WATER ALLOCATION PLAN

McLaren Vale Prescribed Wells Area

2007

Government of South Australia
Adelaide and Mount Lofty Ranges
Natural Resources Management Board

Water Allocation Plan for the McLaren Vale Prescribed Wells Area

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Prepared by

Adelaide and Mount Lofty Ranges NRM Board

2007

Natural Resources Management Act 2004

Water Allocation Plan

for the

McLaren Vale Prescribed Wells Area

I, Gail Gago, Minister for Environment and Conservation, hereby adopt this Water Allocation Plan pursuant to section 80(3)(a) of the Natural Resources Management Act 2004

Hon Gail Gago MLC
Minister for Environment and Conservation

Date: 17/2/07

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1 THE McLAREN VALE PRESCRIBED WELLS AREA

1.1 Location

The location and boundaries of the McLaren Vale Prescribed Wells Area (McLaren Vale PWA) are shown in **Figure 1**. The McLaren Vale PWA covers an area of approximately 320 square kilometres, with the Onkaparinga River forming part of the northern boundary, while much of the south-eastern boundary follows the ridge of the Sellicks Range.

The McLaren Vale PWA comprises underground water resources contained within the sediments of the Willunga Embayment, the fractured basement rocks underlying the Willunga Embayment and the fractured basements rocks present east of the Willunga Fault.

1.2 Background to the water allocation plan

The McLaren Vale PWA was gazetted on 7 January 1999, under the provisions of the then operational *Water Resources Act 1997*. Pursuant to regulation changes under the Act, the gazettal amalgamated the areas known as the Willunga Basin Prescribed Wells Area and the Upper Willunga Catchment Moratorium Area to establish the McLaren Vale PWA.

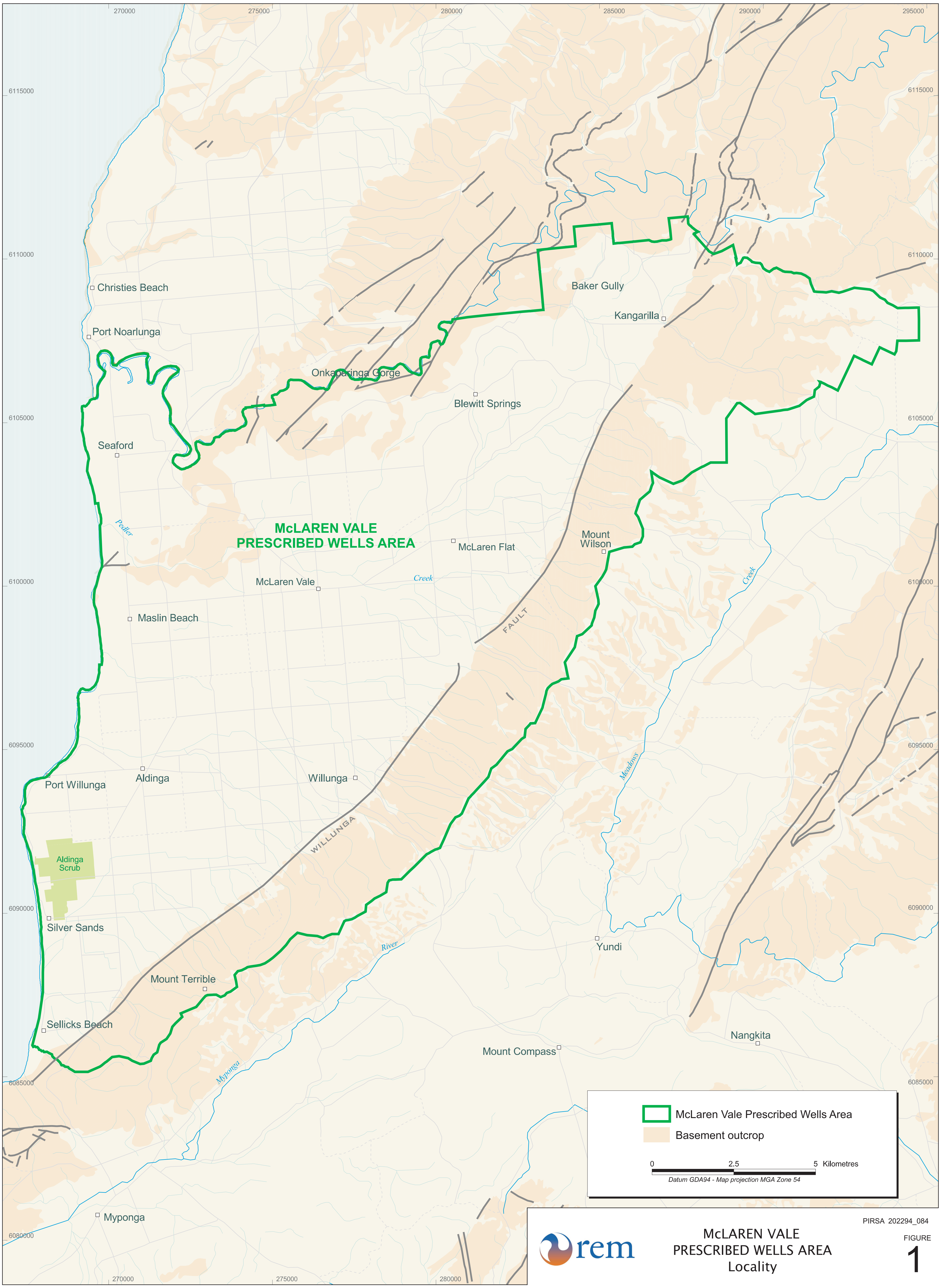
With the declaration of the McLaren Vale PWA under section 8 of the *Water Resources Act 1997*, it became a legal requirement for the then operational Onkaparinga Catchment Water Management Board (OCWMB) to prepare a water allocation plan (WAP) for this prescribed water resource.

The Adelaide and Mount Lofty Ranges Natural Resources Management Board (Board) was established in May 2005, and is now responsible for water allocation planning in the McLaren Vale PWA.

The relevant provisions of the *Water Resources Act 1997* have now been replaced by the *Natural Resources Management Act 2004*.

The Minister approved the first McLaren Vale PWA WAP in November 2000 and underground water licences were varied to allocate water in accordance with the WAP at the end of 2000. The aim of the WAP was to ensure that underground water levels and underground water salinity levels were maintained at the levels measured when the WAP was prepared and to ensure that the resource could be used sustainably.

The OCWMB completed a review of the existing plan in 2003, which considered the administrative performance of the WAP (that is, whether the policy was workable) and the impact of the WAP policy on the condition of the underground water resource. The availability of additional information (from studies and monitoring) was taken into account in the review.



Christies Beach
Port Noarlunga
Onkaparinga Gorge
Seaford
Pedler
Baker Gully
Kangarilla
Blewitt Springs
McLAREN VALE
PRESCRIBED WELLS AREA
McLaren Flat
Mount Wilson
McLaren Vale
Creek
Maslin Beach
FAULT
Creek
Port Willunga
Aldinga
Willunga
WILLUNGA
Meadows
Aldinga Scrub
Silver Sands
River
Yundi
Mount Terrible
Sellicks Beach
Nangkita
Mount Compass
Myponga
Myponga
270000
275000
280000
285000
290000
295000
6115000
6110000
6105000
6100000
6095000
6090000
6085000
6080000
McLaren Vale Prescribed Wells Area
Basement outcrop
0
2.5
5 Kilometres
Datum GDA94 - Map projection MGA Zone 54
rem
McLAREN VALE
PRESCRIBED WELLS AREA
Locality
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FIGURE
1

The OCWMB prepared a Proposal Statement, which was released for public consultation in 2004. Feedback on the proposal statement and outcomes from the review were taken into account when a revised set of selected WAP policies were developed.

This WAP has been prepared in accordance with the requirements of the *Water Resources Act 1997* to provide a basis for longer term, sustainable management of the underground water resources in the McLaren Vale PWA. Transitional provisions under the *Natural Resources Management 2004* validate the procedures and processes undertaken under the *Water Resources Act 1997* in preparing the WAP.

This water allocation plan replaces the water allocation plan approved by the Minister in November, 2000.

The McLaren Vale PWA falls within the Western Mount Lofty Ranges Prescribed Water Resources Area. The Adelaide and Mount Lofty Ranges Natural Resources Management Board is currently preparing a water allocation plan for the entire area. This water allocation plan will include policies for the McLaren Vale PWA and will replace this plan. The process for preparing the water allocation plan for the Western Mount Lofty Ranges will involve further consideration of the issues of climate change, which is not considered in this plan. It will also involve further consideration of the role of underground water in supporting ecological outcomes.

1.3 Underground water systems in the McLaren Vale PWA

Aquifer system

Underground water in the McLaren Vale PWA is contained within the four aquifers shown schematically in **Figure 2**. A summary of the main attributes of each aquifer is provided in **Figure 3**.

There is a complex multi-aquifer system within the McLaren Vale PWA divided into four main aquifer units, Quaternary, Port Willunga Formation, Maslin Sands and fractured basement rock (fractured rock).

The *Quaternary aquifer* is largely unconfined and forms the watertable aquifer in many areas. It occurs in areas with thick Quaternary cover, mainly south of Pedler Creek, and as smaller perched aquifers in gullies and along the edges of the basin. The Quaternary sediments generally comprise silts, clays and floodplain sediments, which can make it a low yielding aquifer. As a consequence, the Quaternary aquifer is generally not used to meet large scale irrigation demand.

The Quaternary aquifers play an important role in supporting underground water dependent ecosystems such as Aldinga Scrub and by providing baseflow to creeks and streams along the coastal margin.

The *Port Willunga Formation* aquifer is separated from the overlying Quaternary aquifer by the Ngaltinga Formation, which is described as a silty clay. The Port Willunga Formation aquifer is generally unconfined in the central and eastern half

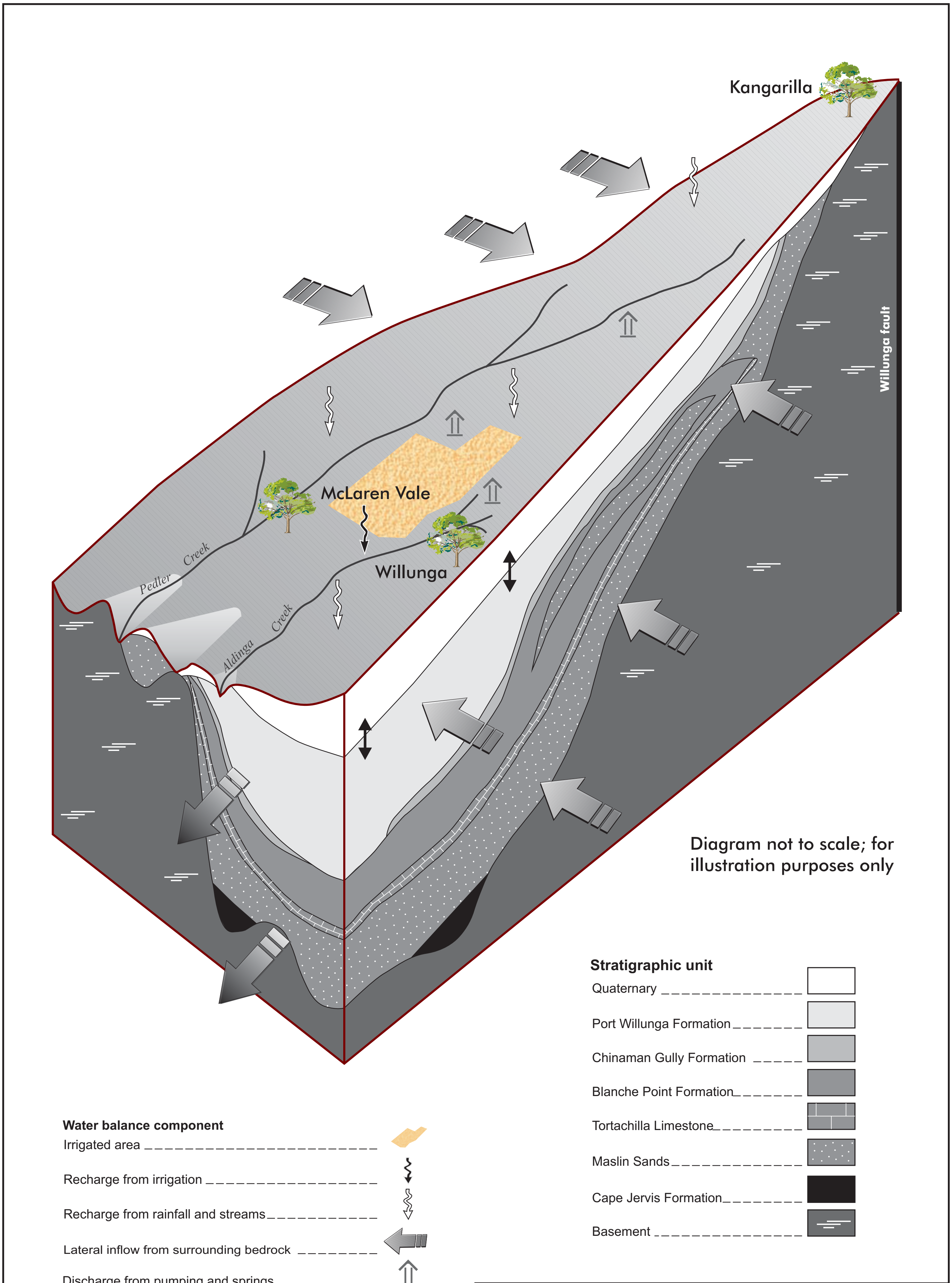

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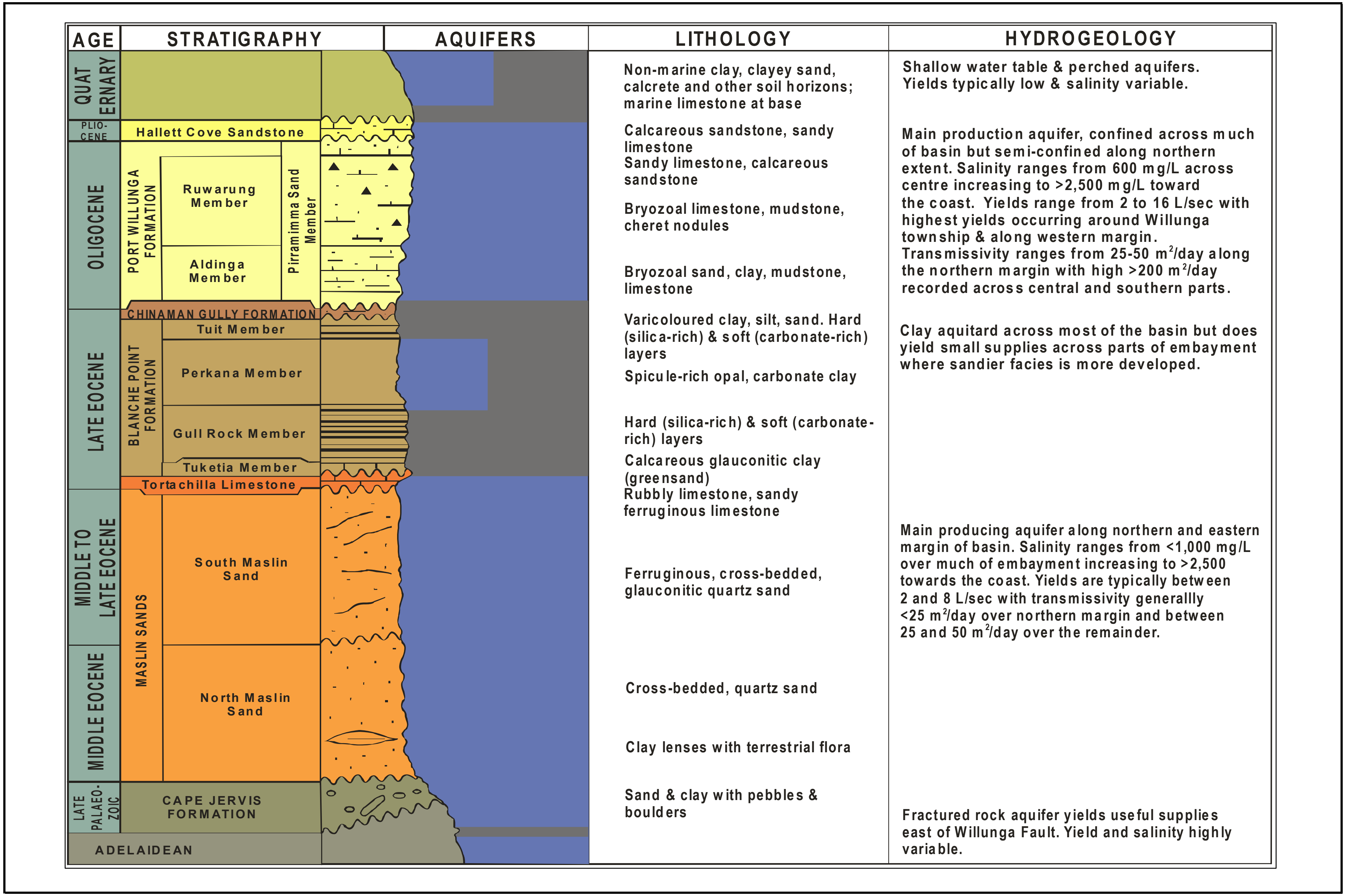
FIGURE 2

Underground water system



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Summary of the McLaren Vale PWA hydrogeology

Figure 3

of the basin (overlain by a thin layer of modern alluvium), but becomes confined by Quaternary sediments south of Pedler Creek and towards the coast. The Port Willunga Formation aquifer is most productive in the south-western part of the McLaren Vale PWA. The Port Willunga Formation aquifer provides a significant volume of underground water for licensed use.

The Blanche Point Formation sits below the Port Willunga Formation and yields some useful quantities of underground water in some parts of the basin. However, yields are lower and salinity is slightly higher than either the Port Willunga Formation or Maslin Sands aquifers.

The *Maslin Sands aquifer* is confined and underlies the Port Willunga Formation and the regionally extensive Blanche Point Clay and Chinaman Gully aquitards across much of the McLaren Vale PWA.

The Maslin Sands aquifer outcrops along the northern edge of the McLaren Vale PWA, where it is unconfined. It comprises fine to coarse sands and clays and is generally lower yielding than the Port Willunga Formation aquifer. South of Pedler Creek the Maslin Sands aquifer is confined by the Blanche Point Formation aquitard, which separates it from the Port Willunga Formation aquifer. The Maslin Sands aquifer can be reasonably productive but bore yields are generally lower than for bores completed within the Port Willunga Formation aquifer.

The *fractured rock aquifer* outcrops east of the Willunga Fault and at the northern extent of the McLaren Vale PWA along the Onkaparinga Gorge, where it forms the watertable aquifer. It underlies the sedimentary aquifers (described above) across the remainder of the McLaren Vale PWA. Underground water flow in this aquifer occurs mainly through fractures and fissures, which makes both salinity and yield highly variable. Spring discharge is known to occur from the fractured rock aquifer along the Sellicks Hill Range and within the Onkaparinga Gorge.

Recharge and discharge of underground water

Recharge to the Quaternary aquifer system/s results from infiltration of rainfall or infiltration through streambeds and banks during the winter months. Recharge to the Maslin Sands and Port Willunga Formation occurs via direct rainfall infiltration (over areas of outcrop or where the Quaternary cover is thin), recharge from streams and more importantly, lateral inflow from the surrounding fractured rock aquifer which in-turn is recharged by direct infiltration of rainfall (**Figure 2**).

Underground water level measurements suggest that underground water flows through the aquifer sediment (or fractures in the case of fractured rocks) from the north east toward the coast where it discharges to the ocean. Shallow underground water discharge can also occur as spring discharge or seepage to streams forming pools or low flow. Ecosystems near where underground water is discharged are defined as being “underground water dependent”.

Anecdotal reports of freshwater seeps occurring on the beach at low tide in the area between Port Willunga and Sellicks Beach townships are numerous. In the Sellicks Beach area these seeps (discharge) most likely originate from the perched Quaternary aquifer/s. The Port Willunga Formation and Maslin Sands aquifers occur at depths of approximately 40 and 200 metres below ground surface along this coastal reach and continue to dip to depths of greater than 100 metres and 400 metres respectively beneath the Gulf St Vincent. However, near the township of Port Willunga the seeps along the beach may originate from the Maslin Sands aquifer as the sediments of the Port Willunga Formation are exposed in the cliffs and the Maslin Sands outcrop north of Blanche Point.

Discharge of underground water also occurs through extraction principally from the Port Willunga Formation and Maslin Sands aquifers. More recently, an increasing number of wells have been targeting the fractured rock aquifer to provide useful supplies of underground water, particularly to the east of the Willunga Fault.

Salinity of underground water

Salinity of underground water in the Quaternary aquifer is variable but generally below 1,500 mg/L, increasing towards the coast.

In the Port Willunga Formation aquifer underground water salinity varies between approximately 350 mg/L to greater than 2,500 mg/L near McLaren Vale and McLaren Flat.

Underground water salinity in the Maslin Sands aquifer varies from less than 500 mg/L to more than 50,000 mg/L at the coast. Salinity of underground water in the fractured rock varies between 1,000 and 2,000 mg/L over much of the basin. Along the margins of the basin, there are some isolated parts within the fractured rock aquifer where salinity exceeds 2,000 mg/L.

Well yields

Well yields from the Port Willunga Formation aquifer typically lie in the range of 2 to 16 litres per second (L/s). Yields are generally lower from within the Maslin Sands aquifer ranging between 2 and 8 L/s. Well yields of up to 20 L/s from the fractured rocks have been recorded near McLaren Vale.

1.4 Nature and volume of underground water extraction

Underground water is taken in varying amounts from four main aquifers associated with:

- Quaternary sediments;
- Port Willunga Formation;
- Maslin Sands; and
- Fractured rock.

There are approximately 430 licensed water users within the McLaren Vale PWA. Licensed underground water is used for a variety of activities including irrigation, recreational, commercial and industrial uses.

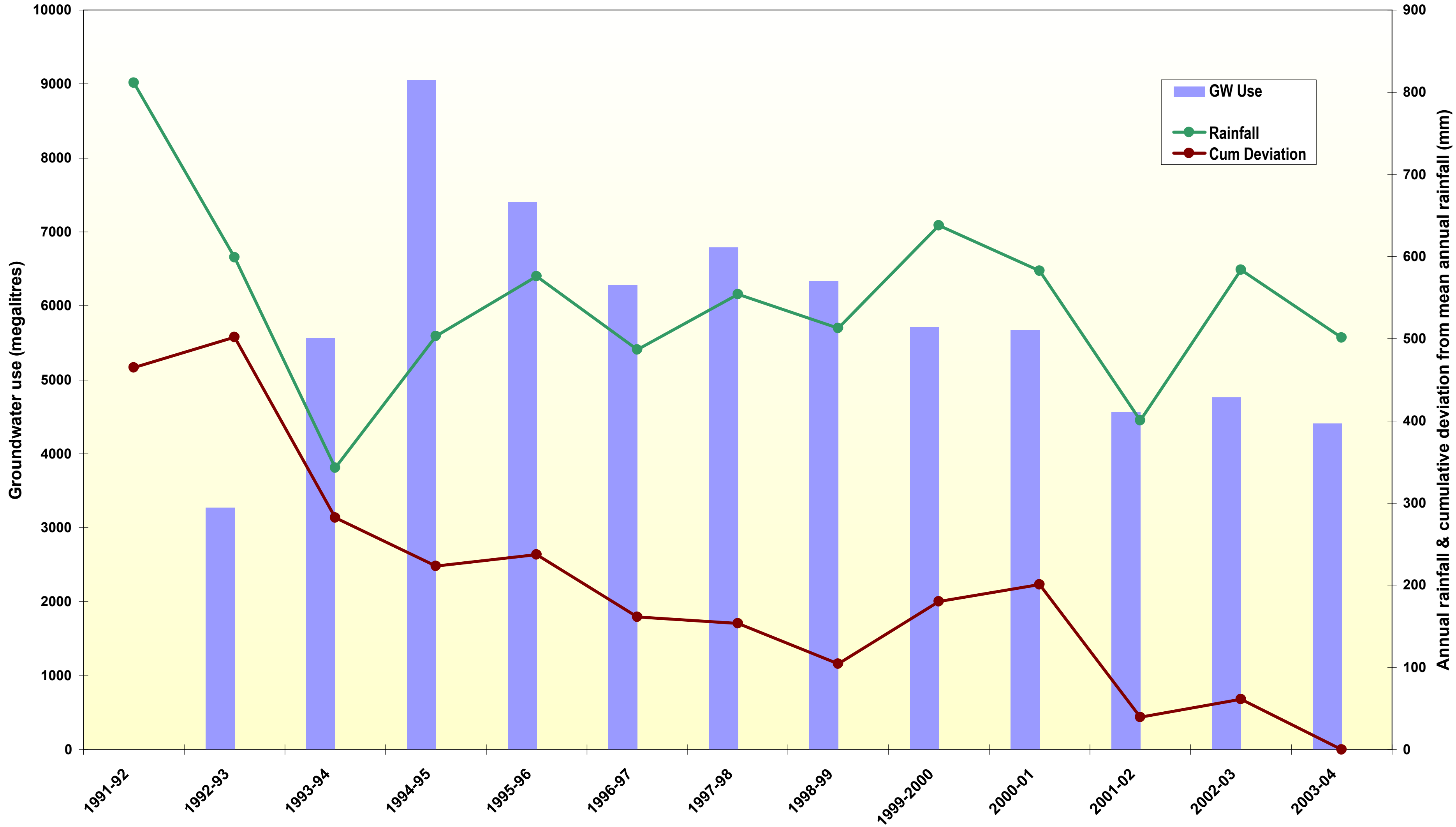
The annual volume of licensed underground water extraction since metering began in 1992/93 is provided in **Figure 4** with a plot of the cumulative deviation of annual rainfall from the average rainfall for the Bureau of Meteorology McLaren Vale rainfall station. This figure shows that underground water use has declined from 5,700 ML in 2000/01 (the first season the McLaren Vale PWA WAP has been used) to 4,412 ML in 2003/04.

The Port Willunga Formation and Maslin Sands aquifers supply most water for irrigation. For the period 2000/01 to 2003/04, it was estimated that around 64% of metered underground water extraction occurred from the Port Willunga Formation, 20% from the Maslin Sands and 16% from fractured rock. Less than 1% of metered water was extracted from the Quaternary sediments.

The volume of underground water extracted in 2003/04 was 67% of the volume allocated.

Underground water is also used for stock and/or domestic use. There are approximately 600 bores identified as being used for stock and/or domestic purposes, with most located in the upper part of the McLaren Vale PWA where mains water is unavailable.

Stock and domestic water use is not licensed and therefore generally not metered. It is estimated that on average, stock and/or domestic bores use around 0.85 megalitres per year (ML/yr) , which equates to around 500 ML/yr of underground water (for all stock and/or domestic bores) taken from the entire McLaren Vale PWA.



Source Data:
Metered Groundwater Use - DWLBC
Rainfall Data - Bureau of Meterology McLaren Vale Rainfall Station 023876

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McLaren Vale Prescribed Wells Area - Metered groundwater use and annual rainfall

FIGURE
4

PROJECT AW-001-10

Date: August-05

2 ASSESSMENT OF NEEDS OF UNDERGROUND WATER DEPENDENT ECOSYSTEMS

2.1 Ecosystems dependent upon underground water in the McLaren Vale PWA

The requirements of ecosystems that depend on underground water must be assessed as required by section 76(4)(a)(i) of the *Natural Resources Management Act 2004*. Ecosystem requirements include both the local influence of underground water within an ecosystem and the influence on receiving environments downstream.

The following four types of underground water dependent ecosystems are relevant to the McLaren Vale PWA:

- **Phreaphytic vegetation** is vegetation that exists only because its roots can access underground water. Underground water sustains deep-rooted phreaphytic plants in an otherwise dry environment. An example is the river Red Gums found on the flats and dry creek beds in the McLaren Vale PWA which are supported by the shallow Quaternary aquifer.

- The discharge of underground water to the surface (or near surface) can support **wetlands** by creating a damp, saturated or flooded soil environment. Surface runoff also contributes to the water in wetlands, but underground water influences the timing, duration and extent of wet conditions during dry periods. Wetlands support particular plants, and animals such as frogs, invertebrates and water birds. Wetlands are found throughout the McLaren Vale PWA.

- **Watercourses** are dependent on underground water where this discharge contributes to flow or water quality. In the McLaren Vale PWA, underground discharge typically varies seasonally as underground water levels rise in response to winter rainfall recharge, so that underground water prolongs flow in late spring and summer and increases stream salinity at this time. The increase in salinity is a natural process that occurs because there is a greater proportion of salty underground water flowing within the watercourse. These types of underground water dependent ecosystems are also known as baseflow systems.

- The **marine environment** receives a significant quantity of underground water from aquifer discharge and through baseflow discharging to watercourses which then flow to the ocean. The influx of freshwater will affect the marine habitat along the coast and may support particular species or communities. However, there is no data available to describe such an interaction.

Detailed information on these systems in the area is limited. The information that is available points to three principal underground water environments that directly support ecosystems:

- seeps and springs from the fractured rock aquifer;
- the shallow aquifer in the Blewitt Springs / Kangarilla area; and
- the shallow aquifer on the Willunga Basin plain.

These areas have been identified from underground water depth data, remnant vegetation mapping, historical records and consultation with local naturalists.

A number of “priority” underground water dependent ecosystems have been identified based on their conservation significance. The location of these ecosystems is shown in **Figure 5**.

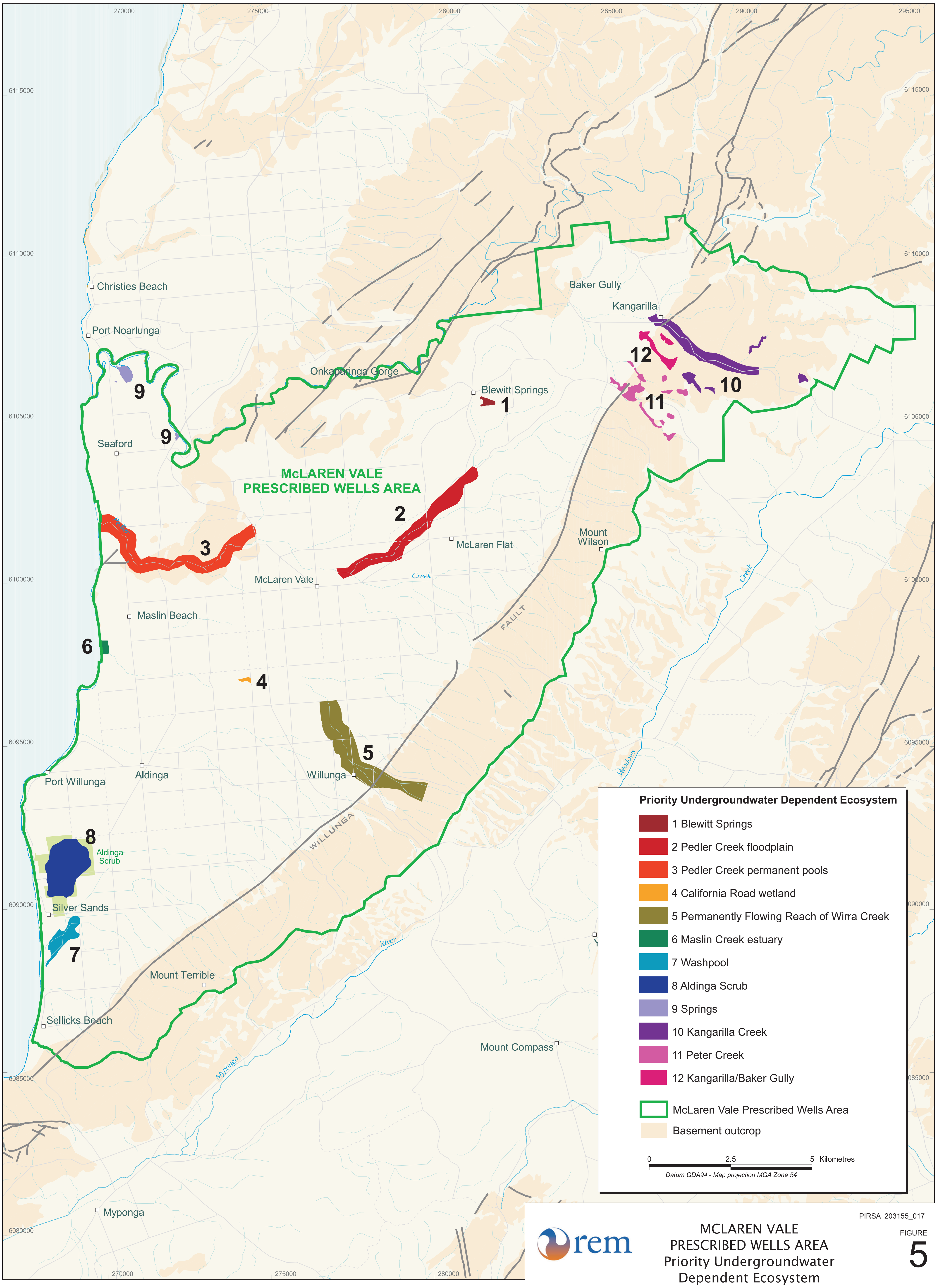
2.1.1 Fractured rock aquifer

Underground water in the fractured rock aquifer discharges to slopes and drainage lines where saturated fractures within this formation outcrops. The outcrops in the McLaren Vale PWA are the Sellicks Hill Range and the southern bank of the Onkaparinga Gorge. Pedler Creek flows through an outcrop of this formation between the Victor Harbor Rd and Main South Rd. The aquifer is fed by rainfall in the local vicinity.

Underground water discharge to the surface occurs at isolated sites creating perennially or seasonally waterlogged conditions. These sites may occur on hill slopes but more commonly in drainage lines. Discharge prolongs the duration of boggy soils following seasonal rainfall in Winter and Spring and may create perennially waterlogged conditions.

The native vegetation of the Sellicks Hill Range and other basement rock outcrops has been modified extensively such that there are few underground water dependent wetlands remaining. One site occurs near the crest of the Sellicks Hill Range on the North-Western slope in the vicinity of the intersection of Cowper Road and Range Road. In this area underground water discharges to the hill slope near a watercourse and in the stream bed supporting wetland plant species including *Typha* sp., *Juncus* spp., *Phragmites australis* and *Eucalyptus camaldulensis*. Seeps in drainage lines on the southern bank of the Onkaparinga Gorge near Chapel Hill support local patches of *Eucalyptus camaldulensis* and *Leptospermum lanigerum* and reed beds of *Cyperus gymnocaulos.*

Underground water discharge to watercourses contributes to the duration and frequency of flow and the salinity of surface water. Underground water discharge may affect stream flow either by maintaining a wet stream bed (and reducing seepage) or making a significant direct contribution to stream flow. A survey of 22 watercourses draining the north-western slopes of the Sellicks Hill Range found that underground water contributed to all watercourses, with underground water representing up to 90% of flow in March 2004. The high salinity reported in many of these watercourses reflected the contribution of underground water. The lowest



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MCLAREN VALE
PRESCRIBED WELLS AREA
Priority Undergroundwater
Dependent Ecosystem

FIGURE
5

salinity reported in any watercourse in Spring ranged from 240 mg/L to 1,230 mg/L and reached 1,686 mg/L in one creek in Autumn. The condition of most watercourses is poor, with most native vegetation removed and weed infestations common. However, the streams provide temporary aquatic habitat for frogs and macroinvertebrates and maintain limited remnant riparian vegetation including *Eucalyptus camaldulensis* and *Cyperus gymnocaulos*.

Underground water discharge maintains perennial flow in Wirra Creek in Willunga. Flow commences in the Sellicks Hill Range approximately 1.5 km south-east of Willunga and normally continues for a further 3 km. Based on observations in May 2005, which was at the end of the driest Autumn on record in Adelaide, the minimum flow at the old Willunga Courthouse is believed to be about 3 L/s, all of which is likely to be generated by underground water discharge. This watercourse represents a refuge for drought intolerant fauna, such as the native fish *Galaxias olidus* and *Galaxias brevipinnis* which have not been reported at the site, but potentially occur. It also supports dense reed beds in places. However, most of this reach has been cleared of native vegetation. Scattered mature *Eucalyptus camaldulensis* are present, but the understorey is generally dominated by *Pennisetum clandestinum* and other weeds such as *Zantedeschia aethiopica*.

In many areas, particularly watercourses, underground water is likely to contribute to the water requirements of vegetation with deep roots, particularly *Eucalyptus camaldulensis*. These trees are likely to access underground water in cracks and fissures in the fractured rock aquifer.

Seeps have often been selected as sites for farm dams, where underground water discharge maintains dam levels throughout the year. Generally, native vegetation has been cleared and the impact of stock trampling and grazing has increased as a result of dam construction.

Seeps may be vulnerable to underground water abstraction in the immediate vicinity. Discharge from a spring near Edwards Road, East of Willunga, is reported to have ceased following an increase in pumping from the fractured rock aquifer in the vicinity. However, the hydrogeology of fractured rock aquifers can be unpredictable, and a bore adjacent to a discharge point may not necessarily divert underground water from the seep. The effects of underground water extraction on the Sellicks Range springs can only be interpreted on a case by case basis.

2.1.2 Blewitt Springs district

The geological strata in which the Port Willunga Formation and Maslin Sands aquifers occur are either close to the surface or outcrop in the Blewitt Springs district. This district is bounded to the north-east and north-west by the outcropping basement and to the south by the overlapping Quaternary sediments.

An assessment of underground water for this district and an assessment of the floristic vegetation mapping indicates that the depth to underground water is less than 10 metres in a number of substantial and well preserved vegetation remnants. Consequently, the underground water table occurs close to the surface near a number of significant ecosystems. Vegetation in these remnants is likely to be dependent on underground water and may be vulnerable to a reduction in the underground water level.

Perennial underground water discharge contributes to the water requirements of wetland vegetation at the Blewitt Springs Reserve. This is a council reserve containing remnant wetland vegetation, including *Leptospermum lanigerum*, *Baumea juncea, Juncus* spp., *Eucalytpus camaldulensis, Eleocharis acuta* and *Isolepis nodosa*. Observation bores near the base of the drainage line reported underground water within 0.7 metres of the surface in May 2004. Higher levels would be expected in winter and spring, and perennial discharge occurs, creating boggy conditions, on the eastern slope of the reserve near Brunato Rd. There is a clear relationship between vegetation and underground water depth at this site, with wetland plant species present in areas where underground water was less than 2 metres deep in Autumn and terrestrial plant species (such as *Xanthorrhea semiplana, Banksia marginata* and *Exocarpos cupressiformis*) present where underground water was deeper than 2 m.

Similar vegetation associations in valley floors have been reported elsewhere in this district including the corner of Blythmans and Bell Roads, Jackson Rd and Douglas Gully Guides SA Camp-site.

The requirements of these ecosystems for underground water are threatened by pumping from the Maslin Sands aquifer. The provision of underground water to these ecosystems is also affected by actions that affect the flow of surface water, which is strongly influenced by underground water discharge. These actions include the construction of dams and use of water from dams and the construction of drains through swampy valley floors.

2.1.3 Willunga Basin Plain

The Quaternary sediments of the Willunga Basin Plain lie at the surface in the low lying plain north-west of the Willunga Fault. These sediments form a shallow, unconfined aquifer, which is fed from surface water runoff or rainfall in the immediate area. Surface water runoff may be supplemented by underground water discharge from aquifers higher in the catchment: the fractured rock aquifer, Maslin Sands aquifer and Port Willunga formation aquifer. There may also be some movement of underground water from the lower lying Port Willunga Formation and Maslin Sands aquifers into the Quaternary sediments.

Shallow underground water occurs on the floor of Maslin Creek for a distance of approximately 3.5 km from just upstream of Pethick Rd to Branson Rd. The valley floor supports *Phragmites australis,* which extends in beds up to 200 metres wide. Perennial growth in *P. australis* is interpreted to result from having access to shallow underground water, which is likely to discharge to the surface in Winter and Spring. Underground water discharges to the surface throughout the year at California Road where a remnant *Leptospermum lanigerum* shrubland occurs together with a number of wetland plants of regional and state conservation significance. This site includes a permanent pool, which potentially supports drought intolerant fauna such as native fish.

Shallow underground water in Quaternary sediments near McLaren Vale contributes to stream flow in Pedler Creek. The water table lies below the creek level in Winter and Spring, such that surface water recharges the aquifer. However, by the end of Spring, the water table rises in response to recharge from the creek and local rainfall. The water table exceeds the creek level as stream flow declines in Spring and Summer and underground water discharges to the watercourse. This interaction prolongs stream flow in Pedler Creek and increases the availability of surface water for aquatic biota such as fish and frogs. Recharge from the creek will also maintain the underground water on which phreatophytes such as riparian *Eucalyptus camaldulensis* depend.

The Aldinga Scrub is a remnant of coastal native vegetation within the Aldinga Scrub Conservation Park. The scrub occurs over a perched aquifer within the Semaphore Sand, which is underlain by the Hindmarsh Clay aquitard. Underground water is reported to be at depths of less than 2 metres over most of the site. The range of plant associations in the scrub, partly reflect the range of underground water depths and salinities in the perched aquifer. Underground water that lies within 1 m of the surface, or that seasonally discharges to the surface, tends to support *Eucalyptus camaldulensis* and *E. fasciculosa* woodland over sedges and rushes. Where underground water is fresh the dominant understorey species include *Juncus pauciflorus* and *Cyperus vaginatus*. Areas with saline shallow underground water, support *Juncus kraussii*. The scrub includes a number of permanent and temporary underground water-fed waterholes that provide watering points for terrestrial fauna, hunting sites for insectivorous birds and bats, breeding habitat for frogs and hunting and nesting habitat for waterbirds. Underground water therefore contributes to the water requirements of phreatophytes and wetland communities.

Detailed underground water data were first collected in 1988 and have been collected regularly since 2001. No trends in underground water depth or salinity have been reported. However, underground water levels may have fallen prior to monitoring following the construction of drains in the catchment since the 1950s which may have intercepted surface and sub-surface flows that contribute to the perched aquifer.

Underground water contributes to the water requirements of coastal lagoons at the mouth of Maslin Creek.

A sand bar across the mouth of Maslin Creek detains water in the lagoon at least 20 m upstream. The lagoon is permanent and is believed to reflect the underground water surface in the Semaphore Sands Formation of the surrounding coastal dunes. The lagoon is also maintained by sea water inflow during storms and high tides. Flow in Maslin Creek also contributes to the lagoon. Monthly salinity monitoring conducted since 1999 reflects the contributions of these three sources. Salinities ranged from approximately 26,000 mg/L in July 2000 to approximately 1,500 mg/L in September 2001. The failure of salinities to fall below this minimum value suggests that saline underground water discharge makes a significant contribution to the lagoon even during stream flow events. The lagoon is surrounded by a narrow fringe of emergent wetland plants

(*Phragmites australis, Schoenoplectus pungens* and *Bolboschoenus medianus*) and provides habitat for estuarine, marine and freshwater fish.

A similar environment occurs at the mouth of Pedler Creek in a lagoon that extends over 300 m upstream from the coastal sand bar. Here the lagoon is also permanent, but salinities have ranged from approximately 4000 mg/L in March 2002 to around 175 mg/L in February 2000. The lower salinities may reflect a greater contribution of stream flow to the lagoon, lower salinity in the Semaphore Sand aquifer and less sea water inflow.

The presence of permanent water in these lagoons, as well as reports of permanent waterholes in Aldinga Scrub suggest that underground water supports other wetland habitats in the coastal dunes.

2.1.4 Determination of underground water needs of dependent ecosystems

This section provides an assessment of the underground water quantity and quality requirements of the environment, including the times and periods in which underground water must be available, in accordance with the requirements of the *Natural Resources Management Act 2004*. The purpose of this assessment is to enable the identification of changes to underground water availability and quality that may harm ecosystems dependent upon underground water by reducing ecological function.

Ecosystems dependent upon underground water are adapted to a particular quantity and quality of underground water and to receiving it in a particular annual and inter-annual pattern. Changes in the quality or availability of underground water will affect ecosystems and can reduce their spatial extent or reduce their biodiversity. Activities that affect these factors, such as vegetation clearance, land use practices, irrigation and underground water extraction and recharge, should be managed with regard to their impacts on underground water dependent ecosystems.

The most likely water quality threat to ecosystems is increasing underground water salinity. The taking of underground water has increased salinity in some parts of the McLaren Vale PWA by concentrating or mobilising saline underground water. Other water quality threats include contamination of underground water from agricultural or industrial sourced chemicals or nutrients.

The depth to underground water increased in some parts of the McLaren Vale PWA during the 1980’s and 1990’s and threatened to reduce access to underground water by dependent ecosystems. More recently underground water levels have declined at a slower rate and appear to be approaching a new equilibrium, but ecological response to these altered conditions may not be fully apparent and may still be a threat to ecosystems. Species may be lost through lack of water to survive, grow or reproduce. The abundance of individuals may be reduced as the spatial extent of the ecosystem declines.

A *decrease* in depth to underground water (i.e. an increase in the underground water level) can also threaten ecosystems by altering the natural water regimes on which they rely. Underground water may rise in response to vegetation clearance or irrigation. Habitat may be lost as ecosystems become waterlogged.

A change in the rate of discharge of underground water can affect baseflow ecosystems and the marine environment. The rate of discharge can be reduced through extraction from the confined aquifer.

Each ecosystem with a dependence on underground water has its own water requirements and further research should clarify the particular requirements of such ecosystems in the McLaren Vale PWA. The protection of ecosystems of particular conservation significance and threatened ecosystems is a priority.

The requirements of underground water dependent ecosystems in the McLaren Vale PWA can be expressed in qualitative terms:

- naturally permanent pools must be maintained with permanent water within prescribed minimum / maximum levels;
- seasonal wetlands need regular inundation interspersed with periods of drying;
- underground water levels must be kept at levels sufficient to maintain vegetation (other than in wetlands) that is dependent upon access to underground water;
- aquifer and cave ecosystems must be maintained through adequate underground water flows;
- minimum baseflows to the sea need to be identified and maintained; and
- salinity must be kept within “natural” limits.

Environmental water requirements for underground water dependent ecosystems should ideally be developed to achieve specific ecological outcomes. The role of underground water in supporting ecological outcomes is not sufficiently understood to specify the required underground water regime. Section 10 sets out provisions for ongoing monitoring and research that will help to improve this understanding. In the interim, the underground water requirements of ecosystems can be provided by controlling activities which will significantly change the underground water environment around the priority underground water dependent ecosystem.

Table 1 describes the role of underground water in maintaining the ecological values of the priority underground water dependent ecosystems. Activities which potentially change these factors should be assessed on a case by case basis in terms of their risks to ecosystems.

Table 1. A qualitative framework for definition of water requirements of underground water dependent ecosystems.

Underground water dependent ecosystem	Underground water environment	Ecosystem characteristics that can be used to quantify water requirement	Role of underground water
BLEWITT SPRINGS	Discharge from outcropping Maslin Sands aquifer.	Sustained Winter and Spring waterlogging, and flooding.	Shallow underground water supports growth of phreatophytes and contributes to seasonal inundation of the site.
PEDLER CREEK FLOODPLAIN	Shallow watertables within Quaternary sediments.	Baseflow duration as reported by stream flow gauges.	Underground water discharge prolongs baseflow in late Spring early Summer.
PEDLER CREEK PERMANENT POOLS	Discharge from Maslin Sands and fractured rock aquifer to stream bed in north and from Quaternary in the south.	Minimum annual depth of permanent pools.	Perennial or seasonal discharge of underground water to stream bed.
CALIFORNIA ROAD WETLAND	Shallow watertables within Quaternary sediments.	Permanent freshwater pool (s) and permanent waterlogging of wetland. Prolonged seasonal waterlogging of reeds in Maslin Creek near California Rd.	Underground water remains near surface throughout year and contributes to prolonged seasonal waterlogging.
WIRRA CREEK	Fractured rock aquifer discharges to catchment of Wirra Creek upstream of Willunga.	Annual minimum discharge at the Willunga Fault. Minimum downstream extent of flow is Malpas Rd.	Perennial discharge of low salinity underground water from the fractured rock aquifer at a single site on multiple sites up to 1km upstream at Willunga
ALDINGA SCRUB	Shallow perched aquifer.	Wetland develops at Cliffs waterhole in winter and spring in high rainfall years.	Shallow water table supports growth of phreatophytes and contributes to water regime at wetlands and soaks.
SPRINGS IN THE OUTCROPPING	Discharge from fractured rock	Localised areas of seasonal or perennial water logging or	Underground water discharge prolongs or maintains waterlogging

Underground water dependent ecosystem	Underground water environment	Ecosystem characteristics that can be used to quantify water requirement	Role of underground water
FRACTURED ROCK AQUIFER	aquifer.	flooding.	or flooding.
PETER AND KANGARILLA CREEKS	Fractured rock aquifer discharges to streams in catchment upstream of Willunga Fault	Maximum annual stream salinity.	Underground water discharge prolongs streamflow and increases stream salinity.

Policies that broadly maintain the existing range of underground water depth and salinity in the water table aquifers are likely to protect the water requirements of ecosystems.

The objective of these policies within the plan is to manage the taking of underground water so that current underground water levels are maintained or improved. The objective is not to reinstate an underground water condition that might have existed prior to the development of the resource.

However, specific ecosystems can be protected from impacts by controlling the use of the underground water on which they depend. This may be achieved by providing a buffer (e.g. a zone where the rate of underground water extraction cannot increase) around ecosystems of high conservation significance in which underground water use is managed specifically to provide ecosystem water requirements. While the use of buffers delays the impacts of extraction, they do not affect the magnitude of the full impact of abstraction of underground water.

This plan contains policies that will protect underground water dependent ecosystems from the future taking of underground water, from the operation of aquifer storage and recovery schemes and from the use of imported water or effluent.

It is not appropriate to make further generalisations about underground water criteria that must be adopted. Each ecosystem will have its own characteristics and its own water requirements. Ongoing monitoring and research will help to clarify the particular needs of specific ecosystems. Section 10 contains an outline of the monitoring provisions of this plan.

3 ASSESSMENT OF EFFECTS ON OTHER WATER RESOURCES

Section 76(4)(a)(ii) of the *Natural Resources Management Act 2004* requires an assessment of the potential effect of the plan on other water resources. Other water resources within the McLaren Vale PWA comprise the following surface water systems.

- Onkaparinga River, which forms part of the northern boundary of the McLaren Vale PWA; and
- Pedler, Maslin, Port Willunga and Sellicks Creeks, the catchments for which are largely within the McLaren Vale PWA.

The McLaren Vale PWA contains a number of underground water dependent ecosystems (refer to Section 2). These are linked with the shallow underground water system in the area but also rely to some extent on direct inflow of surface water.

The degree of interaction between underground water and surface water systems is primarily dependent on physiographic and climatic conditions but may be significantly impacted by activities that alter the water regime, such as underground water extraction. The distance between a surface water body and a pumping well strongly influences the timing and degree of impact that pumping will impose on surface water depletion. Pumping underground water near a hydraulically connected surface water body will have an almost immediate impact on the surface water source. The magnitude of the full impact may be nearly equal to the rate of underground water pumping. At greater distances, the effects of pumping will be distributed over longer time periods and may be shared with other hydraulically connected surface water bodies.

If underground water levels decline and there is a strong hydraulic connection between the main production aquifers and the surface water feature, extraction of underground water can be expected to have an impact. It is important to consider that although creek reaches adjacent to underground water extraction areas will be affected locally, overall reduction in regional base-flow may impact reaches downstream of underground water extraction as well. This occurs because underground water extraction may influence vertical upward fluxes from deeper aquifers (e.g. from the Port Willunga Formation) and shift regional underground water discharge further downstream.

Extraction of underground water from the Port Willunga Formation and Maslin Sands aquifers comprise the majority of underground pumping in the McLaren Vale PWA. Extraction from these aquifers poses a low to moderate threat to environmental flows where these aquifers outcrop or are only overlain by a thin layer of modern alluvial sediments. For example, in the Pedler Creek subcatchment, this is represented by gaining reaches (that is, where underground water seeps to the stream) in the undulating hills at Blewitt Springs, Chapel Hill, and Hardy Scrub and the variable gaining and losing reach from Douglas Scrub though McLaren Vale. The potential of declining underground water levels to impact on surface water is likely to be more limited where there exists a thick sequence of Quaternary sediments.

Losing (disconnected) stream reaches will not be threatened further by underground water extraction. In the Pedler Creek subcatchment, this condition occurs down gradient of the transition zone to McLaren Vale. In the Maslin Creek subcatchment, this condition occurs in the upper floodplain reach near the confluence of the two major Maslin Creek tributaries East of the Victor Harbor Road.

Extraction from the Quaternary aquifer adjacent to stream channels can be expected to impact surface water where surface water features cut through aquifers in these sediments. Shallow production bores have been identified along the variably gaining and losing reach from Douglas Scrub to McLaren Vale and in the Blewitt Springs area on Pedler Creek and along the lower floodplain reach in Maslin Creek. However, because yields from the Quaternary aquifer are typically low and used primarily for domestic or stock purposes, it is believed that environmental flows along floodplain reaches are more susceptible to reduced surface water flow caused by upstream diversions than from impacts associated with underground water pumping.

Declines in spring flow have been recently reported and linked to increased underground water production East of the Willunga Fault and inferred underground water level declines within the fractured rock aquifer.

The policy objectives and principles set out in this WAP are designed to limit the impact of extraction of underground water on surface water systems. For example, by limiting transfer to areas that could adversely affect the health of underground dependent ecosystems. The overall objective of this WAP is to allocate underground water in a manner, which minimises declines in underground water levels or rises in the salinity of underground water. Consequently, it is expected that the policy objectives and principles in this WAP will not adversely affect surface water resources.

4 ASSESSMENT OF THE CAPACITY OF THE RESOURCE TO MEET DEMAND

Section 76(4)(d) of the *Natural Resources Management Act 2004* requires the WAP to contain an assessment of the capacity of the resource to meet the demands for water on a continuing basis and to provide for regular monitoring of that capacity.

4.1 Trends in underground water levels and salinity

Trends in underground water levels and underground water salinity are used in the assessment of capacity of the resource to meet demand.

Quaternary aquifers

There are long term records available for eight Quaternary aquifer observation wells. The data indicate generally stable underground water level trends over the 2000 to 2003 period with exception of one site, two kilometres North-East of McLaren Flat where underground water levels have fallen.

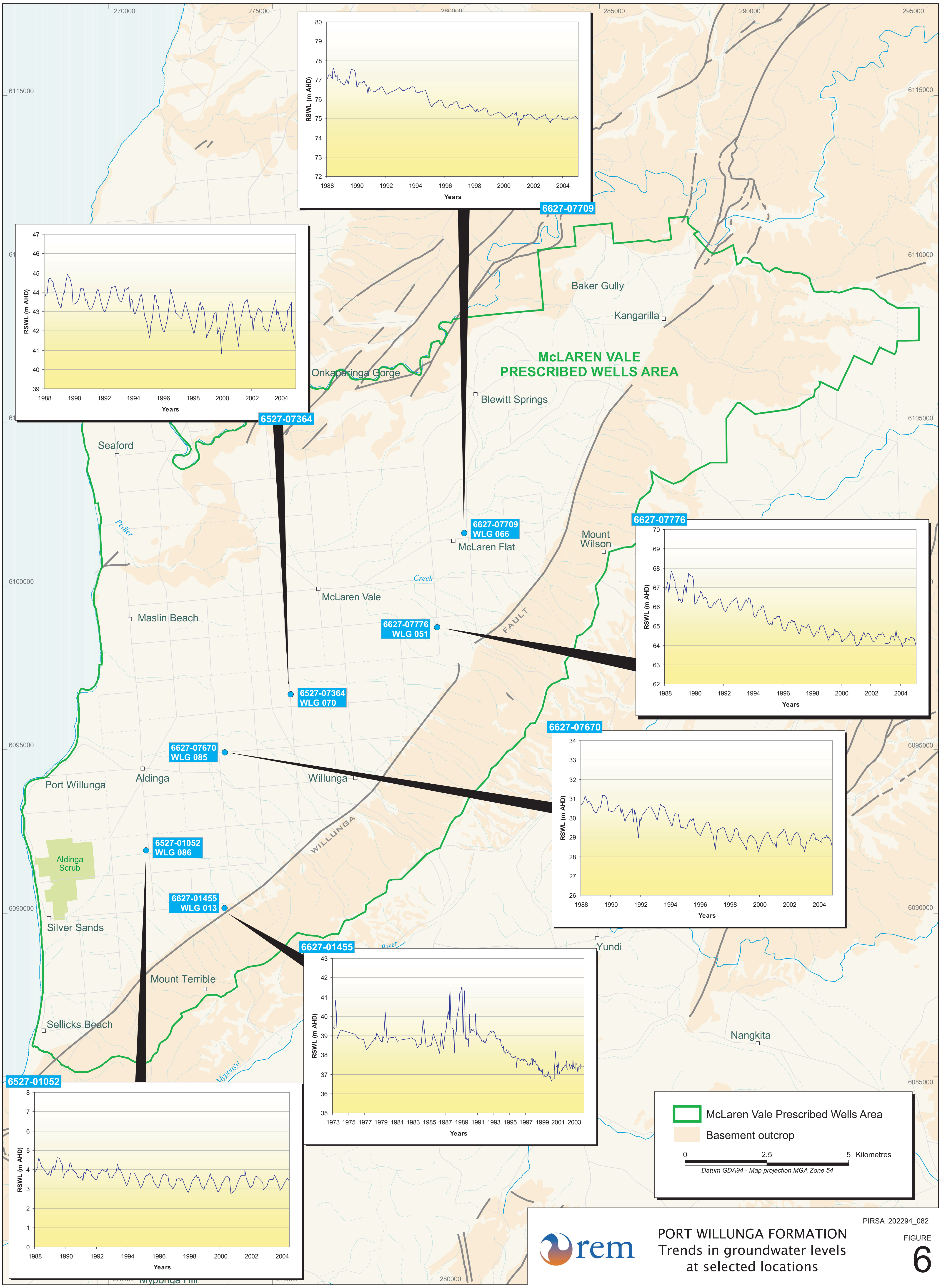
Port Willunga Formation

There are several observation wells in the McLaren Flat, McLaren Vale and Willunga area that show two to four metre falls in underground water levels between the late 1980’s and 2000. These falls in water level occurred when the volume of underground water extracted was in the 5000 to 9000 ML/yr range (**Figure 6**).

The trends in underground water levels over the period of 2000 to 2003 for observation wells completed within the Port Willunga Formation indicate a general decease in the rate of water level decline or in some parts of the area a slight recovery is observed when compared with the 1995 to 1998 period (that is, prior to implementation of the WAP when underground water abstraction rates were high; **Figure 6**).

The annual maximum underground water level rose by at least 0.5 of a metre in around half of the 24 Port Willunga Formation observation wells between 2000 and 2003, but continued to decline in the remaining wells. The decline in the annual maximum underground water level in the remaining wells was generally within the range of 0.1 to 0.3 metres between 2000 and 2003, whereas the decline in underground water level observed between 1995 and 1998 were generally greater than 0.5 metres, especially in the Willunga, McLaren Vale and McLaren Flat area.

The annual maximum salinity fell in around half the observation wells in the period 2000 to 2003 and rose in the remaining wells over the same period.



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PORT WILLUNGA FORMATION
Trends in groundwater levels at selected locations

FIGURE 6

Maslin Sands

The longer term trend in water levels in the Maslin Sands appears variable (**Figure 7**). There are some wells that have shown a significant decline (around a five metre fall since the mid-1970's) while several other wells indicate static underground water levels over the period of the record.

The more recent trends in underground water levels for observation wells completed within the Maslin Sands aquifer (**Figure 7**) are similar to the Port Willunga Formation. There has been a general reduction in the rate of decline of annual maximum underground water levels and recovery in many of the observation wells in the period 2000 to 2003 and maximum underground water levels rose in nearly two-thirds of the Maslin Sands aquifer observation wells between 2000 and 2003.

There is an area between McLaren Vale and Blewitt Springs where maximum underground water levels continued to fall, but at about half the rate to the rate of fall measured between 1995 to 1998.

The maximum annual underground water salinity fell in 90% of the monitored wells during the period 2000 to 2003.

Fractured rock

Underground water levels in observation wells completed in the fractured rock in the Kuitpo region are stable or increasing over the past four years. Similar trends are found in observation wells completed in the fractured rock in the central part of the embayment. There are only limited records (two to three years) for observation bores completed in fractured rock near the Willunga Fault.

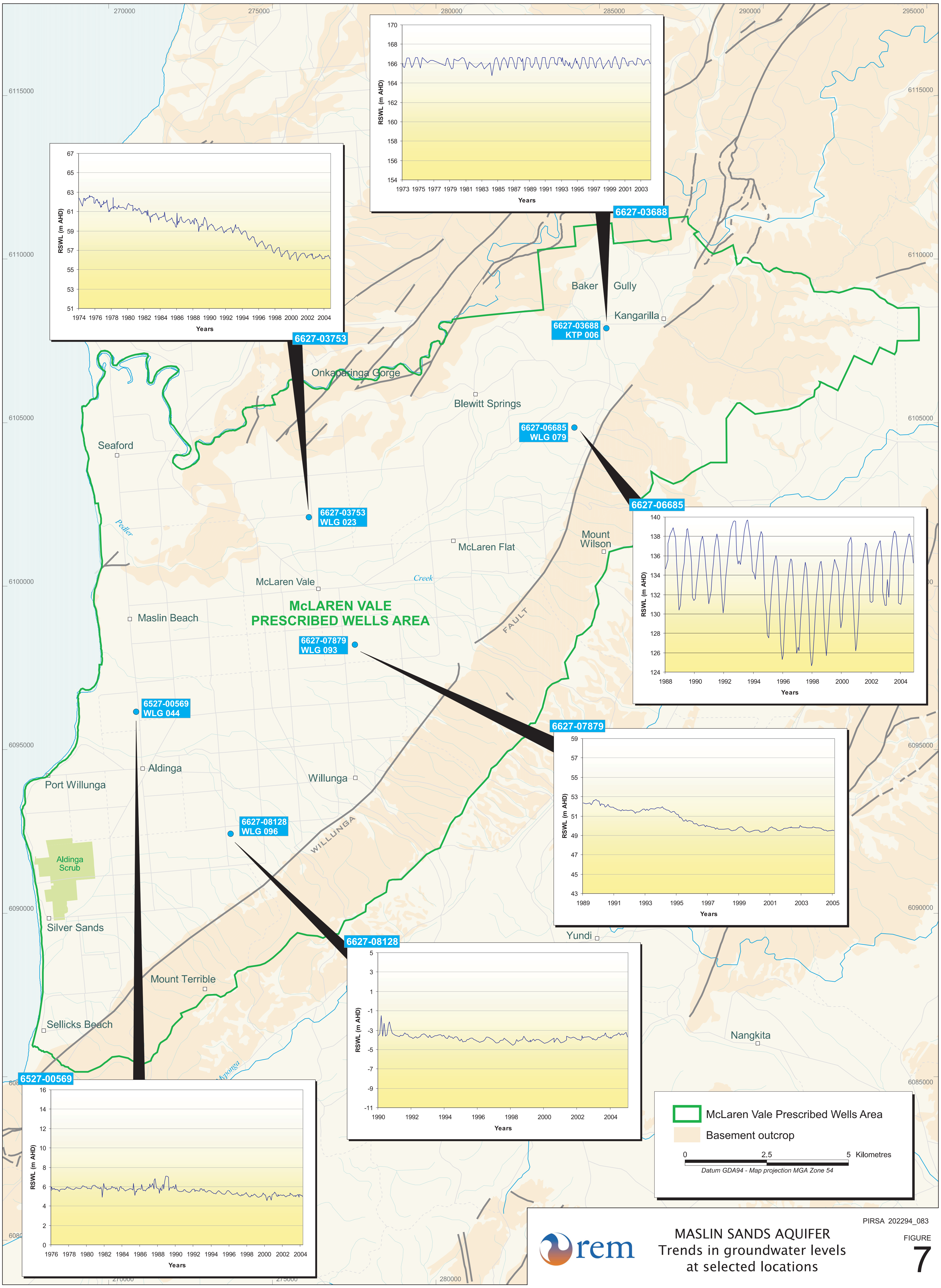
4.2 Likely demand for underground water

The rate of underground water use has declined substantially since the 2000/01 irrigation season, even though there has been substantial new development of irrigated land. The 1999 land use survey indicated that there were around 4,400 ha of irrigated viticulture. In 2003 there was more than 9,700 ha of irrigated viticulture. A large part of the expansion has occurred over the western parts of the McLaren Vale PWA where imported water (from the Christies Beach wastewater treatment plant) is available. Expansion in other areas would have occurred with the conversion from other crops such as almonds to grapes.

The reduced rate of underground water use is also likely to have occurred through improved irrigation efficiency and the occurrence of favourable climate conditions.

The use of imported water from the Christies Beach wastewater treatment plant for the irrigation of horticulture occurs throughout the McLaren Vale PWA. At present, irrigators use between 2,200 and 4,220 ML/yr in the Sellicks, Aldinga, Maslin Beach, Willunga and McLaren Vale areas.

There are no current indicators that suggest the demand for underground water use will increase significantly over the life of this plan. Fluctuations in market



PIRSA 202294_083

MASLIN SANDS AQUIFER
Trends in groundwater levels at selected locations

FIGURE 7

forces and climate may change demand and affect the capacity of the resource to meet demand. It is likely these changes would occur at timescales beyond the life of the plan.

4.3 Capacity of the resource to meet demand

An estimate of the volume of underground water that can be extracted sustainably by metered underground water users is required to appropriately allocate underground water and to protect the long-term viability of underground water resources within the McLaren Vale PWA. The previous WAP provided an estimate of the sustainable yield (previously referred to as safe yield) of 6,560 ML/yr based on analysis of the water balance and an analysis of trends in underground water levels.

It was assumed that the extraction at no more than 6,560 ML/yr would result in a reduction in the rate of decline of underground water levels and the underground water levels would attain a new equilibrium. This would ensure that users of the underground water resource (including dependent ecosystems) would not be adversely affected.

The trends in underground water levels and underground water salinity suggest that the original objectives (to maintain underground water levels and underground water salinity) have been satisfied as there has been widespread reduction in the rate of decline of underground water levels and the underground water levels have stabilised and are beginning to show signs of recovery in many locations. The data indicates possible re-equilibration of underground water levels and underground water salinity to the new water use regime.

There remain some areas with continued falling underground water levels and increasing salinity. These areas will be protected through the policy related to the definition of stressed areas and limits to transfers. Ongoing monitoring will continue to provide information on future trends in underground water levels and trends in underground water salinity. This monitoring data will then be used as a basis for the development of future policy.

The estimate of the sustainable yield has not been altered for this WAP on the basis of favourable trends in underground water levels and salinity and that no other significant verified information has been made available to suggest that the value of sustainable yield should be altered.

Given that demand is currently below the estimated sustainable yield and that demand is currently not thought likely to increase, the aquifers within the McLaren Vale PWA have the capacity to meet the present demand for underground water.

It is acknowledged that in the longer term (beyond the life of this plan) changes to climate may necessitate a review of the sustainable yield and a review of the capacity of the resource to meet demand.

5 WATER ALLOCATION CRITERIA

5.1 Allocation of underground water

The following objectives and principles apply to the allocation of underground water within the McLaren Vale PWA. Additional objectives and principles apply in relation to the allocation of water recharged through aquifer storage and recovery schemes which are set out in section 7 of this Plan.

The Adelaide and Mount Lofty Ranges Natural Resources Management Board, in formulating these objectives has considered the following:

- The present and anticipated future needs of the occupiers of the land for underground water.
- The anticipated future capacity of land within the McLaren Vale PWA for uses that differ from the present uses and the likely needs for water in association with those different uses.
- The likely effect of the criteria for the allocation of the prescribed water resource on the value of the land within the McLaren Vale PWA.
- The needs of the ecosystems that depend on the underground water resource.

Interpretation and definitions

For the purposes of this section of the WAP, any terms used in this WAP that are defined in the *Natural Resources Management Act 2004* have the definitions set out in that Act. In addition the following terms have the definitions set out below:

"existing licence" means a licence in existence at the date of adoption of this plan by the Minister.

"water use year" means the period 1 July to 30 June.

Objectives

(1) To ensure that the volume of underground water taken remains at or below the annual quantity of underground water sustainably available (thereby maintaining or improving current underground water levels and underground salinity levels).

(2) Maintain and where possible increase underground water levels and the quality of underground water of aquifers targeted for licensed use.

(3) Provide flexibility in the way in which underground water resources are managed, so long as the use of the underground water resource remains sustainable in accordance with Objective 5.1 (2)

Principles

Quantity available for allocation

(1) The maximum quantity of underground water available for allocation (taking and holding) from the McLaren Vale PWA is 6,600 ML per annum less the amount of saved water plus the amount available from rollover allocations and recharge allocations.

(2) Water (taking), water (holding) and rollover allocations shall be made in accordance with principles (3) to (9) below.

Water (taking) allocations

(3) Water (taking) allocations shall be a volume of water that may be taken and used in a **water use year** as determined by principle (4).

(4) For existing licences the water (taking) allocation is that expressed on the licence at the date of adoption of this plan as a volume of water to be taken.

Water (holding) allocations

(5) Pursuant to section 153(1) of the *Natural Resources Management Act 2004*, water licences may be endorsed with water (holding) allocations.

(6) The conversion of a water (holding) allocation to a water (taking) allocation shall be in accordance with the transfer of a water (allocation) policies set out in section 6 of this Plan.

Rollover credits and rollover allocations

(7) A rollover credit for a water use year is half of the volume of the water (taking) allocation that was not taken in the previous water use year ("**the credit year**").

(8) A rollover allocation in a water use year is a water (taking) allocation that is the sum of the rollover credits from the immediately preceding three water use years less any rollover credits taken in that period, subject to the following:

a) the rollover allocation shall not exceed 30% of the water (taking) allocation on a licence;

b) a rollover allocation cannot be taken until the full amount of the water (taking) allocation has been taken;

c) a rollover allocation cannot be taken in a water use year in which all or part of the water (taking) allocation is permanently transferred or a temporary transfer is in effect in respect of all or part of the water (taking) allocation; and

d) rollover credits will be converted to rollover allocations in the order they accrue.

(9) Unless taken beforehand, a rollover credit expires at the end of the third full water use year after the credit year.

5.2 Saved water

Interpretation and definitions

Principles contained in Section 5.2 apply to the allocation of **saved water.**

"saved water" means any water previously allocated that has been returned to the Minister in accordance with the *Natural Resources Management Act 2004* or any of its predecessor Acts.

Objective

(1) To assist in the sustainable management and protection of the underground water resource for social, economic and environmental benefit.

Principles

(1) Saved water will not be allocated for any purpose and shall be retained within the aquifer.

5.3 Present and Future Needs of Water Users

Section 76(4)(c) the *Natural Resources Management Act 2004* requires that a WAP must take into account the present and future needs of the occupiers of land in relation to existing requirements and future capacity of the land and the likely effect of those provisions on the value of the land.

The information available indicates that, at present, the occupiers of land in the McLaren Vale PWA have available approximately 6,560 ML (+/- 5%) of underground water per year for their irrigation, industrial and other activities in years of near-average rainfall. The underground water allocations will generally meet the needs of the majority of underground water users in the McLaren Vale PWA. However, there are some users, particularly those growing crops such as pome fruit (e.g. apples and pears), who may need additional water.

The use of imported water (from the Christies Beach wastewater treatment plant) has increased in recent years and now provides more than 2200 ML for irrigation each year.

The future needs of occupiers of land in the McLaren Vale PWA are unlikely to change substantially when considered as an average requirement over the long term. However, there will be short-term fluctuations when more or less water is required, largely linked with variations in climate. In times of drought, allocations of underground water may be insufficient for many licensed users, meaning that access to water from other sources will be needed.

Current information indicates that the land within the McLaren Vale PWA is capable of sustaining the existing and likely future uses provided that other water supply options are developed and that suitable land management practices are maintained to avoid land degradation issues such as erosion and salinity. Likely future uses include a further shift from higher water use crops (such as pome fruit) to lower water use crops (such as grapevines), which should be within the capability of the land. There may also be an ongoing shift from non-irrigated pasture (grazing) to low water use crops such as grapevines, subject to water being available either from underground water licence transfers or from alternative sources.

The likely water needs of future types of land use may not change substantially from the present situation. As noted above, there has been a shift in existing irrigated areas from high water use crops to lower water use crops leading to a net reduction in water use. This was offset by expansion of grapevines or other low water use crops into areas that were previously non-irrigated pasture.

It is considered that the water allocation policies are unlikely to have significant impact upon the value of land in the foreseeable future.

The Adelaide and Mount Lofty Ranges Natural Resources Management Board has taken the above aspects into account in proposing the policies and criteria within this plan.

6 TRANSFER CRITERIA

The following objectives and principles apply to the transfer of licences and/or allocations in the McLaren Vale PWA.

Objectives

(1) Manage the impact of taking underground water by preventing the transfer of an allocation to stressed areas.

(2) Ensure appropriate public notification to raise the awareness of significant transfers.

(3) Ensure that the taking of underground water from the proposed new point of taking does not increase the stress in the aquifer (relative to the original point of taking), does not detrimentally affect the ability of other persons to lawfully take from that underground water, or detrimentally affect any ecosystems that depend on that underground water.

Principles

General

(1) A water licence and/or its water allocation may be transferred where there is no change in the location of the well from which water is taken.

(2) A water (taking) allocation shall not be transferred to a point of taking which is a distance of 300 metres or less from a well used for draining or discharging, unless the water being drained or discharged is less than 500 kilolitres each year of roof run-off.

Transfers to stressed areas

(3) Transfers of water (taking) allocations shall not occur if, at (or within 500 metres of) the proposed point of taking, the aquifer is being stressed by the taking of underground water (or is sensitive to stress by the taking of underground water) including (but not limited to) where:

a) The maximum underground water level has fallen a total of 500 mm or more over the three years preceding receipt of the relevant application to transfer; or

b) The maximum salinity of underground water has increased by a total of 50 mg/L or more over the three years preceding receipt of the relevant application to transfer; or

c) There are other adverse effects caused by the volume of underground water extracted, the proximity of wells or the timing or duration of extraction within 500 metres of the proposed point of taking.

(4) Principle 3 will not apply if there is sufficient technical evidence that the

taking and use of underground water in accordance with the proposed transfer is likely to reduce the stress on the aquifer targeted by the transferee by (among other things):

(a) halting the fall in underground water levels; or

(b) halting the increase in underground water salinity; or

(c) reducing the other adverse effects referred to in Principle (3)(c) above.

(5) A water (taking) allocation cannot be transferred where the taking of water in accordance with the transfer will cause the aquifer to change from a confined aquifer to an unconfined aquifer.

(6) Transfers shall generally result in the relocation of the point of taking underground water being moved away from areas experiencing stress (such as falling water levels and rising salinity levels) but not so as to cause stress on the aquifer in a new location or to extend the area of stress.

(7) The taking of underground water from the proposed new point of extraction will not cause an unacceptable impact on the amount or duration of discharge from the underground water to streams springs and will not detrimentally affect any ecosystems that depend on that discharge.

(8) The Minister may require monitoring of the effects of the taking and use of water on water levels and water salinity, particularly on ecosystems dependent on underground water and/or nearby underground water users.

Managing transfers of rollover allocations

(9) A rollover allocation cannot be transferred.

Managing transfers from the East to West of the Willunga Fault

(10) The transfer shall not occur if the proposed point of taking underground water moves from a well completed in the fractured rock aquifer east of the plane of the Willunga Fault to a well completed in a sedimentary aquifer west of the plane of the Willunga Fault.

Managing transfers of recharge allocations

(11) In addition to the policies for the transfer of water set out in this section of the Plan, transfers of an allocation of recharged water shall be in accordance with the policies for the transfer of recharged water set out in section 7.3 of this Plan.

Transfer of water (holding) allocations

(12) A water (holding) allocation may be transferred.

Notification of transfers

(13) Unless there is no change to the location of the point of taking of underground water or a water (holding) allocation is being transferred,

public notification is required for:

(a) the temporary or permanent transfer of a taking allocation of 20 ML or more; or

(b) a temporary or permanent transfer of a taking allocation that will cause the total cumulative volume of water transferred for use on the same area of land within 3 years of the date of the application to equal or exceed 20ML, less any taking allocation that was temporarily transferred that has returned.

(14) Public notice of applications is to be by publication in the public notices section of the local media and by written notification to owners of land that are is adjacent to the proposed point of taking.

7 DRAINAGE OR DISCHARGE INTO A WELL: AQUIFER STORAGE AND RECOVERY

A permit is required pursuant to section 127(3)(c) of the *Natural Resources Management Act 2004* for the draining or discharging of water directly or indirectly into a well. The draining or discharging of water into a well requires careful management and evaluation to ensure that the activity does not result in unwanted impacts on the underground water resource (thereby rendering the water unsuitable for the intended beneficial end-use), the environment that is dependent on that resource or the ability of other users to lawfully take water from that resource.

The drainage or discharge into a well (recharge) and the subsequent recovery of that water for reuse is, for the purposes of this Plan, termed “Aquifer Storage and Recovery” (ASR). The objective of ASR is to store surplus supplies of water underground and to withdraw an amount (**recovery**) of the recharged water at a later date for use.

In undertaking ASR, a permit is required to drain or discharge water into a well and a licence is required to take water from the underground water resource.

Examples of source water for recharge to an aquifer include:

- rural stormwater runoff;
- urban stormwater runoff;
- watercourse water;
- roof runoff;
- reticulated mains water; and
- treated effluent.

Surface water resources, including stormwater and roof runoff, and watercourse water in the McLaren Vale PWA are prescribed resources, as the McLaren Vale PWA forms part of the Western Mount Lofty Ranges Prescribed Water Resources Area. This means that a water licence issued under the *Natural Resources Management Act 2004* is required to take surface water or watercourse water for the purposes of draining or discharging into a well.

Interpretation and definitions

For the purposes of section 7 (Drainage or Discharge into a Well: Aquifer Storage and Recovery) the following terms apply:

“***attenuation zone***” means the area of the aquifer around an injection well in which the concentration of chemicals of concern in the recharged water is reduced to ambient levels through physio-chemical and microbiological processes.

*“**ambient underground water**”* means the underground water that is present in the relevant aquifer prior to the commencement of ASR, and may be the native underground water or mixed underground water.

*“**native underground water**”* means the underground water (as that term is defined in the *Natural Resources Management Act 2004*) that exists in the relevant aquifer absent of any water drained or discharged to that aquifer by artificial means.

*“**mixed underground water**”* means the underground water that exists in the relevant aquifer that may contain water that has been drained or discharged to the aquifer by artificial means.

*“**recharge**”* or *“**recharging**”* means the act or activity of draining or discharging water directly or indirectly into a well whether by gravity, recharge under pressure or any other means.

*“**aquifer**”* means a permeable deposit which can yield useful quantities of water when tapped by a well.

*“**ASR**”* means aquifer storage and recovery comprising the drainage or discharge of water into a well and the retrieval or recovery of that water (or other water in lieu of the recharged water);

*“**ASR scheme**”* means a scheme for the drainage or discharge (recharge) of water to an aquifer by one or more persons using one or more wells and the recovery of the recharged water (or other water in lieu of the recharged water) from the aquifer by the same or other persons using the same or other wells;

*“**injection well**”* means the well via which water is drained or discharged (recharged) to an aquifer for the purposes of ASR.

*“**recharge period**”* means (for the purposes of allocation) from 1 May each year to 30 September that year.

“***recharged water***” means a quantity of water measured as drained or discharged directly or indirectly into a well in accordance with a permit under section 127(3)(c) of the *Natural Resources Management Act, 2004* or a licence issued under the *Environment Protection Act, 1993*;

“***recovery period***” means (for the purposes of allocation) the period 1 October through to 30 April which follows the preceding recharge period. This is when the water drained or discharged can be taken from the aquifer;

“***source water***” means the water obtained for draining or discharging (recharging) into a well for the purposes of ASR;

Objectives

The following objectives apply to the drainage or discharge (recharge) of water into a well, the allocation of recharged water and the transfer of allocations of recharged water.

(1) Ensure the sustainable operation and management of ASR schemes while facilitating economic development and improved social well-being.

(2) Ensure reasonable and practicable measures are taken to avoid the discharge of waste to the receiving underground water resource during the drainage or discharge of water into a well.

(3) Provide for the drainage or discharge of water directly or indirectly into a well so as not to affect:

(a) the quality of underground water such that it is rendered unsuitable for the intended end use;

(b) the integrity of the aquifer, for example, but not limited to, the confining layer between aquifers and the ability of the aquifer to transmit water;

(c) water tables, for example, but not limited to, water logging, land salinisation, subsidence or heave and damage to infrastructure (roads, buildings, foundations etc.);

(d) any ecologically sensitive area that depends on the underground water resource; and

(e) the ability of other persons to lawfully take from that underground water.

7.1 Permits to drain or discharge water into a well

Principles

The following principles apply to applications for permits to drain or discharge water into a well.

(1) The drainage or discharge of water directly or indirectly into a well shall be carried out in a manner that does not adversely affect the underground water quality, the aquifer or any ecosystem that depends on that underground water or the ability of other persons to lawfully take from that underground water.

(2) Water may be drained or discharged into a well where the substances in the water to be recharged can be attenuated to concentrations of chemicals of concern approximating the ambient underground water concentrations within the designated attenuation zone described in principle (8).

(3) To minimise adverse impacts to existing users the method of drainage or discharge into a well shall:

(a) be undertaken by gravity drainage only, unless it can be demonstrated that there will be no adverse impact on existing users of the underground water if some other method of drainage or discharge is used; or

(b) where drainage or discharge under pressure is proposed, the operational pressures must not cause the overlying confining beds to hydraulically fail.

(4) The ASR scheme must (subject to any other authorisation to the contrary) be operated in a manner which is consistent with the Environment Protection (Water Quality) Policy 2003 under the *Environment Protection Act 1993*.

Public notification

(5) Public notice of applications to drain or discharge water directly or indirectly into a well under section 127(3)(c) of the *Natural Resources Management Act 2004* is to be given pursuant to section 136(1) of the *Natural Resources Management Act 2004* by publication in the public notices section of the local media and by written notification to owners of land adjacent to land that is the subject of an application.

Attenuation zones

(6) Water may only be drained or discharged into a well where the nearest ecosystem dependent on underground water is located a minimum distance of 300 metres from the injection well.

(7) Subject to Principle (6) water may only be drained or discharged into a well where the nearest well from which water is taken (“the adjacent well”) is located a minimum distance of 300 metres from the injection well unless:

(a) the proponent owns and operates the adjacent well for the proponent’s own benefit; or

(b) the adjacent well is part of the ASR scheme; or

(c) the adjacent well accesses an aquifer which is not significantly hydraulically connected to the aquifer accessed by the ASR scheme; or

(d) the water taken from the adjacent well is entirely an authorised temporary transfer of a water allocation of no more than 3 years duration; or

(e) the water to be drained of discharged is sourced from roof run-off at a rate of 500 kilolitres each year or less; or

(f) additional pre-treatment (filtration, ultra violet disinfection or other method) is carried out prior to drainage or discharge into the well to make certain that the substances in the source water will be attenuated to concentrations approximating the ambient underground water concentrations prior to reaching the ecosystem or adjacent well.

(8) Centred around the drainage or discharge well there shall be a distance of 300 metres radius (attenuation zone) which shall not:

(a) be situated, either wholly or partly, within a water protection area (as defined by part 8 of the *Environment Protection Act 1993*); or

(b) extend beyond the boundaries of the land on which the injection well is located, unless additional pre-treatment is carried out in accordance with principle (7)(f); or

(c) have a local underground water hydraulic gradient in the proposed target aquifer of greater than 0.2 metres per 500 metres unless:

(i) the purpose of the ASR scheme is to lessen the development of a cone of depression that has developed as a result of concentrated pumping demand; or

(ii) the ASR scheme incorporates recovery wells down gradient from the drainage or discharge well, at a distance considered appropriate by the Minister.

7.2 Allocation of recharged water

An allocation of recharged water, being a water (taking) allocation granted on the basis of the volume and type of water drained or discharged into a well, may be allocated in accordance with principles (9) to (15) and is subject to the objectives within section 5 of this Plan.

An allocation of recharged water must be taken in accordance with a water licence.

(9) The basis for an allocation of recharged water is an entitlement to take, following a recharge period:

(a) up to 100 percent of the volume drained or discharged into a well during the preceding recharge period if the source water is either effluent or imported water; or

(b) up to 75 percent of the volume drained or discharged into a well during the preceding recharge period if the source water is surface water, roof runoff or watercourse water.

(10) Except where the extraction well is located within a stressed area, an allocation of recharged water may exceed the proportions specified in principle (9) of section 7.2 where a greater proportion of water needs to be taken to maintain the background underground water quality that existed prior to the establishment of the ASR scheme.

(11) Unless taken beforehand, an allocation of recharged water expires within three years of the end of any recharge period.

(12) An allocation of recharged water shall not be taken from within a stressed area, unless the point of recharge is also located in the same stressed area. A stressed area is defined as an area within 500 metres of a location where:

(a) The maximum underground water level has fallen a total of 500 mm or more over the three years preceding receipt of the relevant application; or

(b) The maximum salinity of underground water has increased by 50 mg/L or more over the three years preceding receipt of the relevant application.

(13) The taking of recharged water shall not lower the level of underground water to a level that will detrimentally affect the ability of other persons to lawfully take from that underground water.

(14) The taking of recharged water shall not cause a decrease in the amount or duration of discharge of underground water to streams or springs and shall not detrimentally affect any ecosystems that depend on that discharge.

(15) The taking and use of recharged water shall not cause degradation of the land on which water is used by way of increased soil salinity, soil erosion or any other means.

7.3 Transfer of an allocation of recharged water

The following principles apply to the transfer of an allocation of recharged water:

(16) Transfer of an allocation of recharged water shall be in accordance with the policies for the transfer of water set out in section 6 of this Plan.

(17) An allocation of recharged water shall not be transferred where the proposed new point of taking is within a stressed area or if the point of taking is from a different aquifer into which the water was drained or discharged.

(18) An allocation of recharged water shall not be transferred to another point of taking if the source water used for drainage or discharge is effluent or imported water.

8 USE OF IMPORTED WATER OR EFFLUENT

A water affecting activity permit is required for the use of imported water or for the use of effluent in the McLaren Vale PWA at a rate that exceeds the rate prescribed by this Plan.

The following objectives and principles apply to the use of imported water on land and to the use of effluent on land.

Objective

(1) The sustainable use of imported water or effluent that does not adversely impact on:

- (a) structures or ecosystems through a rise in underground water levels, salinity or nutrient levels; or
- (b) the natural flow of watercourses; or
- (c) the quality of surface water, underground water or water in watercourses or wetlands; or
- (d) the productive capacity of land through rising underground water levels, salinity, water logging or nutrient levels; or
- (e) the condition, biodiversity or extent of underground water dependent ecosystems.

Principles

(1) A water affecting activity permit is required for the use of imported water on land or effluent on land at a prescribed rate exceeding 1ML/yr in the course of carrying on a business. A permit will only be issued where:

- (a) the underground water level in the unconfined aquifer system is more than 2 metres below the ground surface in areas where imported water or effluent will be used for the first time after the date of adoption of this plan; and
- (b) the use of imported water or effluent shall not cause the underground water level in the unconfined aquifer system to rise to within 2 metres of the ground surface; and
- (c) the application of imported water or effluent shall not lead to a rise in underground water levels sufficient to significantly and adversely affect structures or ecosystems; and
- (d) the application of imported water or effluent shall not significantly and adversely affect the natural flow or quality of surface water or underground water; and

(e) the application of imported water or effluent shall not have a significant adverse effect on the productive capacity of the land due to salinisation or waterlogging; and

(f) the application of imported water or effluent shall not cause a significant and adverse effect to underground water dependent ecosystems; and

(g) any necessary facilities for the storage of imported water or effluent are constructed and operated in a manner that prevents any detrimental impact on the quality of underground water or the health of ecosystems; and

(h) there is no imported water or effluent discharged directly or indirectly into a watercourse.

9 WELL CONSTRUCTION

The following objectives and principles apply to permits for activities relating to wells under section 127(3)(a) and (b) of the *Natural Resources Management Act 2004*, comprising the drilling, plugging, backfilling or sealing of a well and the repairing, replacing or altering the casing, lining or screen of a well.

Objectives

(1) To ensure the drilling, plugging, backfilling or sealing of a well occurs in a manner that will protect the quality of underground water resources.

(2) To minimise the impact of repair, replacement or alteration of the casing lining or screen of wells on the underground water resources.

(3) To protect the underground water resources from pollution, deterioration and undue depletion.

(4) To ensure the integrity of headworks are maintained.

(5) To ensure that wells are constructed in the correct aquifer system.

Principles

(1) Well construction must occur in accordance with the approved general specification as they apply from time to time.

Impact of well works on water quality and integrity of the aquifer

(2) The equipment, materials and methods used in the drilling, plugging, backfilling or sealing of a well, or the replacement or alteration of the casing, lining or screen of a well shall not adversely affect the quality of the underground water resource.

(3) Aquifers shall be protected during the drilling, plugging, backfilling or sealing of a well, or the replacement or alteration of the casing, lining or screen of a well, to prevent adverse impacts upon the integrity of the aquifer.

(4) New wells constructed for the purpose of taking underground water shall not be located within 300 metres of an existing well that has a permit or licence to recharge the underground aquifer and is being used for ASR unless:

   (a) the new well will be completed in an aquifer that is not in direct hydraulic connection with the aquifer into which the water is being recharged; or

   (b) the new well is part of the existing ASR scheme incorporating the existing well or wells within 300m; or

   (c) the new well is used to drain or discharge roof run-off at a rate of 500 kilolitres each year of less.

Sealing between aquifers

(5) Where a well passes or will pass through two or more aquifers, an impervious seal shall be made and maintained between such aquifers.

Design of Headworks

(6) The headworks of a well from which a licensed allocation is to be taken shall be constructed so that the extraction of water from the well can be metered without interference.

Wells for Drainage or Discharge

(6) The headworks for the drainage or discharge of water shall be constructed so that extraction and drainage or discharge operations can be metered without interference.

(7) The headworks for the drainage or discharge of water shall be constructed so that water cannot leak if the well becomes clogged.

(8) Wells constructed for the drainage or discharge of water shall be pressure cemented along the full length of the casing.

10 MONITORING, EVALUATION AND REPORTING

Monitoring, evaluation and reporting is part of the systematic process of optimising performance, through measurements against an agreed reference point. For this Plan, the reference points relate to effectiveness of policies and health of the underground water resource. There is therefore a need to monitor and evaluate to make sure that the underground water resource is used sustainably and to make sure that WAP policies are effective.

Objectives

1. To ensure sufficient data is available to assess the capacity and health of the underground water resource.
2. To ensure timely evaluation and reporting of monitoring data.
3. To ensure sustainable use of underground water resources.
4. To ensure adequate protection of underground water dependent ecosystems.
5. To ensure sustainable operation of aquifer, storage and recovery schemes.

Principles

General monitoring, evaluation and reporting

(1) Undertake the monitoring summarised in Table 2.

Table 2. Summary of monitoring requirements.

What	Where	When	Who
A representative underground water sample to be collected by the licence holder from each licensed well and submitted for salinity analysis.	All licensed wells used by licensed underground water users.	Collected in the last week of February and submitted by the end of March.	Licence Holder
Underground water levels	Full network of observation bores completed in the Quaternary, Port Willunga, Maslin Sands and fractured rock aquifers.	Monthly	Minister

What	Where	When	Who
Underground water salinity	Full network of observation bores completed in the Quaternary, Port Willunga, Maslin Sands and fractured rock aquifers.	Once every three months.	Minister
Record meter readings from all existing meters.	All existing meters	July, November, February and April each year.	Minister
Install meters to quantify stock and domestic use from wells also used for licensed taking of underground water.	All wells that are used for both stock and/or domestic and licensed use occurs.	Install meters prior to June 2008.	Licensee will install the meter
A survey of water use including crop types and areas irrigated and industrial uses.	Across the entire McLaren Vale PWA.	2008	Minister
Monitoring, evaluation and reporting of use of imported water or effluent.	Refer to Section 10 (12-16)	Refer to Section 10 (12-16)	Permit holder
Monitoring, evaluation and reporting when draining or discharging water into a well	Refer to Section 10 (7-11)	Refer to Section 10 (7-11)	Permit holder
Monitoring, evaluation and reporting when taking of underground water from an ASR scheme	Refer to Section 10 (7-11)	Refer to Section 10 (7-11)	Licensee

(2) The Board is to undertake a review of the shallow underground water quality and level monitoring program and implement the revised program on an annual basis. The Board will also integrate the shallow underground water program with monitoring associated with the use of imported water and effluent and with assessment of underground water dependent ecosystems.

(3) Once each year the Board is to prepare a summary of the patterns in use of underground water and key trends in underground water levels and underground salinity levels. The summary of key trends should place the annual data in the context of full record of trends in underground water levels and salinity.

(4) In the 2007/2008 water use year the Board is to:

(a) re-assess trends in underground water level and salinity;

(b) re-evaluate the estimate of sustainable yield;

(c) re-assess the capacity of the resource to meet demand; and

(d) commence a review of the water allocation plan.

(5) The Board is to prepare and implement a detailed underground water dependent ecosystem monitoring program based on the National Natural Resource Management Monitoring and Evaluation Framework, Resource Condition Indicators (Inland Aquatic Ecosystem Integrity).

(6) For the purposes of the monitoring program principle (5), underground water dependent ecosystems will be included in the monitoring program if they are priority areas or representative of a wetland habitat type found within the McLaren Vale PWA based on ecological requirement. At the location of each significant underground water dependent ecosystem measure, record, evaluate and report:

(a) seasonal underground water level fluctuations;

(b) seasonal underground salinity fluctuations;

(c) species composition and abundance;

(d) species recruitment;

(e) specific vegetation health; and

(f) ecosystem water use; and

(g) surface water flow regimes.

Monitoring, evaluation and reporting for operation of an ASR scheme

(7) Holders of permits for draining or discharging water into a well (proponents) will be required to submit (to the Minister) results from all water quality analysis within 7 days of completion of the analysis and submit an annual monitoring and evaluation report to the Minister within 30 days of the end of the recharge period including but not limited to the following information:

(a) water quality of the source water and recovered water at the frequency identified in Table 3;

(b) underground water level monitoring at the frequency identified in Table 3; and

(c) the volume of water recharged and the volume of water taken during the specified recharge and taking periods for the source water types.

The scope of the monitoring program can be reviewed and altered following the monitoring, evaluation and reporting of two consecutive cycles of recharge and recovery from an ASR scheme.

Table 3. Monitoring and evaluation schedule for reporting of ASR operations.

Source water	Source water analysis		Recovered water analysis		Frequency of underground water level recording	Separate monitoring well required (refer to principles (8) and (9)
	Less than or equal to 15 ML/yr	Greater than 15 ML/yr	Less than or equal to 15 ML/yr	Greater than 15 ML/yr		
Storm water (urban & rural)	1 sample taken within 7 days of the start of drain or discharge and 1 sample in the first week of July	1 sample per 10 ML drain or discharged (or part thereof)	1 sample per 5 ML recovered (or part thereof)	1 sample per 10 ML recovered (or part thereof)	Weekly	Yes
Roof runoff (less than or equal to 500 kilolitres per year)	1 sample taken within 7 days of the start of drain or discharge		1 sample 30 days following start of recovery		None Required	No
Roof runoff (more than 500 kilotres per year)	1 sample taken within 7 days of the start of drain or discharge	1 sample per 15 ML (or part thereof)	1 sample 30 days following start of recovery	1 sample per 15 ML (or part thereof)	Fortnightly	No
Mains water	Single water quality certificate from supplier		1 sample 30 days following start of recovery	1 sample per 15 ML (or part thereof)	Weekly	No
Effluent	Monthly water quality certificate from supplier		2 samples per 5 ML recovered (or part thereof)	2 samples per 5 ML recovered (or part thereof)	Weekly	Yes

(8) If the attenuation zone is likely to extend beyond the boundaries of the property, then a sufficient number of underground water monitoring wells (as determined by the Minister) will be installed by the operator and sufficient representative samples collected by the operator once each six months. The samples will be analysed for the same chemicals analysed in the source water.

(9) For the purposes of Principle (8) the water quality parameters to be analysed for will be determined by the Minister as part of the conditions of the permit or licence.

(10) All samples taken must be sufficient representative samples, which means suitable samples, collected with equipment appropriate for the substance, material or characteristic to be measured and taken at suitable locations and times to accurately represent the quality of the relevant water.

(11) A laboratory certified by the National Association of Testing Authorities (NATA) for the analysis undertaken must carry out all water quality testing.

Monitoring, evaluation and reporting of the use of imported water or effluent

(12) The Minister may require a property scale underground water and/or surface water monitoring program to ensure the criteria associated with section 8, principle (1) have been met.

(13) Operators of schemes that supply imported water or effluent and/or users of imported water or effluent are required to submit (to the Minister) an annual monitoring and evaluation report to the licensing or permitting authority within 30 days of the end of the annual water use year including but not limited to the following information:

(a) Water quality and quantity of the imported water or effluent, used underground water level and elevation, underground water quality and surface water quality measured at a frequency and measured at locations identified in Table 4.

Table 4. Monitoring and evaluation schedule for reporting of the use of imported water or effluent for Operators.

Attribute	Frequency and timing	Location
Surface water quality	Twice each year when there has been 10 mm of rainfall within the previous 24-hour period.	Upstream and downstream of the area irrigated with imported water or effluent
Underground water quality	May and November	At monitoring well locations across the full extent of the area irrigated with imported water or effluent, as agreed by the Minister.
Underground water depth and elevation	February, May, August and November	At monitoring well locations across the full extent of the area irrigated with imported water or effluent, as agreed by the Minister.

(14) For the purposes of Principles (12) and (13), the water quality parameters to be analysed will be determined by the Minister and will be chosen depending on the quality of imported water or effluent.

(15) All samples taken shall be sufficient representative samples, meaning suitable samples, collected with equipment appropriate for the substance, material or characteristic to be measured and taken at suitable locations and times to accurately represent the quality of the relevant water.

(16) A laboratory certified by the National Association of Testing Authorities (NATA) for the analysis undertaken must carry out all water quality testing.

11 CONSISTENCY WITH OTHER PLANS OR LEGISLATION

The WAP shows relevant benefits of consistency with the following plans and policies as listed below:

(a) relevant management plans under the *Coast Protection Act 1972*;

(b) relevant Development Plans under the *Development Act 1993*;

(c) relevant environment protection policies under the *Environment Protection Act 1993*;

(d) relevant plans of management under the *National Parks and Wildlife Act 1972*;

(e) guidelines relating to the management of native vegetation adopted by the Native Vegetation Council under the *Native Vegetation Act 1991*;

(f) *Adelaide and Mount Lofty Ranges Initial Natural Resource Management Plan*

(which includes the Onkaparinga Catchment Water Management Plan); and

(g) *State Natural Resources Management Plan 2006*.

APPENDIX 1: SUMMARY OF COMMON AND SCIENTIFIC NAMES

Scientific Name	Common Name
Typha sp.	Bull rush/Cumbungie
Juncus spp	Rushes
Phragmites australis	Common reed
Eucalyptus camaldulensis	River Red Gum
Leptospermum lanigerum	Woolly Tea Tree
Cyperus gymnocaulos	Spiny Flat-Sedge
Galaxias olidus	Mountain Galaxias
Galaxias brevipinnis	Climbing Galaxias
Pennisetum clandestinum	Kikuyu Grass
Zantedeschia aethiopica	Arum Lily
Baumea juncea	Bar Twig Rush
Eleocharis acuta	Common Spike-rush
Isolepis nodosa	Knobby Clubrush
Xanthorrhea semiplana	Grass tree/Yacca
Banksia marginata	Silver Banksia
Exocarpus cupressiformis	Native Cherry
Eucalyptus fasciculosa	Pink Gum
Juncus pauciflorus	Loose Flower Rush
Cyperus vaginatus	Flat Sedge
Juncus kraussii	Dune Slack Rush/Matting Rush/Sea Rush
Schoenoplectus pungens	Common Three-square Rush/Chair-maker's Rush/Sea Club Rush
Bolboschoenus medianus	Marsh-club Rush