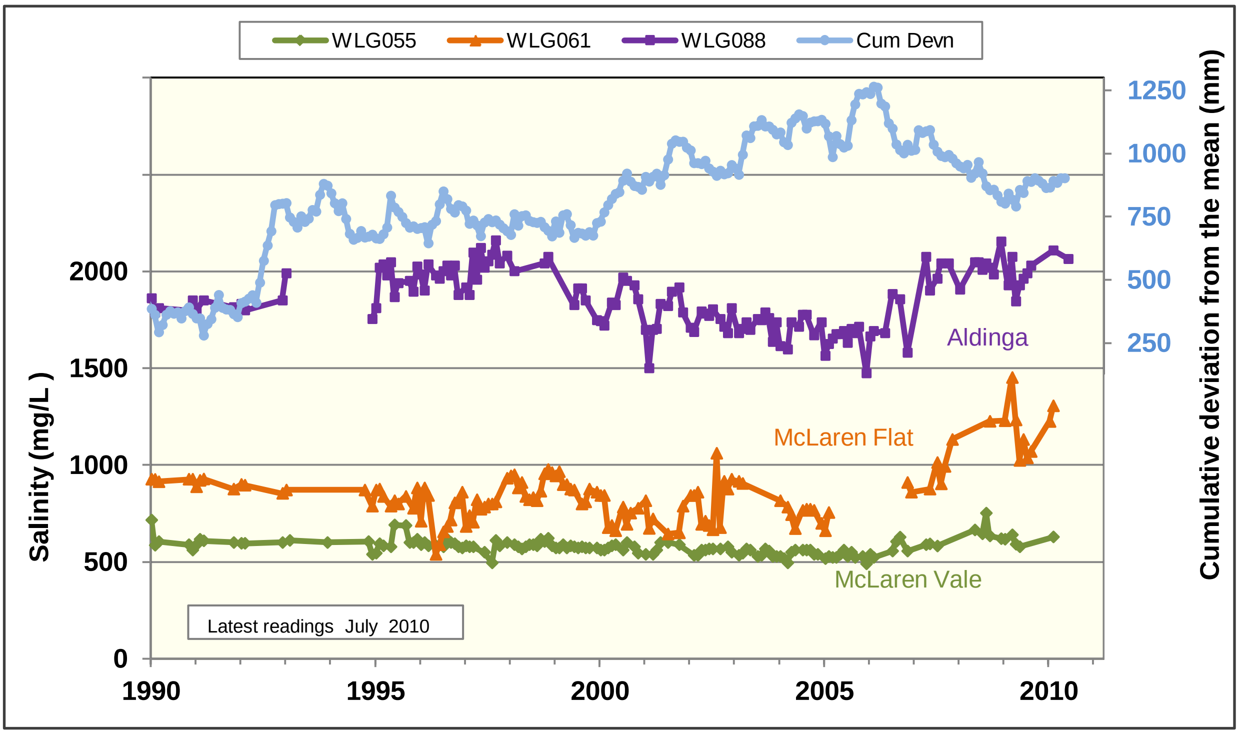

Figure 18. Groundwater salinity trends for the Port Willunga Formation Aquifer in the McLaren Vale PWA

Maslin Sands

Long-term groundwater salinity trends for the Maslin Sands correlate well with rainfall (Fig. 19). Since 2007, 57 irrigation wells completed in the Maslin Sands have been sampled for salinity. Of these, 43 wells (75%) have shown an increase in salinity, averaging 182 mg/L, in response to the dry period, which represents a 14% increase in salinity. Over half of these wells that displayed an increase have shown a recent decline in groundwater salinity due to higher rainfall during 2009–10, however 19 wells are still rising at an average rate of 46 mg/L/yr.

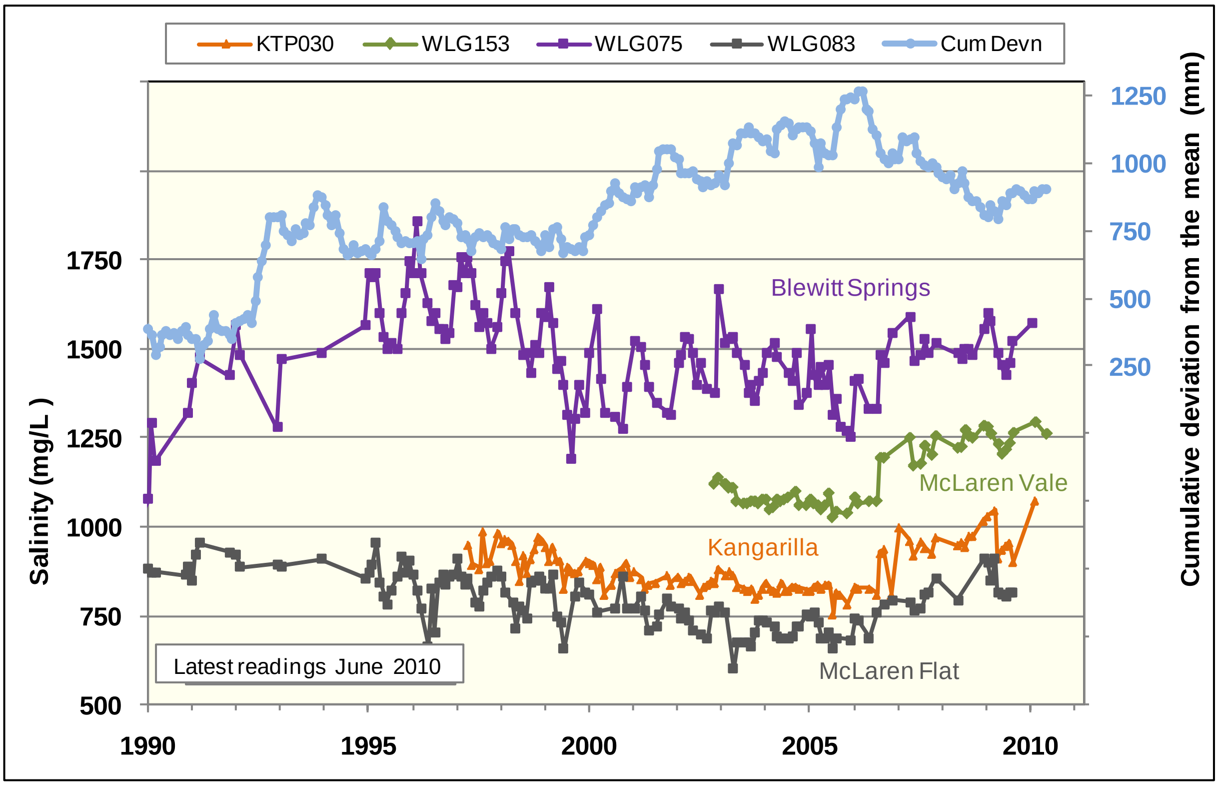

Figure 19. Groundwater salinity trends for the Maslin Sands Aquifer in the McLaren Vale PWA

FRACTURED ROCK

Figure 19 displays groundwater salinity trends from three irrigation wells which tend to follow rainfall trends as discussed earlier. Samples from 62 irrigation wells completed in the Fractured Rock Aquifer have been tested for salinity since 2007, with 44 of these (71%) showing an increase in salinity during the dry period following 2006. The average rise in groundwater salinity was 155 mg/L (a 12% increase in TDS), with several values over 300 mg/L. Fortunately, the majority of these wells are showing a response to the higher rainfall in 2009 and 2010 with rising trends stabilising or actually decreasing. However, 14 wells are showing a continuous rise in salinity, at an average rate of 63 mg/L/yr.

Despite the medium-term trends displayed in Figure 19, a comparison of recent salinity data with sample results taken at the time of drilling 20–25 years previously consistently shows a long-term increase in salinity in 30 of the 62 irrigation wells sampled, averaging a total increase of 350 mg/L. Only four wells with salinities at the time of drilling did not show an increase.

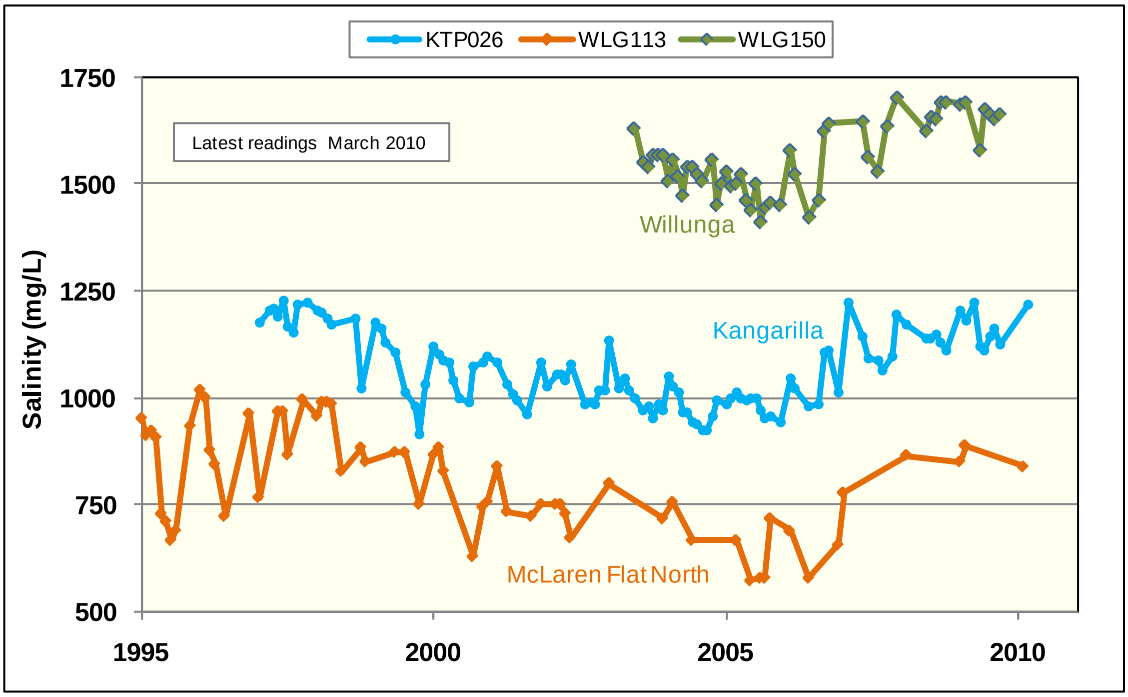

Figure 19. Groundwater salinity trends of the Fractured Rock Aquifer in the McLaren Vale PWA

WATER FOR GOOD