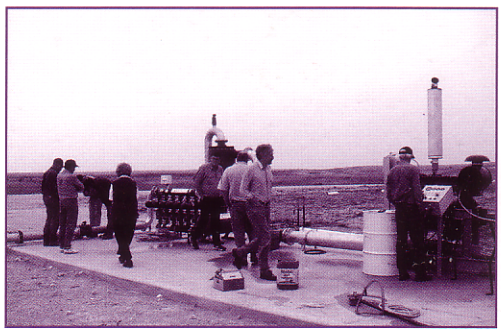
Water Allocation Plan

South East Catchment Water Management Board



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NARACOORTE RANGES PRESCRIBED WELLS AREA

Water Resources Act 1997

Water Allocation Plan

for the

Naracoorte Ranges Prescribed Wells Area

I, Mark Brindal, Minister for Water Resources, hereby certify that this plan is the Water Allocation Plan for the Naracoorte Ranges Prescribed Wells Area adopted by me on 29 June 2001 and amended pursuant to section 118 of the *Water Resources Act 1997*.

.....
Hon Mark Brindal MP
Minister for Water Resources

Date: 14/10/01

Prepared by

South East Catchment Water Management Board

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1 The Naracoorte Ranges Prescribed Wells Area

This document is the water allocation plan for the Naracoorte Ranges Prescribed Wells Area, pursuant to Part 7, Division 3 of the *Water Resources Act 1997*. This Water Allocation Plan replaces the *Naracoorte Ranges Prescribed Wells Area Water Allocation Plan* as varied by the Plan published in the Government Gazette on 27 July 2000.

The Naracoorte Ranges Proclaimed Region was gazetted on the 9 January 1986 under the provisions of the *Water Resources Act* 1976. Upon the introduction of the *Water Resources Act* 1997 the Naracoorte Ranges Proclaimed Region became known as the Naracoorte Ranges Prescribed Wells Area (PWA).

The Naracoorte Ranges PWA covers an area of approximately 2400 km^2 and includes the Hundreds of Beeamma, Geegeela, Hynam, Binnum, Naracoorte, Jessie, Robertson and Joanna (Fig. 1.1). The northern part of Zone 4A, all of Zones 5A and 6A, and the southern part of Zone 7A of the Border Designated area are located inside the Naracoorte Ranges PWA. The major township in the Naracoorte Ranges PWA is Naracoorte (population ~ 5000). The town is situated in the south-western portion of the PWA and lies on the Keith to Mount Gambier main road.

The climate in the Naracoorte Ranges PWA is typical of the South East; hot, dry summers and cool, wet winters. The mean rainfall generally increases from north to south. In the north at Kybybolite the average annual rainfall is 553 mm, at the Naracoorte Post Office the average rainfall is 580 mm/annum, and in the south at Comaum, the average rainfall is 611 mm/annum. The annual potential evapotranspiration is approximately 1500 mm in the south of the PWA, increasing to more than 1600 mm in the northern portion of the PWA.

Sheep and cattle grazing, and dryland cropping are the major land uses in this PWA. Irrigation activities covered 11,884 hectares or 5 % of the total land area of the PWA in 1998-99. However, irrigation contributes significantly to the local economy, particularly through pasture and lucerne seed production and a burgeoning wine industry, centred in the Wrattonbully district south-east of Naracoorte.

The PWA can be divided by topography into a low-lying interdunal flat located in the south-western portion of the PWA and an elevated highlands area in the north-east. The two terrains are separated by the NW–SE Kanawinka Fault.

The Prescribed Resource

The prescribed water resources of the Naracoorte Ranges PWA, consist of two distinct underground water aquifer systems, the upper Unconfined Tertiary Limestone Aquifer system (known generally as the unconfined aquifer), and the lower Tertiary Confined Sand Aquifer (known generally as the confined aquifer). A schematic east-west geological cross section of the Naracoorte Ranges PWA is shown in Figure 1.2.

Unconfined Aquifer

Underground water flow in the unconfined aquifer in the Naracoorte Ranges PWA is generally from east to west. The unconfined aquifer is a multi-lithological system that is

hydraulically continuous across the PWA. In the east, in the Naracoorte highlands, underground water flows mainly through the Gambier Limestone Formation. On the coastal plain the unconfined underground water also flows through the Padthaway and the underlying Bridgewater Formations.

In the northern portion of the PWA the unconfined aquifer is ~75 m thick, in the south it decreases from ~75 m beneath the coastal plain to ~50 m at the border. The depth to water depends mainly on the topography. On the plain the water table generally ranges from 0 to 5 m below ground. In the Naracoorte highlands the depth to water varies from 5 to 20 m.

Transmissivity values derived from pump tests for the aquifer ranged from ~ 200 m^2 /d to more than 10 000 m^2/d. The considerable variation in transmissivity is typical of karstic limestone that has developed a high secondary porosity. Specific yield values ranged from 0.01 to 0.15. Well yields are commonly high, ranging from 50 to 100 L/sec.

The salinity of the unconfined aquifer ranges between ~900 and ~2500 mg/L.

Confined Aquifer

Underground water flow in the confined aquifer in the Naracoorte Ranges PWA is generally from east to west. In the Naracoorte Ranges PWA, the unconfined and confined aquifers are separated by a low permeability aquitard, comprised mainly of glauconitic marl and dark brown carbonaceous clay. The combined thickness of the aquitard is generally more than 20 m.

Vertical recharge to the confined aquifer from the overlying unconfined aquifer in the PWA is considered to be very low. A recent study suggests that there is no vertical recharge to the confined aquifer east of the Kanawinka Fault. Recharge to the aquifer is predominantly via lateral throughflow from the east, possibly sourced from the Dundas Plateau.

There are very few confined aquifer wells in the Naracoorte Ranges PWA, with the confined aquifer only used for town water supply of the Naracoorte township.

The depth to the confined aquifer is ~130 m on the plain. In the highlands the depth to the aquifer is slightly more at approximately ~145 m. The aquifer generally increases in thickness in a southerly direction. At Naracoorte it is approximately 45 m thick increasing to 75 m in the south-western portion of the PWA. Further drilling is required to establish the local extent of the aquifer in the PWA.

The salinity of confined aquifer underground water ranges from ~830 mg/L to ~2100 mg/L.

2 Assessment of the Needs of Dependent Ecosystems

The needs of ecosystems include both the local influence of underground water within an ecosystem and the influence on receiving environments downstream.

Ecosystem Water Requirements

In ecosystems dependent on underground water currently undisturbed by the taking and use of underground water, the current conditions (that account for natural patterns such as climate) can be considered as providing the water needs of the ecosystem in question. Where undisturbed ecosystems dependent on underground water have been identified, the underground water data available during October 2000 has been interpreted as the Ecosystem Water Needs of dependent ecosystems (see Table 2.1). For ecosystems subject to changing underground water conditions, the the data that describes the most recent steady state underground water conditions have been interpreted from available records and adopted as the Ecosystem Water Needs (Table 2.1).

Water needs were collectively described for ecosystems sharing common environments, termed land units, in which current underground water conditions and trends were consistent. Four land units were identified within the Naracoorte Ranges PWA (Figure 2.1). These land units are the:

- Geegeela Beeamma Mallee Land Unit in the north;
- Naracoorte Plateau in the south east;
- Naracoorte Ranges comprising of the relatively high elevation Bridgewater Formation dune; and
- Naracoorte Plains comprising of the flats to the west.

The quantity of underground water which ecosystems need was described in terms of water table elevation and underground water quality. Underground water quality was described in terms of salinity levels.

Ecosystems Dependent on Underground Water in the Naracoorte Ranges PWA

Geegeela Beeamma Mallee Land Unit

The Geegeela Beeamma Mallee Land Unit comprises of the northern part of the Naracoorte Ranges PWA and is bounded by the transition of surface geology from predominantly Molineaux Sand to Predominantly Parilla Sand. The area has a relatively high elevation (more than 95m AHD) and the water table lies generally 25m below the surface over most of the land unit. The following water dependent ecosystems have been identified as present, or are likely to be present within the Geegeela Beeamma Mallee land unit:

- Karsts – Given the substantial depth to underground water, karsts are likely to be one of the only ecosystems dependent on underground water within this area. Little is known about the extent of karsts in this land unit in terms of whether they

intersect the underground water table or the nature of the biota they support. Mallee vegetation is considered to be independent of underground water.

- Hypogean Ecosystems – These macroinvertebrate and microbial ecosystems where present, occur underground within the water filled pore spaces of the aquifer system. There are no records of such ecosystems within the Geegeela Beeamma Mallee Land Unit. However, they are likely to exist within this area.

Naracoorte Plateau Land Unit

The Naracoorte Plateau comprises of the area east of the Naracoorte Range, south of the Hundreds of Geegeela and Beeamma. The geology is predominantly Parilla Sand overlying Gambier Limestone, which outcrops in the vicinity of Naracoorte and Wrattonbully. The landscape is gently undulating and includes a number of depressions at elevations of 85 to 95m AHD. The elevation of the water table declines from the west to the east, from approximately 100m AHD near Wrattonbully, to 60m AHD near the edge of the Naracoorte Range.

The following ecosystems dependent on underground water have been identified as present, or are likely to be present within the Naracoorte Plateau Land Unit:

- Wetlands – There are numerous swamps within this land unit, which vary in their proximity to underground water from 2m to more than 10m. These wetlands are believed to be perched, pooling local rainfall and runoff from drainage lines. Underground water dependence in these wetlands is likely to be through the presence of phreatophytes, particularly *Eucalyptus camaldulensis*. The water regime of wetlands under which a shallow water table occurs may include the existence of a underground water mound. A potentially significant example is the Mullinger Swamp Conservation Park which lies at 85m AHD and where the water table may only be 2m below the surface.

- Streams – There are four streams in this area, namely Morambro Creek, Naracoorte Creek, Mosquito Creek and Yelloch Creek. In this land unit all streams lie at elevations of more than 5m above the water table and are not believed to receive underground water discharge.

- Phreatophytes – *Eucalyptus camaldulensis* is the dominant tree species in many of the wetlands, depressions and watercourses, where the surface elevation is between 80 and 95m AHD and the underground water table is less than 10m below the surface. These trees are likely to be dependent on underground water in many areas, variously through permanent use and temporary dependence during dry periods.

- Karsts – There are numerous sinkholes and other karst features in the Naracoorte Plateau, many of which intersect the underground water table. There is no information available on the nature of the biota they support.

- Hypogean Ecosystems - These macroinvertebrate and microbial ecosystems where present, occur underground within the water filled pore spaces of the aquifer system. There are no records of such ecosystems within the Naracoorte Plateau Land Unit. However, they are likely to exist within this area.

Naracoorte Ranges Land Unit

The Naracoorte Ranges Land Unit comprises a dune of the Bridgewater Formation, which overlies the Gambier Limestone. It is bounded to the east by the 80m AHD topographic contour and to the west by the 50m AHD contour. This area also includes a number of low-lying areas in which the Padthaway Formation and Gambier Limestone are exposed. The hydraulic gradient in the water table flattens across the range, as it crosses the Kanawinka Fault and decreases from 65m AHD on the Naracoorte Plateau to 55m AHD on Mosquito Creek flat.

The following ecosystems dependent on underground water have been identified as present, or are likely to be present within the Naracoorte Ranges Land Unit:

- Karsts – This area includes a number of karsts, including the Naracoorte Caves National Park. However, most are not believed to intersect the water table, with the exception of features S102 (Cave Divers Association Reference No.), which is temporarily inundated.

- Wetlands – There are a number of wetlands formed in small, enclosed depressions, which appear to receive underground water discharge. The most significant of these is Deadmans Swamp, which appears on the National Heritage Register. Despite its small catchment, the wetland is permanent, in contrast to other wetlands in the area, which suggests that underground water maintains the system at least during dry periods. The wetland lies at approximately 62m AHD, which is similar to the water table elevation. Deadmans Swamp and other depressions like it support fringing vegetation of Tea Trees and other species, which are probably dependent on underground water and specifically a shallow water table.

  A number of springs drain into Mosquito Creek as it flows through the Naracoorte Range. The springs do not contribute significantly to stream flow, which is dominated by runoff from its western Victorian catchment. The springs do, however, form pools, which may be significant permanent water refuges for aquatic fauna, including the Vulnerable Yarra Pygmy Perch.

- Hypogean Ecosystems - These macroinvertebrate and microbial ecosystems where present, occur underground within the water filled pore spaces of the aquifer system. There are no records of such ecosystems within the Naracoorte Range Land Unit. However, they are likely to exist within this area.

Naracoorte Plain Land Unit

The Naracoorte Plain comprises the low relief inter-dunal flat to the west of the Naracoorte Range. The geology of the area comprises Padthaway Formation underlain by the Gambier Limestone. The land unit is bound to the east by the 50m AHD topographic contour. The underground water table lies at less than 5m below the surface near the Naracoorte Range and less than 2m in the west of the land unit.

The following ecosystems dependent on underground water have been identified as present, or are likely to be present within the Naracoorte Plain Land Unit:

- Wetlands – This area is characterised by numerous scattered wetlands, many of which have conservation significance. Most wetlands lie at elevations between 45

and 50M AHD above an underground water table of 46 to 49m AHD. Hacks Lagoon Conservation Park is the only semi-permanent wetland, and the surface flow, which enters the wetland from Mosquito Creek, is believed to be supplemented by underground water discharge. Hacks Lagoon forms part of the Bool Lagoon Ramsar site.

The water regime of many of these wetlands is likely to be influenced by the shallow water table and the possible formation of underground water mounds beneath them. Mounds, where they occur, affect seepage rates and the duration and extent of surface flooding. The surface water regime is important in the growth and reproductive cycles of wetland biota. Underground water will also provide water to phreatophytic vegetation, particularly *Melaleuca halmaturorum* which is present in Bool Lagoon and other wetlands. The wetlands exhibit a range of salinities and a corresponding range of vegetation types. The discharge of saline underground water is the likely to be the reason for the presence of communities dominated by salt tolerant species in some wetlands. The salinity of some wetlands may have increased through the evaporative concentration of salts that accumulate through the action of the capillary fringe.

- Hypogean Ecosystems - These macroinvertebrate and microbial ecosystems where present, occur underground within the water filled pore spaces of the aquifer system. There are no records of such ecosystems within the Naracoorte Plain Land Unit. However, they are likely to exist within this area.

Water Needs of Identified Ecosystems Dependent on Underground Water

Table 2.1 sets out the quantity (elevation and annual range), quality (salinity) and timing (seasonality of maximum and seasonality of minimum) of water needed by the ecosystems identified in each of the four land units of the Naracoorte Ranges PWA. The current conditions (as at October 2000) within each land unit, have been included to provide a comparison with the identified ecosystem water needs (most recent observed steady state conditions).

Table 2.1: Requirements of Identified Ecosystems Dependent on Underground Water

Land Unit	Parameter	Current Conditions at October 2000	Ecosystem Water Needs	Most Recent Observed Steady State Period
Geegeela Beeamma	Salinity	increase up to 35 mg/L/yr since 1987	1000-1500 mg/L	1990
	Elevation of Water Table	+>1 m since 1979	70-75 m AHD	1970-1979
	Annual Fluctuation	no change	0.05-0.1 m	1970-2000
	Seasonality of Maximum	no change	Spring	1970-2000
	Seasonality of Minimum	no change	Autumn	1970-2000
Naracoorte Plateau	Salinity	no change or minor increase	800-1500	1970-2000
	Elevation of Water Table	no change	100-60 m AHD	1970-2000
	Annual Range	no change	0.2 m	1970-2000
	Seasonality of Maximum	no change	Spring	1970-2000
	Seasonality of Minimum	no change	Autumn	1970-2000
Naracoorte Range	Salinity	no change	1300 mg/L	1971-2000
	Elevation of Water Table	mostly rising, especially in north	steady state	1971-1993
	Annual Range	no change	0.1-0.3 m	1971-2000
	Seasonality of Maximum	no change	spring	1971-2000
	Seasonality of Minimum	no change	autumn	1971-2000
Naracoorte Plain	Salinity	+ up to 350 mg/L/year near Naracoorte Township	1000-4000 mg/L	1990
	Elevation of Water Table	no change	55-45 m AHD	1970-2000
	Annual Range	up to 2.8 m	0.5-1.5 m	1970-1988
	Seasonality of Maximum	no change	Spring	1970-2000
	Seasonality of Minimum	no change	Autumn	1970-2000

Glossary

Amphipod	A small (approximately 5mm long) aquatic crustacean found in fresh waters including cave environments.
Hydraulic gradient	Spatial variation in the effective elevation of the water table, which drives lateral flow in underground water.
Hypogean ecosystems	Macroinvertebrate and microbial communities that occur within the water filled pore spaces of the saturated zone.
Invertebrate	An organism with an external skeleton.
Karst Feature	Cavity or cave formed by the solution of limestone by naturally occurring acids.
Macroinvertebrate	An invertebrate greater than 0.5 mm in length.
Microbial	Bacteria, fungi etc. that are invisible to the naked eye.
Phreatophyte	A plant that is dependent on underground water.
Recharge	Water that replenishes the aquifer by infiltration from the land surface.
Saturated zone	The zone in which voids within soils and rocks are completely filled with water, also known as the phreatic zone.
Stromatolite	Layered deposits of calcium carbonate and various other minerals which have been created by the action of living organisms such as microscopic algae, bacteria and other microbes.
Stygobite	An organism which exclusively inhabits underground habitats, such as caves and subterranean waters.
Syncarid	A small (approximately 3 mm long) aquatic invertebrate belonging to an ancient order of crustaceans, the Syncaridae. Their form has changed little over millions of years, and they are sometimes referred to as a living fossil. They are usually found in underground environments and are generally rare.
Through-flow	Lateral passage of underground water, driven by a hydraulic gradient.
Unsaturated zone	Region above the water table through which recharge infiltrates, also known as the vadose zone.
Water table	Upper surface of saturation in the unconfined aquifer.

3 Assessment of Effects on Other Water Resources

Section 101 (4) (b) of the Act requires the Plan to contain an assessment of whether the taking of water will have a detrimental effect on the quality and quantity of water available from any other water resource.

Other water resources within the Naracoorte Ranges PWA comprise the following:

- Morambro, Naracoorte, Mosquito and Yelloch Creeks; and
- Wetlands and springs, including Deadmans Swamp and Hacks Lagoon.

The potential detrimental impacts of taking, or using, water from the unconfined aquifer in the Naracoorte Ranges PWA on the quantity or quality of water in the confined aquifer resource, and the impacts taking or using water from the confined aquifer may have on the quantity or quality of water in the unconfined aquifer resource, were also considered, as well as the impacts of taking and use of underground water from the Naracoorte Ranges PWA on other water resources in adjacent PWAs.

Creeks

There are four streams in the Naracoorte Ranges PWA, Morambro, Naracoorte, Mosquito and Yelloch Creeks. All the creeks lie at elevations of more than 5 metres above the water table and are not believed to receive groundwater discharge. ie they are losing (recharging) creeks. Thus use of the unconfined aquifer resource can have no direct effect on the flow regime of the watercourses.

Wetlands

The northern and eastern areas of the Naracoorte Ranges PWA are generally more than 10 metres above the water table and are not believed to support groundwater dependent wetlands. Deadmans Swamp and other depressions like it in the Naracoorte Ranges Land Unit are probably dependent on groundwater and specifically a shallow water table. The Naracoorte Plain Land Unit is characterised by numerous scattered wetlands, many of which have conservation significance. Hacks Lagoon Conservation Park is the only semi-permanent wetland, and the surface flow which enters the wetland from Mosquito Creek is believed to be supplemented by groundwater discharge. Hacks Lagoon forms part of the Bool Lagoon Ramsar site.

A number of springs drain into Mosquito Creek as it flows through the Naracoorte Range. The springs do not contribute significantly to stream flow, however, the springs do form pools which may be significant permanent refuges for aquatic fauna.

The taking and use of underground water is not expected to detrimentally affect the quantity and quality of water available in these wetlands and springs.

Confined Aquifer

The aquitard that separates the unconfined and confined aquifers in the Naracoorte Ranges PWA is generally more than 20 metres thick and has a very low permeability. While the potential for recharge to the confined aquifer exists (ie. the head in the

unconfined is higher than the potentiometric head in the confined aquifer) the low permeability would inhibit downward leakage to the confined aquifer. It is therefore unlikely that any use in the unconfined aquifer would directly affect the confined aquifer.

Unconfined Aquifer

The presence of the low permeability aquitard between the confined and unconfined aquifers would make it most unlikely that extraction from the confined aquifer would impact on the unconfined aquifer.

However, if underground water were to be taken from the confined aquifer then the only foreseeable way it could affect the unconfined aquifer would be if the water from the confined aquifer were added to the unconfined aquifer. In this scenario, there may be an additional volumetric effect, due to the increased quantity of water applied to the unconfined aquifer, and possibly a quality effect due to the addition of salts in the water. As the underground water in the confined aquifer is generally of a similar salinity to that of the unconfined aquifer, the additional salt load will have a negligible detrimental effect. The application of an additional volume of water is also unlikely to have any long-term effect on the unconfined aquifer in the Naracoorte Ranges PWA, given that there is only a minimal response in the aquifer when additional volumes of water are applied during point source recharge events.

Water Resources in Adjacent PWAs

The taking and use of underground water (from either the confined or unconfined aquifers) within the Naracoorte Ranges PWA is not expected to have a detrimental effect on water resources within adjacent PWAs.

4 Assessment of the Capacity of the Resource to Meet Demands

4.1 Capacity of the Resource

The capacity of the underground water resources of the Naracoorte Ranges PWA to meet demands on a continuing basis will depend on several factors. One of the main factors is the rate of extraction of underground water by underground water users. Systems for appropriately allocating underground water and managing its use are required for the protection of the long-term condition of the resource.

The Permissible Annual Volume (PAV) as defined by the *Groundwater (Border Agreement) Act 1985* in effect relates to the volume that can be allocated for licensed extraction within the Border Designated Area. In calculating the PAV for the Border Designated Area , stock and domestic use has been excluded in the definition of PAV, as a water licence is not required for these purposes.

It is now recognised that it is preferable to calculate the volume of water to allocate throughout the area covered by this Plan, by making provision for stock and domestic use, the expansion of plantation forestry, and the environment. For this reason, the concept of Volume for Licensed Allocation (VLA) has been developed.

The VLA is the total quantity of water (in megalitres) available for licensed extraction on an annual basis within each management area (see Table 4.1 or Table A, annexed hereto). The VLA is calculated differently for each aquifer.

The Volume for Licensed Allocation in each management area for the unconfined aquifer is calculated as follows:

> The Permissible Annual Volume, less provisions for the effect of forestry plantations on annual average vertical recharge, stock, domesticand environmental demands, less a further 10% buffer in areas that were not fully allocated (or did not become fully allocated as a result of the buffer) at **date of adoption**.

The Volume for Licensed Allocation in each management area for the confined aquifer is calculated as follows:

> The Permissible Annual Volume, less provisions for the effect of leaking wells, stock, domestic and future urban (town) use.

4.2 The Unconfined Aquifer

4.2.1 The Capacity of the Resource

The annual rate of net removals of underground water from the unconfined aquifer should roughly equate to the estimated average annual vertical recharge to the water table. The principle behind this approach is that lateral throughflow is maintained in the aquifer, thereby allowing any salts accumulated during recharge to be flushed down-gradient.

The PAV has been estimated by calculating the annual average vertical recharge to the aquifer in accordance with the following formula:

PAV for all management areas (in ML per year) = (sum of $(A_n X R_n))XS_f$

Where:

- A_n is the land area (in square kms) of a defined recharge region within the individual management area;
- R_n is the annual average vertical recharge rate (in mm per year) of the defined recharge region A_n;
- S_f is the salinity factor adopted for the management area.

As shown in Figure 4.1, a management area can comprise one or more recharge regions, each of which is assigned an individual recharge rate. The recharge rate is determined by considering factors such as land use, soil type, depth to groundwater and seasonal groundwater level responses. The salinity factor is a proportional reduction of the total recharge in the management area, where the extraction of 100% of the annual average vertical recharge is expected to lead to unacceptable salinity impacts.

In 2000, the Department for Water Resources estimated the PAV for the Naracoorte Ranges PWA to be 80,937 ML. The PAV for each management area within the Naracoorte Ranges PWA is shown in Table 4.1.

Note that the PAVs in some of the management areas in the Naracoorte Ranges PWA are less than the annual average vertical recharge volume because of concerns with rising underground water salinity.

Table 4.1: Naracoorte Ranges PWA unconfined aquifer PAVs and licensed allocations and estimated use for 1998/99 (all in ML)

Management Area	PAV	Annual Average Vertical Recharge [1]	Licensed allocations and Estimated Use 1998/99			
			Total Licensed Allocations	Irrigation Allocations	Industrial and Recreational Allocations	Estimated Use
Struan	3,700		4,126	4,126	0	1,815
Joanna	10,000	33,580[3]	10,258	10,236	22	7,986
Zone 5A	18,500	19,980	18,767	18,171	596	9,843
Bangham	4,170		N/A	N/A	N/A	N/A
Frances	4,680	10,760[2]	8,849[2]	8,827[2]	22[2]	2,649[2]
Western Flat	952	N/A	952	952	0	154
Bool	3,200	3,200	1,154	1,154	0	0
Hacks	3,700	3,700	3,686	3,686	0	664
Moyhall	4,800	4,800	1,115	1,115	0	660
Ormerod	6,095	6,800[4]	N/A	N/A	N/A	N/A
Stewarts	7,140	8,040[4]	13,881[2]	13,805[2]	77[2]	9,983[2]
Hynam West	4,000	4,600[4]	4,008	4,008	0	1,374
Hynam East	5,000	4,750[4]	5,146	5,146	0	1,741
Beeamma	5,000	5,290[4]	5,928	5,928	0	2,112
Total	**80,937**		**77,871**	**77,154**	**717**	**38, 982**

1 annual average vertical recharge values available for full zones within the Border Designated Area only.

2 combined Bangham and Frances data (formerly Zone 6A) and combined Ormerod and Stewarts data (formerly Hundred of Naracoorte).

3 annual average vertical recharge figure for all of Zone 4A.

4 estimated valuestaken from the Naracoorte Ranges Prescribed Wells Area Water Allocation Plan 14 August 2000. These values may be subject to change.

4.2.2 Current Demand

The historic and current level of allocation and use in the Naracoorte Ranges PWA gives a good indication of the present demands on the unconfined aquifer.

General

The total annual underground licensed water allocation for the 1998/99 irrigation season for the Naracoorte Ranges PWA was 77,871 ML, which represents 112% of the VLA. Total underground water usage for the same period was estimated to be 38,982 ML, which represents about half of the total allocation.

Demand has been exceptionally high in Stewarts management area, where the Total Licensed Allocations as at 23 May 2001 exceed the VLA by more than 7,000 ML, as shown in Table 4.2 and Table A. Allocations in the Stewarts management area are primarily used for irrigating pasture for grazing stock; vineyards are also located within this management area. Other management areas within the Naracoorte Ranges PWA,

which are over-allocated by between 1,200 and 2,800 ML, include Joanna, Zone 5A, Bangham, and Beeamma management areas.

However, underground water usage must be interpreted carefully, due to the method by which use for irrigation purposes is calculated. Historically, allocation of water licences for irrigation have been based on area and the irrigated crop water use requirement relative to a reference crop. The water usage volume is then estimated from annual seasonal returns supplied by water users and correlation with aerial photography. The volume of water used by crops is calculated by converting the area of irrigated crops to megalitres, using crop area ratios. The irrigated crop water requirement method does not reflect the actual volume of groundwater extracted from the aquifer, and estimation of the volume used by each licensee relies on the veracity of the water user and the irrigated crop requirement method. A suitable method of measuring actual underground water use is required.

In contrast, allocations of water licences for industrial & recreational purposes are issued volumetrically. However, there is no recorded usage of these allocations. Even though allocations exist and some wells are equipped with meters, there is no regular meter reading program.

Irrigation

Irrigation is by far the greatest user of underground water in the PWA. A total of 11,884 hectares of irrigated crops were grown in the Naracoorte Ranges PWA in 1998/99, which represents 5% of the total land in the PWA. The majority (42%) of this area is pasture, most of which is fully irrigated (60%). Lucerne hay (15%), start/finish pasture (14%), and lucerne grazing (7%) make up the remainder of the 5,002 ha of pasture. Pasture/seeds, comprising mostly of clover and Haifia seed crops, are the next largest group, with 2,543 ha (21% of total area). The third most dominant crop in the Naracoorte Ranges PWA is irrigated lucerne seed, which has tripled in size since 1986/87 to cover 1,121 ha in 1998/99.

The total irrigated area has expanded by roughly 30% in the last ten years. Irrigated pastures have increased in area, but the most significant increase in irrigation activity has been of vines, with an area that has increased from 45 ha in 1986/87 to cover 1,548 ha in 1998/99.

Industrial and recreational use

717 ML had been allocated in 1998/99 in the Naracoorte Ranges PWA for both industrial and recreational use, combined. The licences held under the recreation category are largely held by sporting clubs (for watering sports fields, greens and gardens) and Local Government (for the watering of parks and gardens.)

Stock, domestic and town water use

Total annual stock underground water use from the unconfined aquifer for the PWA is estimated to be 1,895 ML (as shown in Table 4.2). These figures are based on stock numbers for the 1996/97 season in the Naracoorte Ranges PWA which were obtained from the Australian Bureau of Statistics, and multiplied by the average daily stock consumption figures from data supplied by the New South Wales Department of Agriculture. The stock underground water use estimates are to the nearest 5 ML.

Domestic use was estimated during the recent pro-rata roll out, as shown in Table 4.2. Domestic use has only been estimated for those areas that were being considered for the pro-rata roll out.

Naracoorte township sources its water from the confined aquifer, therefore there are no town use estimates in Table 4.2.

Table 4.2: Licensed and unlicensed demands for the unconfined aquifer in the Naracoorte Ranges PWA

Management Area	PAV ML	Forestry Commit-ment ML	Stock Use ML	Domestic Use ML	Environ-ment ML	VLA[(a)] ML	Total Licensed Allocations at 23/05/01[(b)] ML
Struan	3,700	0	70	0	370	3,260	4,097
Joanna	10,000	0	330	0	1,000	8,670	10,223
Zone 5A	18,500	0	505	0	1,850	16,145	18,955
Bangham	4,170	0	155	0	417	3,598	4,796
Frances	4,680	0	140	0	468	4,072	4,710
Western Flat	952	0	30	0	95	827	964
Bool	3,200	50	60	16	320	2,479	1,795
Hacks	3,700	50	60	18	370	3,202	3,686
Moyhall	4,800	50	60	23	480	3,768	2,310
Ormerod	6,095	0	85	0	610	4,860	360
Stewarts	7,140	0	85	0	714	6,341	13,521
Hynam West	4,000	0	70	0	400	3,530	4,008
Hynam East	5,000	0	140	0	500	4,360	4,543
Beeamma	5,000	0	105	0	500	4,395	5,688
Total	**80,937**	**150**	**1,895**	**57**	**8,094**	**69,507**	**79,656**

4.2.3 Future Demand

Irrigation

Apart from the Bool,Moyhall and Ormerod management areas, the Naracoorte Ranges PWA is fully allocated, and the remaining management areas are all over-allocated, if all bona fide unlicensed uses (stock, domestic, and forestry and environmental commitments) as well as licensed allocations, are taken into account.

However, there may be expansion in irrigation through the transfer of allocations, or as unused allocations are brought into production.

Industrial and recreational use

The future use for recreational and industrial use is expected to remain the same as current use. No significant future industrial users of underground water are known.

Forestry Commitments

Plantation expansion can potentially have an impact on future demand. If the area under plantation were to expand then annual average vertical recharge to the unconfined aquifer would effectively be reduced. During the recent pro-rata roll out process, the expected reduction in annual average vertical recharge due to forestry expansion was calculated as 50 ML in each of the Bool, Hacks and Moyhall management areas. Forestry expansion was estimated by including any forestry proposal not yet commenced but which had an approval under a Local Government Development Plan and industry estimates of firm proposals for developments that had not yet obtained approval under a Local Government Development Plan.

There are currently few established pine or bluegum plantations in the Naracoorte Ranges PWA. However, if in the future there was a dramatic increase in forestry development then it becomes unclear how the PAV will be reduced to compensate for the reduction in annual average vertical recharge.

Environmental Commitment

During the recent pro-rata roll out, an allowance of 10% of the PAV was made for environmental requirements in the Naracoorte Ranges PWA in management areas Bool, Hacks and Moyall. An allowance of 10% for environmental commitments has also been made in the remaining management areas.

Stock and domestic

Annual fluctuations in stock and domestic water use are anticipated to be small.

4.2.4 Current Status of the Water Resources

Underground Water Flow

The direction of underground water flow is generally from the South Australian – Victorian Border in the east towards the coast in the west.

Water Level Trends

Long term water level trends from hydrographs located in the Naracoorte Ranges PWA are shown on Figure 4.2. Only wells with more than five years data and currently part of the monitoring network were included in the assessment.

With the exception of the Hundreds of Beeamma and Geegeela in the north of the PWA, water levels from well hydrographs generally show a recent decline or have shown no significant change in water level over the monitoring period.

Most of the decline in water levels has occurred over the last eight years and is consistent with a period of below average annual rainfall that has occurred since the end of 1992. Generally the average long-term decline ranges between one and four cm/yr but this is influenced by the recent higher rate of water level decline. Observation wells NAR049 in the Ormerod management area, NAR063 in the Stewarts management area and JOA018 in the Joanna management area have a much greater rate of decline when compared to the average. These wells have a shorter, more

recent monitoring record than the other wells. The trend values therefore represent the recent short-term decline in water level.

In the Hundreds of Beeamma and Geegeela water levels are on average increasing at a rate ranging between 4 and 26 cm/yr. The rise in the water table is considered an outcome of the clearance of native vegetation (50–100 years ago) and the failure of lucerne crops in the mid-1970s. The largest increase is observed in BMA006 located in the south-west of the Hundred of Beeamma. Since 1971 the water level has risen more than seven metres.

The low levels of use of allocations in the northern management areas of the PWA may be contributing to the long-term rise in water levels. However by actively encouraging water use there may be deleterious effects such as increasing underground water salinity from irrigation returns.

Recently, however, the hydrographs in the northern portion of the PWA have stabilised (some show a slight decline). This may be a result of the aquifer finding a new equilibrium or more probably it is a reflection of the recent below average rainfall.

The present management strategy of adopting a 'wait and see' approach augmented by continued monitoring is probably the most effective option for the management of the Naracoorte Ranges PWA.

Salinity Distribution

The salinity distribution for the Naracoorte Ranges PWA is shown on Figure 4.3. Generally the salinity ranges from ~900 mg/L to ~2500 mg/L.

Salinity Trends

Salinity monitoring on a regular basis began in 1987 giving thirteen years of records. Shorter term data runs are available from wells added to the network at later dates. Figure 4.4 shows the long term trends in underground water salinity in mg/L/year. There is no overall consistent pattern to such trends except that in general the small increases in salinity are occurring in the higher areas in the Hundreds of Beeamma, Geegeela and Binnum. The increase in underground water salinity in these Hundreds is attributed to higher rates of annual average vertical recharge mobilising salts stored in the unsaturated zone as a result of land clearance in the late 1800s and early 1900s.

In the southern highland areas (Hundreds of Jessie and Joanna and possibly the Hundred of Binnum), the increasing salinity is attributed to high levels of irrigation activity.

Studies to differentiate between an increase in underground water salinity caused by land clearance and that of high density irrigation (underground water recycling) have been inconclusive. Further study into understanding salt accession mechanisms to the unconfined aquifer is required.

The much higher values shown on Figure 4.4 relate to shorter length data sets. Observation well JOA018 in the Joanna management area has been increasing on average 95 mg/L/year since 1994. The cause of this increase in not obvious and requires further investigation. On the plain the increasing underground water salinity is

attributed to evaporative underground water discharge (eg, as evident in the Hundred of Robertson).

The underground water salinity is generally considered to be well within the accepted limits for livestock use. Of more concern is the effect the rising underground water salinity will have on crop yields.

In Table 4.3 the relationship between crop yield and irrigation water salinity (in mg/L TDS) for potatoes, onions, clover pasture and grapes are shown. With reference to the table it is apparent that as salinity increases crop yields reduce. The difference in yield potential between individual crops is related to the salt tolerance of each crop type.

Table 4.3: Influence of Irrigation Salinity on Yield Potential

	Yield Potential*			
Crop Type	**100%**	**90%**	**75%**	**50%**
Potato	605	940	1380	2170
Onion	440	660	990	1610
Clover Pasture	550	1210	2170	3830
Grape	550	940	1500	2510

** irrigation salinity is in mg/L*

It is not only the applied irrigation salinity that can influence crop yields; soil type, climate, chemistry of the water, land and irrigation management practices can all impact on crop production.

Water Balance

A water balance also helps to determine whether the capacity of the resource is sufficient to meet demand on a continuing basis.

A generalised water balance for the unconfined aquifer has been determined on a management area basis for the Naracoorte Ranges PWA (Table 4.4). The balance is by no means comprehensive and should be treated as a rough approximation only. Transmissivity values for each management area were those as adopted under the *Groundwater (Border Agreement) Act 1995*. A transmissivity of 3000 m^3/day/m was adopted for the lowland plains area. Lateral inflow and outflow calculations were estimated using flow-net analysis.

In its most general form the water balance for any closed basin may be expressed as follows:

$\sum$(inputs) - $\sum$(outputs) = change in storage

A tentative water balance for the Naracoorte Ranges PWA (in ML) is therefore as follows:

(171 380 ML) - (131 620 ML) = (39 760 ML)

The change in storage is most evident in the northern portion of the PWA where a significant rise in the water table has occurred.

Conclusion

The overall capacity of the water resources in the Naracoorte Ranges PWA are considered to be sufficient to meet all existing and reasonably foreseeable future demands for water, with the exception of the management areas which are currently over-allocated if all bona fide unlicensed uses (stock, domestic and forestry and environmental commitments) as well as licensed allocations, are taken into account (refer to Table A, annexed hereto). Full use of allocations in these management areas may accelerate the rate of salinisation of the unconfined aquifer.

Increasing underground water salinity in the unconfined aquifer is the main water resource management issue for the Naracoorte Ranges PWA. As outlined above it has not been possible to distinguish salinity increases caused by land clearance from increases resulting from irrigation activity. Generally the present rates of salinity increase are not of major concern, however in those areas showing above average salinity increases, further investigation is warranted. In the long term the viability of growing salt sensitive crops such as those listed in Table 4.3 may be under threat.

Table 4.4: Management Area Water Balance for the Unconfined Aquifer in the Naracoorte Ranges PWA

Inputs	Management Area														
					Zone 6A			Naracoorte							
	Joanna	Bool	Struan	Zone 5A	Frances	Bangham	Moyhall	Ormerod	Stewart	West Flat	Beeamma	Hacks	Hynam E	Hynam W	Totals
Underground water Inflow	5480	4930	7310	6870	540	1320	9040	9040	6980	1840	5630	2470	4250	9590	75290
Rainfall Recharge	14760	3200	7200	19980	2960	7800	4800	6800	8040	1500	6000	3700	4750	4600	96090
Total in															171380
Outputs															
Underground water Outflow	8040	5420	8500	5150	630	3520	9040	9040	9040	2110	4570	3620	14930	9040	92650
Crop Use (1998/99)	7990	0	1820	9840	2650	2650*	660		9980*	150	2110	660	1740	1370	38970
Total Out															131620
Change in Storage															39760

* combined Bangham and Frances data (formerly Zone 6A) and combined Ormerod and Stewarts data (formerly Hundred of Naracoorte).

4.3 Confined Aquifer

4.3.1 Capacity of the Resource

The PAV for the confined aquifer in the South East is the volume of underground water that can be used on an annual basis from the confined aquifer without causing significant adverse water level or water quality impacts to the underground water resource.

The PAV for each management area in the South East region was estimated by the Department for Water Resources in 2000 and is shown in Table 4.6. The confined aquifer management areas are different to those of the unconfined aquifer, and are shown in Figure 4.5.

Due to the confining layer (aquitard) the underground water in the confined aquifer is under pressure. Unlike the unconfined aquifer, the confined aquifer receives very little direct rainfall recharge. Therefore the proposed PAVs have been developed for each management area for the confined aquifer using a combination of underground water throughflow determinations and computer flow modelling. Various extraction scenarios were modelled to examine the longer term change in aquifer pressure and changes in leakage between the confined & unconfined aquifers.

Other key considerations in determining the PAV included:

- Limiting the magnitude of head decline as a result of increased withdrawals from the confined aquifer, and the impacts to existing users of the confined aquifer

- Consideration of the impact on the unconfined aquifer of increased use of the confined aquifer for irrigation purposes (Confined aquifer water excess to crop requirements returns to the unconfined aquifer. This has the potential to increase salt accessions and water levels within the unconfined aquifer)

- Consideration of the impact of increased extractions from the confined aquifer on marine discharges. However, such impacts are difficult to assess given the lack of present understanding of these processes.

- Modelling limitations in terms of uncertainty in the levels of extraction from the aquifer, and limited extraction data in some areas; both affect calibration of the model.

After consideration of all the above factors, a precautionary approach to the specification of the management prescription for the Tertiary Confined Sand Aquifer has been taken. Limiting the water available for allocation to a proportion (0.75) of the groundwater throughflow volume would adequately allow for the current limited technical understanding of the resource and the lack of knowledge of the environmental significance of the marine discharges from the confined aquifer.

The South East Catchment Water Management Board considered the regional declines in potentiometric (pressure) levels across the aquifer that would be acceptable based on its consultation with the community. The Board considered that a decline in the potentiometric level of generally 2 metres in the next 20 years, with a limited area of 4 metres in the Kalangadoo management area, would be acceptable at this time.

The PAV has therefore been set at 50% of the upper limit of the proportion (0.75) of the groundwater throughflow to maintain recovered seasonal potentiometric levels within this acceptable range of 2 to 4 m, for all management areas except Kingston.

The management prescription recommended for the Kingston Management Area sets the PAV at the current level of allocation and use of water in this area. While this level of allocation is considered to be too high based on the current level of assessment and understanding of the resource, measures will be put in place to improve water use efficiency, and reduce underground water use, over the next five years. Such measures include introducing metering to gain a clear picture of extraction levels from the aquifer, and reducing water wastage through well rehabilitation. If after this time a review indicates that the level of allocation and use is not sustainable, then it is likely that the PAV for the Kingston management area will be reduced, and management strategies introduced to decrease allocations and use to the revised PAV, over the following five year period.

The management prescription for the confined aquifer in the South East is shown in Table 4.5.

Table 4.5: Management Prescription for the Confined Aquifer

AREA	MANAGEMENT PRESCRIPTION
Border Designated Area - Zones 1A-11A	PAV = 50 % x (0.75 x throughflow volumes)
Outside Border Designated Area	PAV = 50 % x (0.75 x throughflow volumes)
Kingston Management Area	PAV = 25,000 ML/annum

Table 4.6: PAVs, VLAs and Licensed and Unlicensed Demands for the Confined Aquifer in South Australia

Management Area	PAV	Stock & Domestic Use	Future Town Use	Allowance for Leaking Wells	VLA (a)	Total Licensed Allocations at 23/05/01 (b)	Irrigation Extraction Factor (c)
Fairview	290	6	0	0	284	0	0
Kalangadoo	3,900	78	0	0	3,822	1,993	386
Keith	2,500	50	0	0	2,450	130	0
Kingston	25,000	500	360	1,761	22,379	19,755	2,935
Lucindale	3,600	72	90	0	3,438	1,325	123
Millicent	10,800	216	0	0	10,584	4,376	676
Taratap	330	7	0	0	323	16	3
Wirrega	960	19	0	0	941	300	0
Zone 1A	9,200	184	210	0	8,806	404	81
Zone 2A	2,900	58	0	0	2,842	50	0
Zone 3A	1,900	38	0	0	1,862	0	0
Zone 4A	710	14	0	0	696	280	56
Zone 5A	540	11	0	0	529	0	0
Zone 6A	360	7	0	0	353	0	0
Zone 7A	350	7	0	0	343	0	0
Zone 8A	340	7	0	0	333	0	0
Zone 9A	570	11	0	0	559	0	0
Total	**64,250**	**1,285**	**660**	**1,761**	**60,544**	**28,629**	**4,259**

Notes:

1. SA Water may soon be issued with water licences for extraction of water for town water supply purposes. However, SA Water did not apply for the full estimated maximum annual usage in some areas. Therefore 560 ML in the Kingston management area, 90 ML in the Lucindale management area and 210 ML in Zone 1A has been set aside in the column titled 'Future Town Use'. Licensed town water supply volumes are included in the column titled 'Total Licensed Allocations'.

2. Stock and domestic use has been estimated at 2% of PAV, across all confined aquifer management areas.

3. An allowance of 10% of total irrigation use (Ha IE irrigation licences converted to a volume using CARs plus the irrigation extraction factor) has been made for loss from confined aquifer leaking wells in the Kingston management area.

4. As area based HaIE licences represent the irrigated crop water requirement, and not the actual volume extracted from the aquifer, a further 20% of HaIE irrigation licences (converted to a volume using CARs) was considered to be extracted from the confined aquifer and recharged to the unconfined aquifer through irrigation root zone drainage, in the column titled 'Irrigation Extraction Factor'.

4.3.2 Historical and Present Demand

General

Part or all of the following six confined aquifer management areas cover the Naracoorte Ranges PWA as shown in Figure 4.5; namely Zone 4A, Zone 5A, Zone 6A, Zone 7A, Wirrega and Lucindale confined aquifer management areas. The licensed allocations at 23 May 2001 in these confined aquifer management areas are presented in Table 4.6.

Town Use

There are currently five wells that supply underground water from the confined aquifer to the township of Naracoorte. The Naracoorte town supply wells are located on the western side of the township in the Lucindale confined aquifer management area. SA Water (town water supply) constitutes the largest user of confined aquifer water in the Naracoorte Ranges PWA.

Combined water use from the wells between 1991/92 and 1998/99 ranged from ~480 to 690 ML per annum. Water use for Naracoorte from July 1998 to June 1999 was 630 ML.

Irrigation , Industy and Irrigation Extraction Factor

Within the boundaries of the Naracoorte Ranges PWA, 39 ML from the confined aquifer is allocated for irrigation purposes, in Zone 4A. No water is allocated from the confined aquifer in the Naracoorte Ranges PWA, for industrial purposes.

As area based HaIE licences represent the irrigated crop water use requirement, and not the actual volume extracted from the aquifer, a further 20% of HaIE irrigation licences (converted to a volume using Crop Area Ratios(as described under section 4.3)) was considered to be extracted from the confined aquifer and recharged to the unconfined aquifer through irrigation root zone drainage, under the Irrigation Extraction Factor in Table 4.6. Unlike the unconfined aquifer, where a portion of the excess irrigation water filters back down through the soil and back into the aquifer, no excess irrigation water extracted from the confined aquifer returns to the confined aquifer.

Stock and Domestic

Current stock and domestic use of the confined aquifer has been estimated at 2% of the PAV across all confined aquifer management areas.

Leaking Wells

There are no known leaking wells in the Naracoorte Ranges PWA.

4.3.3 Future Demand

SA Water believe Naracoorte's water use has stabilised and predict a maximum annual usage of 700 ML over the next five years. SA Water may soon be issued with water licences for extraction of water for Naracoorte's town water supply. 700 ML for Naracoorte's town water supply use has been included in the column titled 'Total Licensed Allocations' in Table 4.6.

The salinity of the underground water in the confined aquifer is relatively high (especially for drinking water) at around 1300 to 1500 mg/L. The cost/benefit of drilling a well into the confined aquifer to obtain better quality underground water is therefore marginal. The confined aquifer may not be present over the whole of the PWA, hence it is unlikely that the confined aquifer will be actively targeted in the immediate future.

4.3.4 Current Status of the Water Resources

Underground water Flow

Within the confined aquifer underground water flow is in a westerly direction. The potentiometric head decreases from around 70 m above AHD at the State Border in the east to 50 m above AHD in the western portion of the Hundred of Hynam.

Water Level Trends

Five confined aquifer monitoring wells exist in the Naracoorte Ranges PWA of which three have records of around 20 years duration. Until around 1992 all three exhibited seasonal fluctuations of the order of 0.5 m with no discernible trend. Since then the three have shown a downward trend imprinted on top of the seasonal fluctuations.

Salinity Distribution

The salinity of the underground water in the confined aquifer ranges from ~830 to ~2100 mg/L. There are however only five sampling points and, while some measurements occurred around five years ago, the aquifer salinity is unlikely to change appreciably in the short to medium term given the depth to the aquifer and the presence of the overlying clay aquitard.

Salinity Trends

There is currently not enough data to assess salinity trends in the confined aquifer but, as referred to previously, a short-term change in underground water salinity is unlikely.

Conclusion

The capacity of the confined aquifer is sufficient to meet demand on a continuing basis.

5 Definitions

Any terms used in this Plan that are defined in the *Water Resources Act 1997* have the definitions set out in that Act and in addition for the purposes of this Plan the following terms have the definitions set out below:

"Adjoins" or **"Adjoining** means in relation to an allotment or management area that the allotment or management area, or any part of the allotment or management area, is contiguous with another allotment or management area and includes allotments or management areas that are separated only by a road, street, footpath, railway or thoroughfare.

"AHD" means the Australian Height Datum, which is the datum used for the determination of elevations in Australia. The determination used a national network of bench marks and tide gauges, and set mean sea level as zero elevation.

"Allotment" means:

(a) the whole of the land comprised in a certificate of title including a community or development lot or common property within the meaning of the *Community Titles Act 1996* or a unit or common property within the meaning of the *Strata Titles Act 1988*;

(b) the whole of the land comprised in a registered conveyance of land that has not been brought under the provisions of the *Real Property Act 1886*;

(c) a separately defined piece of land that is delineated on a public map and separately identified by a number or letter (not being a piece of land that is identified in a Treasury receipt, certificate or other document or instrument of title as being part only of an allotment);

(d) two or more separately defined pieces of land that are delineated on a public map and that are identified in a Treasury receipt, certificate or other document or instrument of title as forming one allotment for the purposes of the *Real Property Act 1886*;

(e) a separately defined piece of land delineated on a plan of division for the purpose of enabling the separate ownership in fee simple of that land;

(f) a separately defined piece of land identified as an allotment for the purposes of the Real Property Act in a plan prepared by the Registrar-General and accepted for filing in the Lands Titles Registration Office;

(g) where a primary plan of community division has been cancelled under Part 7 Division 3 of the *Community Titles Act 1996* or a strata plan has been cancelled under Part 2 Division 7 of the *Strata Titles Act 1988* – the land comprising the former community parcel or site shown on the plan.

"Aquaculture" means the propagating or keeping of stocks of any aquatic or marine organism.

"Aquifer storage and recovery" means the process of drainage or discharge of water directly or indirectly to a well for the purposes of refilling or replenishing the aquifer or storing water in the aquifer for subsequent extraction.

"Confined Aquifer" means the saturated sands and gravels of either the Dilwyn Formation or the Mepunga Formation in the Otway Basin, or the Renmark Group in the Murray Basin.

"Draw down" means the occasional, seasonal or permanent lowering of the water table or reduction in pressure (head) of an aquifer resulting from the extraction of underground water.

"Exceptional circumstances" means the death or serious illness of or serious injury to the licensee or, where the licence is held by a company, partnership or incorporated body, the death or serious illness or injury to a director, partner or office holder respectively, that prevents the licensee from using the allocation with the minimum of delay and in any case within 3 years of the date of the granting of the allocation.

"Flood irrigation" means irrigation where underground water is pumped or directed onto an irrigation bay or levelled land and flows uniformly across the bay or the land without the aid of sprinklers, drippers or other infrastructure.

"Imported water" means water which has been brought into a management area by means of a pipe or other channel, and the water (including surface water) has been extracted and piped, or directed into a channel, under licence or permit under the *Water Resources Act* 1997, *South Eastern Water Conservation and Drainage Act 1992* or *Groundwater (Border Agreement) Act 1985* from the originating management area or zones within the Border DesignatedArea.

"Industry" means the carrying on, in the course of a trade or business, of any purposes for, or incidental to:

(a) The making of any article (or part thereof); or

(b) The altering, repairing, ornamenting, finishing, assembling, cleaning, washing, packing, bottling, canning or adapting for sale, or the breaking up or demolition of any article; or

(c) The getting, dressing or treatment of materials.

"Management area" means for the unconfined aquifer, a part of a Prescribed Wells Area as shown in Figure 1.1 and for the confined aquifer, a part of a Prescribed Wells Area shown in Figure 4.5.

"Permissible Annual Volume" means for the unconfined aquifer in the South East, the volume of water that can be sustainably used or assigned from the unconfined aquifer on an annual basis in a particular management area. For the purpose of this definition, "assigned" means the volume set aside for environmental and future forestry commitments.

"Permissible Annual Volume" means for the confined aquifer in the South East, the volume of underground water that can be used on an annual basis from the confined aquifer without causing significant adverse water level or water quality impacts on the underground water resource.

"Pollution" includes any solid, liquid, gas or heat (or any combination thereof) that directly or indirectly causes or has the potential to cause harm to the environment, structures, persons or organisms.

"Potentiometric level" means the level to which water rises in a well due to water pressure in the aquifer. May also be referred to as the "potentiometric surface" or the "potentiometric head".

"Public water supply" means the supply of water by reticulation primarily for domestic purposes.

"Recharged water" means water which has been drained or discharged directly or indirectly into a well in accordance with a permit granted under the *Water Resources Act 1997*.

"Recreational use" means the use of water for the irrigation of parks, gardens and sports grounds, whether publicly or privately owned.

"Rotational crop" means a crop or plantation of a species/cultivar that produces one harvest per planting and requires an inter-rotational break period of three years or greater from the date of the previous planting before the same crop or plantation can be replanted at the same location.

"Same ownership" means any allotment or allotments where the registered proprietor is, or proprietors are, a member of the same family. For the purpose of this definition, "same family" includes a company where the director, directors or shareholders are members of the family or a trustee of a trust where the beneficiaries of that trust are one or more members of that family.

"Specific Yield" means the ratio of the volume of water a rock or soil will yield by gravity drainage, to the volume of the rock or soil.

"Unconfined Aquifer" means the saturated sequence of rocks occurring above the aquitard on top of the Dilwyn Formation or the Mepunga Formation in the Otway Basin, or the Renmark Group in the Murray Basin, whether occurring within the Gambier Limestone of the Otway Basin, the Murray Group Limestone of the Murray Basin, or some other younger geological unit.

"Volume for Licensed Allocation (VLA)" means the total quantity of water (in megalitres) available for licensed extraction on an annual basis within each management area (see tables A and B, annexed hereto).

The Volume for Licensed Allocation in each unconfined aquifer management area is calculated as follows:

> The Permissible Annual Volume less provisions for the effect of forestry plantations on annual average vertical recharge, stock, domestic, and environmental demands, less a further 10% buffer in areas that were not fully allocated (or did not become fully allocated as a result of the buffer) at **date of adoption**.

The Volume for Licensed Allocation in each confined aquifer management area is calculated as follows:

> The Permissible Annual Volume, less provision for the effect of leaking wells, stock, domestic and future town use.

"Water use year" means a period of 12 months commencing on the 1 July in any year.

"Wild flooding" means flood irrigation where no adequate system such as land levelling, or irrigation bays is used to ensure uniform distribution of water.

6 Allocation Criteria – Unconfined Aquifer

The present and future needs for water by the occupiers of land in the Naracoorte Ranges Prescribed Wells Area have been outlined in section 4. The present needs for water of the occupiers of land in the Naracoorte Ranges Prescribed Wells Area are mainly irrigation, stock and domestic water use, town water supplies, and industrial use. Stock, domestic and town water use is expected to remain relatively stable. Irrigation is expected to remain the largest water use in the Naracoorte Ranges Prescribed Wells Area, and it is likely to expand further in all management areas as unused allocations are brought into production. Industrial and recreational use are expected to remain steady.

An assessment of irrigated crop potential of the land in the Naracoorte Ranges Prescribed Wells Area indicates that significant increases in the area of crops irrigated can be expected despite the high levels of allocation throughout the PWA. This potential exists due to the relatively low levels of groundwater usage (currently about half of total allocation) throughout the area.

There is no overall consistent pattern to the salinity trends of the Naracoorte Ranges PWA. In general, small increases are occurring in the higher areas within the Hundreds of Beeamma, Geegeela and Binnum. The increase in salinity in these areas is generally attributed to the mobilisation of salts through an increase in recharge rates resulting from land clearance. Salinity increases (10 - >20 mg/L/year) are also evident in the southern highland areas within the Hundreds of Jessie, Joanna and possibly Binnum. The increase in these areas is attributed to high levels of irrigation activity. Should these trends continue the irrigation crop potential of the effected portions of the southern highlands, may be reduced. Irrigation will tend to concentrate in areas that combine good quality water with suitable soils. The productive capacity of the land will also depend on land management practices and standards directed at avoiding land degradation issues such as erosion, water logging and land salinisation.

The overall capacity of the water resources in the Naracoorte Ranges Prescribed Wells Area are considered to be sufficient to meet all existing and reasonably foreseeable future demands for water, considering the capacity of the land, with the exception of a number of management areas which are currently over allocated if all bona fide unlicensed uses (stock, domestic, town use and forestry and environmental commitments) as well as licensed allocations, are taken into account (refer to Table A, annexed hereto). While it is noted that water levels within parts of the Beeamma management area are increasing at rates of 25 to 30 centimetres per year, it is considered that allowing use to increase to the current levels of allocation in this management area would not be appropriate as it would be likely to significantly accelerate the rate of salinisation throughout the area. Water level trends throughout Zone 5A are relatively stable, however the rate that salinity is increasing throughout the area indicates that use should not be allowed to increase to the level of current allocation. Many of the other management areas (except Bool and Moyall) are also over allocated.

Locally, in areas that combine the availability of good water quality with suitable soils, the demand for water may develop to exceed the capacity of the water resource. However, improvements in irrigation efficiency (where allocations are expressed volumetrically), more active use of trade of licensed water allocations, and the use of

imported water, may accommodate further development of water–based enterprises in these areas.

Some of the policies contained within this Plan may have potential impacts on land values in the Naracoorte Ranges PWA. The policies with this potential generally relate to the protection of the resource from degradation through over allocation, the concentration of water extraction and use, or inappropriate water use and management. It is considered that any potential impacts on the value of land are outweighed by the benefits of protecting the condition of the resource, so that it may continue to be used on a sustainable basis.

Land suitable for irrigation in an area with good quality underground water will tend to have a higher value than land that is not suitable for irrigation, or land located in an area where access is limited to underground water which is low yielding, unsuitable or marginal, for irrigation.

The SE Catchment Water Management Board has taken the above aspects into account in setting the policies and criteria within this plan.

6.1 Objectives

1. To ensure that underground water extractions remain within the sustainable limits of the unconfined aquifer by preventing over allocation of the resource at the local and management area scale and throughout the entire Prescribed Wells Area;

2. To protect the resource locally, throughout each management area and the entire Prescribed Wells Area, by ensuring that the taking and use of underground water does not cause a significant increase in the salinity of underground water, or cause a significant decrease in the elevation of the water table.

3. To provide flexibility and equity in access to the underground water resource of the unconfined aquifer;

4. To minimise constraints to economic activity throughout the region that result from the under use of water allocations;

5. To protect ecosystems dependent on underground water by ensuring that the taking and use of underground water from the unconfined aquifer does not cause significant degradation of the ecology and biodiversity of the region;

6. To protect the environment generally by ensuring that the taking and use of underground water from the unconfined aquifer does not cause significant degradation of any other resource such as soils or other water resources;

7. To manage the underground water resource of the unconfined aquifer so that it may continue to be utilised by future generations;

8. To encourage and expedite an active water market so that water allocations are readily available for future economic development;

9. To promote the active and efficient use of water allocations according to current industry best practice standards; and

10. To minimise the potential negative impacts of aquifer storage and recovery on underground water quality, and the integrity of the unconfined aquifer.

6.2 Principles

Limit to total allocation

1. Water shall not be allocated from the unconfined aquifer (by water (holding) or water (taking) allocation) where the allocation would cause the total amount allocated on all licences for the relevant management area to exceed the Volume for Licensed Allocation (VLA) for the relevant management area (see Table A), except where:

   (a) Water is to be allocated to existing non-licensed users in accordance with principles 6.2.2 and 6.2.3 (Unlicensed pre-existing water use);

   (b) A water allocation is to be taken from another management area in accordance with principles 6.2.30 (Crop rotations) or 7.2.15 (Applications to transfer water (taking) allocations – Destinations); or

   (c) Water is allocated above the VLA in the relevant management area at the **date of adoption**, in which case the taking of water will not cause significant adverse impacts on the unconfined aquifer within the relevant management area, and provided that where water is allocated above the VLA the total amount allocated on all licences within the relevant management area does not exceed the PAV for that management area (see Table A). Where water is allocated above the VLA within the relevant management area at the **date of adoption**, no further water shall be allocated, except where principles 6.2.1 (a) & (b) apply.

Unlicensed pre-existing water use

2. Water may be allocated to existing non-licensed water users where:

   (a) It can be demonstrated that the water use in its present form at the date of application, was also in existence during the year prior to 10 April 1997;

   (b) Water is used for the following:

   - Operation of a dairy licensed by the Dairy Authority of South Australia at the date of application, (including wash down, washing up and milk cooling);
   - Intensive animal keeping;
   - An intensive plant production system such as greenhouses, hydroponics or nurseries;
   - Industry; or
   - Recreation;

(c) The source aquifer nominated on the application is the aquifer from which the unlicensed water was being taken at 12th February 2001; and

(d) An application for a water allocation is received no earlier than 5p.m. on 30th June 2002 and no later than 5 p.m. on 31st July 2002.

3. Water shall be allocated for unlicensed pre-existing water use in the following manner:

(a) Where water remains available, or becomes available for allocation within a management area, up to 200ML shall be reserved for the purposes of allocation to unlicensed pre-existing water use, subject to 6.2.2 and 6.2.3 (b) – (d), until 5 p.m. on the 31 July 2002;

(b) The water allocation shall meet the applicant's reasonable requirements up to 10 megalitres per annum, except for dairies which milk in excess of 300 cows in which case the allocation shall meet the applicant's reasonable requirements;

(c) In the case of dairies, the water allocation shall be calculated as whichever is the greater of, the reasonable requirements of the water user at the time of application, or the average of the annual reasonable requirements over the preceding three year period; and

(d) Allocations granted under section 6.2.2 are exempt from sections 6.2.4 (Unallocated water), 6.2.11 (Quantity for allocation), 6.2.14 to 6.2.18 (Active and expeditious use of water), and 6.2.19 to 6.2.23 (Hydrogeological effects).

Where the 200 ML set aside in accordance with this principle has not been allocated then any remaining water shall be available for allocation in accordance with this Plan.

Unallocated water

4. Water may be allocated in the following manner:

(a) All applications for a water licence and/or a water (taking) allocation (not including any application that involves the surrender of a water licence, water (taking) allocation or part thereof) received by the Minister after 5.00p.m. on **adoption date**, will be given a serial number and dealt with in the following manner:

(i) Applications from the same management area will be accumulated together;

(ii) At 5.00p.m. on the last Friday of each month, all applications received for that month will be anonymously given a random rank number for that management area;

(iii) After any application for an allocation under 6.2.4 (b), (c) & (d) received in that month have been determined, the Minister will consider and determine applications for each management area by commencing with the lowest rank number within each management

area first, and then in order of increasing rank number until all applications received in that month have been determined;

(iv) Any applications received in successive months will be dealt with in the same manner;

(v) Only one application per allotment for each management area will be determined by the Minister in each month; and

(vi) Where in any month, more than one application is made in relation to the same allotment, if one of those applicants is the registered proprietor of the land, then that proprietor shall have his or her application determined before the any other applicant, regardless of the rank number of his or her application.

(b) Where a confined aquifer licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation is surrendered to the Minister under section 31 of the *Water Resources Act 1997* after 5p.m. **adoption date**, then an unconfined aquifer water (taking) allocation and/or licence may be granted to that licensee within the unconfined aquifer management area that corresponds with the relevant confined aquifer management area, in accordance with the provisions of this Plan, except that the provisions of principles 6.2.10 & 6.2.11 (Quantity of allocation) and 6.2.14 – 6.2.18 (Active and expeditious use) shall not apply to such an allocation and/or licence.

(c) Where a confined aquifer licence with a water (taking) allocation, or the whole or part of a water (taking) allocation held within the Kingston management area is surrendered by the licensee to the Minister under section 31 of the *Water Resources Act 1997* after 5p.m. **adoption date**, then an unconfined aquifer water (taking) allocation and/or licence may be granted to that licensee within any management area that lies within the Naracoorte Ranges PWA in accordance with the provisions of this Plan, except that the provisions of principles 6.2.10 & 6.2.11 (Quantity of allocation) and 6.2.14 – 6.2.18 (Active and expeditious use) shall not apply to such an allocation and/or licence.

(d) Where a licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation, originates from a management area adjoining a zone within the border Designated Area, but is taken and used in a zone within the border Designated Area on an allotment divided by a border Designated Area boundary, water may be allocated in the zone within the border Designated Area to the applicant provided that a licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation is surrendered to the Minister under section 31 of the *Water Resources Act 1997* in the originating management area. Such allocations shall be in accordance with the provisions of this Plan, except that the provisions of principles 6.2.10 & 6.2.11 (Quantity of allocation) and 6.2.14 – 6.2.18 (Active and expeditious use) shall not apply to such an allocation and/or licence.

Underground water resource condition

5. The taking and use of water shall not cause, or be likely to cause:

   (a) A mean (arithmetic) increase in salinity of the underground water resource of greater than 10 mg/L per year (measured over the preceding 5 years) within the vicinity of the point of use (including neighbouring properties and the nearest salinity monitoring wells), or within the relevant management area;

   (b) A mean (arithmetic) decrease in underground water levels within the vicinity of the point of taking (including neighbouring properties and the nearest underground water level monitoring wells), or within the relevant management area of greater than 0.1 metres per year (measured over the preceding 5 years), except where the taking and use of water is for the purposes of industry or energy generation;

   (c) A decline in underground water levels over a period of greater than 3 years within the vicinity of the point of taking (including neighbouring properties and the nearest underground water level monitoring wells), or within the relevant management area, before a new stable equilibrium water level is acheived, where the taking and use of water is for the purposes of industry or energy generation.

Water (holding) allocations

6. No water (holding) allocation shall be endorsed on a licence after **adoption date** except where a water (taking) allocation, either in whole or part, endorsed on a licence is converted to a water (holding) allocation with the exception that any water (taking) allocation on a licence that is subject to a condition or conditions requiring the expeditious use of water (including a requirement that the equipment, or land by which or on which the water is used be developed in a certain term) shall not be converted to a water (holding) allocation if that condition has, or those conditions have, not been satisfied.

Basis of allocation

7. Allocations of water granted after 5.00 p.m. on adoption date will be expressed volumetrically except for:

   (a) Allocations granted in accordance with principles 6.2.4 (b) – (d), which shall be expressed in the same units of measure as those on the water licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation surrendered to the Minister under section 31 of the *Water Resources Act 1997*.

   (b) Allocations that have been obtained through transfers, which shall be expressed in the same units of measure as those used prior to the transfer;

   (c) Allocations varied through conversion from a water (taking) allocation to a water (holding) allocation, which shall remain expressed in the same units of measure as those used prior to conversion; and

(d) Allocations varied through conversion from a water (holding) allocation to a water (taking) allocation, which shall remain expressed in the same units of measure as those used prior to conversion.

Purpose of use

8. Water shall not be taken and used for the purposes of wild flooding.

9. Water shall not be taken from the unconfined aquifer and used for the purpose of aquaculture unless:

   (a) The volume of tail water produced for disposal does not exceed an amount reasonably produced according to current best industry practice; and

   (b) The disposal of tail water does not result in an increase (above seasonal fluctuations) in underground water levels in the unconfined or confined aquifers at the boundary of the allotment where the tail water is disposed of, or at the boundary of any adjoining allotment held by the same owner, whichever is the greater distance from the point of disposal;

   (c) Disposal of tail water does not result in an accelerated increase in salinity of the unconfined or confined aquifers, or result in pollution of these aquifers by any other substance; and

   (d) The ponds, tanks, vessels or other places for the keeping of any water for the aquaculture process have no significant hydraulic connection with the unconfined or confined aquifers.

Quantity of allocation

10. Where water is to be used for irrigation purposes, the allocation shall not exceed the amount reasonably required to irrigate the area of the particular crop type, on the dominant soil type and given the local average meteorological conditions applicable to the relevant allotment.

11. Where water is to be used for purposes other than irrigation, the allocation shall not exceed the amount reasonably required (applying current industry best practice standards) for the purpose proposed.

Efficient use of water

12. Water shall be used and applied using water efficient technologies and techniques appropriate for the particular purpose and circumstance for and in which the water is to be used in accordance with current industry best practice standards.

13. For the purposes of principle 6.2.12 the particular circumstances for the use of water for irrigation include (but are not limited to) the:

   (a) Plant type;

   (b) Climate, dominant soil type and topography of the allotment;

(c) Location of remnant native vegetation and/or other permanent structures such as powerlines, which may limit the method of application of water; and

(d) Salinity of the water to be used.

Active and expeditious use of water

14. All water (taking) allocations granted on or after **adoption date**, excluding allocations which have been obtained through transfers shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation.

15. All water (taking) allocations granted before **adoption date**, with a condition requiring active and expeditious use, shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation.

16. All water (taking) allocations granted after 5pm 1 September 2000, resulting from the conversion of a water (holding) allocation, shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation.

17. For the purposes of principles 6.2.14, 6.2.15 and 6.2.16, the use of an allocation includes the development of the land and equipment upon or by which the water is used, to a capacity that enables the water (taking) allocation to be utilised at its maximum lawful rate.

18. Without in any other way affecting the operation of principles 6.2.14, 6.2.15 and 6.2.16, where **exceptional circumstances** apply to the licensee, the maximum period may be increased to 4 years from the granting of the allocation.

Hydrogeological effects

19. The taking of water for industrial, energy generation or public water supply purposes shall not adversely affect to a significant extent:

    (a) The quality of water in the confined aquifer by (including but not limited to) an increase in salinity by exceeding the rate specified in principle 6.2.5 (a);

    (b) The water level of the unconfined aquifer by causing or contributing to a long term decline in underground water levels by exceeding the rate specified in principle 6.2.5 (c) for industrial or energy generation use, or 6.2.5 (b) for public water supply use; and

    (c) The structural integrity of the aquifer.

20. The taking of water for all purposes other than those mentioned in principle 6.2.19 shall comply with the 4 kilometre square test and the taking and use of water shall not adversely affect to a significant extent:

    (a) The quality of water in the unconfined aquifer by (including but not limited to) an increase in salinity by exceeding the rate specified in principle 6.2.5 (a);

    (b) The water level of the unconfined aquifer by causing or contributing to a long term decline in underground water levels by exceeding the rate specified in principle 6.2.5 (b);

(c) The structural integrity of the aquifer;

(d) Any other water resource (including but not limited to the confined aquifer, or any relevant surface water resource), both within and beyond the Naracoorte Ranges Prescribed Wells Area; and

(e) Ecosystems dependent on underground water, by contravening principle 6.2.24.

21. The "4 kilometre square test" requires that the granting of a water (taking) allocation shall not cause the total volume of water (taking) allocations within a square with 4 kilometre long sides to exceed 1.25 times the amount of annual average vertical recharge for the management area.

22. The 4 kilometre square shall be centred on the specified point of taking of the water or, where the precise point of taking is not specified, the 4 kilometre square shall be centred on the centremost point of the nominated allotment involved in the application. Where the point of taking of the water is not specified the well shall be constructed for the taking of the water within a 1 kilometre radius of the centremost point of the nominated allotment.

23. For the purposes of the 4 kilometre square test, the amount of annual average vertical recharge is whichever is the lesser of:

(a) The annual average vertical recharge rate set out in Table C (annexed hereto) for the relevant management area, or recharge sub area delineated on General Registry Office Plan 395/00 (whichever is relevant) multiplied by 16km^2; or

(b) The amount determined by the following formula – Specific yield within the 4 kilometre square multiplied by long term seasonal underground water level fluctuation.

Ecosystems dependent on underground water

24. Water shall not be taken and used if to do so may create a significant adverse affect on ecosystems that depend on the underground water by causing:

(a) The mean water table elevation within the vicinity of the point of taking or within the relevant land unit (see Figure 2.1) to drop below that identified for the relevant land unit as specified in Table 2.1;

(b) The seasonal water table range within the vicinity of the point of taking or within the relevant land unit (see Figure 2.1) to exceed the range identified for the relevant land unit as specified in Table 2.1;

(c) The seasonality of the minimum or maximum water table level within the vicinity of the point of taking or the relevant land unit (see Figure 2.1) to vary from that identified for the relevant land unit as specified in Table 2.1; and

(d) Salinity of underground water within the vicinity of the point of use or within the relevant land unit (see Figure 2.1) to exceed the range identified for the relevant land unit as specified in Table 2.1.

25. Factors that will be considered in assessing the likelihood of significant adverse impacts include, but are not limited to the:

    (a) Distance of the proposed extraction point from ecosystems that depend on the underground water; and

    (b) Local hydrogeology.

Piping of water more than 2km

26. Where water is to be taken from one point and transported by pipe or other means to be used at another point at least 2 kilometres from the point of taking, both the taking and use of water shall comply with principles 6.2.19 and 6.2.20 (Hydrogeological effects). The 4 kilometre square test shall only apply at the point of taking.

Divided allotments

27. Where an allotment is, or two or more adjoining allotments held by the same owner are, divided by a management area or prescribed wells area boundary, but a water allocation is held in only one of the management areas or prescribed wells areas, the allocation may be taken and used anywhere throughout the allotment or adjoining allotments, provided that:

    (a) The taking and use of water meets the hydrogeological criteria defined in principles 6.2.19 – 6.2.23 (Hydrogeological effects);

    (b) The point of extraction and/or use is not moved more than 2 kilometres into an adjacent management area or prescribed wells areaunless it can be demonstrated that the allocation (or part thereof) was being extracted at the current location in an adjacent management area or prescribed wells area prior to **adoption date**;

    (c) An allocation from another management area is not taken in a zone within the area designated under the *Groundwater (Border Agreement) Act 1985* unless it can be demonstrated that the allocation (or part thereof) was being taken at the current location in a zone within the border Designated Area prior to **adoption date**;

    (d) The allocation remains referenced to, and accounted for in the originating management area and prescribed wells area; and

    (e) The allocation will not be available for further transfer within the receiving management area and prescribed wells area.

Crop rotations

28. Subject to principles 6.2.29 to 6.2.30, an allocation of water from a management area may be taken from another management area ("the receiving management area") for the purposes of irrigating a rotational crop for a maximum period of 5 years (from the date that the application to take the allocation of water from a receiving management area is approved) provided the taking of water from the

receiving management area complies with principle 6.2.20 (Hydrogeological effects) of this Plan.

29. For the purposes of clause 6.2.28, water may not be taken from another unconfined aquifer management area for the purposes of irrigating a rotational crop, where a receiving management area lies within the Padthaway Prescribed Wells Area. An allocation granted for the purposes of irrigating a rotational crop after **adoption date,** may not be taken from a receiving unconfined aquifer management area that lies in a zone within the area designated under the *Groundwater (Border Agreement) Act, 1985.*

30. Where the receiving management area is fully allocated on **adoption date**, or the sum of the amount of water proposed to be taken in the receiving management area and the amount allocated in the receiving management area at the date of application, exceeds the Volume for Licensed Allocation (VLA) for the receiving management area, the allocation of water may only be taken provided that:

    (a) The taking and use of water in the receiving management area complies with principle 6.2.20 (Hydrogeological effects) of this Plan; and

    (b) The level of water use in the year preceding the year ending 30 June did not exceed 90% of the VLA of the receiving management area.

The allocation of recharged imported water from aquifer storage and recovery schemes

Principles 6.2.31 to 6.2.36 apply to the allocation of imported water recharged for the purpose of aquifer storage and recovery, pursuant to a permit under section 9(3)(c) of the *Water Resources Act 1997*

Basis of allocation of recharged imported water

31. The basis for allocating recharged imported water will be an entitlement to take, during a water use year, a percentage (not exceeding 80%) of the measured volume of imported water recharged in the previous water use year under a permit issued under section 9(3)(c) of the *Water Resources Act 1997.*

32. Imported water that is used for recharge under an aquifer storage and recovery scheme will not be available for allocation where it is considered that it would have contributed to the natural vertical recharge of the unconfined or confined aquifer systems. Imported water that is recharged within the Naracoorte Ranges Prescribed Wells Area will only be available for allocation where:

    (a) Underground water that has been imported for the purposes of aquifer storage and recovery has been extracted from the originating management area or a zone within the border Designated Area under a licence issued under the provisions of the *Water Resources Act 1997*, or the *Groundwater (Border Agreement) Act 1985*; or

    (b) Surface water that has been imported for the purpose of aquifer storage and recovery, has been extracted under a licence issued under the provisions of the South Australian *Water Resources Act 1997* or the Victorian *Water Act 1989*.

33. Imported water that is recharged within a border zone designated under the *Groundwater (Border Agreement) Act, 1985* will not be available for allocation.

34. An allocation of recharged imported water must be taken and used within a period of three years calculated from the 1 July of the year in which the allocation is granted.

35. An allocation of recharged imported water shall only be taken from the original well of discharge of the imported water to the aquifer, or from a well within 500 metres radius of it.

Criteria for allocation of recharged imported water

36. Recharged imported water shall only be allocated where the taking and use of the recharged imported water will not cause, or will not be likely to cause:

    (a) Detrimental effects on the underground water resource (including but not limited to increased salinity or pollution);

    (b) A decrease in the productive capacity of the land;

    (c) Perched watertables;

    (d) Waterlogging;

    (e) A decrease in the depth of water exceeding two metres when compared to the prevailing water level at the date of the granting of the permit, in a well within a 500 metre radius of the point from which the recharged imported water is extracted, when the well is owned by someone other than the applicant for allocation of recharged imported water; and/or

    (f) Significant adverse impacts on ecosystems.

7 Transfer Criteria – Unconfined Aquifer

7.1 Objectives

1. To protect ecosystems dependent on underground water by ensuring that the taking and use of underground water from the unconfined aquifer does not degrade the ecology and biodiversity of the region;

2. To protect the environment generally by ensuring that the taking and use of underground water from the unconfined aquifer does not significantly degrade any other resource such as soils or other water resources;

3. To provide flexibility and equity in access to the underground water resource of the unconfined aquifer;

4. To encourage and expedite an active water market so that water allocations are readily available for future economic development;

5. To promote the active and efficient use of water according to industry best practice standards;

6. To manage the underground water resource of the unconfined aquifer so that it may continue to be utilised by future generations;

7. To ensure that extractions remain within the sustainable limits of the unconfined aquifer by limiting the concentration of underground water use from the unconfined aquifer that may result through the transfer of water allocations; and

8. To minimise constraints to economic activity throughout the region that result from the under use of water allocations.

7.2 Principles

Transfers of water (holding) allocations

1. A licence endorsed with a water (holding) allocation, or the whole or part of a water (holding) allocation may be transferred to any person or legal entity, but will continue to be recognised as being held from the same management area from which the allocation was originally granted.

Transfer of water (taking) allocations

2. A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation from the unconfined aquifer, may not be transferred to the confined aquifer.

Applications to transfer water (taking) allocations – Purpose of use

3. Transfer of a licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation will not be granted where water is to be taken and used for wild flooding.

4. Transfer of a licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation that is to be used for the purpose of aquaculture will not be granted unless:

   (a) The volume of tail water produced for disposal does not exceed an amount reasonably produced according to current best industry practice;

   (b) Disposal of tail water does not result in an increase above seasonal fluctuations in underground water levels in the unconfined or confined aquifers at the boundary of the allotment or, at the boundary of any adjoining allotment held by the same owner, whichever is the greatest distance from the point of disposal;

   (c) Disposal of tail water does not result in an accelerated increase in salinity of the unconfined or confined aquifers, or result in pollution of these aquifers by any other substance; and

   (d) The ponds, tanks, vessels or other places for the keeping of any water for the aquaculture process have no significant hydraulic connection with the unconfined or confined aquifers.

Applications to transfer water (taking) allocations – Efficient use of water

5. A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation shall only be transferred where the water shall be used and applied using water efficient technologies and techniques appropriate for the particular purpose and circumstances for, and in which the water is to be used in accordance with current industry best practice standards.

6. For the purposes of principle 7.2.5, the relevant circumstances for the use of water for irrigation include (but are not limited to) the:

   (a) Plant type;

   (b) Climate, dominant soil type and topography of the allotment;

   (c) Location of remnant native vegetation and/or other permanent structures such as powerlines, which may limit the method of application of water; and

   (d) Salinity of the water to be used.

Applications to transfer water (taking) allocations – Hydrogeological effects

7. The taking of water for industrial, energy generation or public water supply use shall not adversely affect to a significant extent:

   (a) The quality of water in the unconfined aquifer by (including but not limited to) an increase in salinity by exceeding the rate specified in principle 6.2.5 (a);

   (b) The water level of the unconfined aquifer by causing or contributing to a long term decline in underground water levels by exceeding the rate specified in principle 6.2.5 (c) for industrial or energy generation use, or 6.2.5 (b) for public water supply use; and

   (c) The structural integrity of the aquifer.

8. Subject to principle 7.2.9, a licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation that is to be used for all purposes other than those mentioned in principle 7.2.7, shall only be transferred where the taking of water complies with the 4 kilometre square test (as defined in sections 6.2.21 - to 6.2.23) and the taking and use of water shall not adversely affect to a significant extent:

   (a) The quality of water in the unconfined aquifer by (including but not limited to) an increase in salinity by exceeding the rate specified in principle 6.2.5 (a);

   (b) The water level of the unconfined aquifer by causing or contributing to a long term decline in underground water levels by exceeding the rate specified in principle 6.2.5 (b);

   (c) The structural integrity of the aquifer;

   (d) Any other water resource (including but not limited to the confined aquifer, or any relevant surface water resource), both within and beyond the Naracoorte Ranges Prescribed Wells Area; and

   (e) Ecosystems dependent on underground water, by contravening principle 7.2.10.

9. A transfer application shall be deemed to have complied with the 4 kilometre square test (as defined in sections 6.2.21 to 6.2.23) without further assessment, where:

   (a) A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation is to be transferred but will continue to be taken from the same well, or is replaced by a new well within 1km of the original well, and is to be used on the same allotment or allotments; or

   (b) An application to renew a temporary transfer (of the same quantity) that proposes taking the water allocation from the same well (or a well that replaces the original well, but lies within 1 kilometre of the original well), and the use of the allocation on the same allotment or allotments, is received and processed prior to the date and time of expiry of the original temporary transfer.

Ecosystems dependent on underground water

10. Transfer of a licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation will not be granted if to do so will create a significant adverse effect on ecosystems that depend on the underground water by causing the:

    (a) Mean water table elevation within the vicinity of the point of taking or within the relevant land unit (see Figure 2.1) to drop below that identified for the relevant land unit as specified in Table 2.1;

    (b) Seasonal water table range within the vicinity of the point of taking or within the relevant land unit (see Figure 2.1) to exceed the range identified for the relevant land unit as specified in Table 2.1;

(c) Seasonality of the minimum or maximum water table level within the vicinity of the point of taking or within the relevant land unit (see Figure 2.1) to vary from that identified for the relevant land unit as specified in Table 2.1; and

(d) Salinity of underground water within the vicinity of the point of use or within the relevant land unit (see Figure 2.1) to exceed the range identified for the relevant land unit as specified in Table 2.1.

11. Factors that will be considered in assessing the likelihood of significant adverse impacts include, but are not limited to the:

(a) Distance of the proposed extraction point from ecosystems that depend on the underground water; and

(b) Local hydrogeology.

Applications to transfer water (taking) allocations – Piping of water more than 2km

12. Where a transfer application proposes the taking of water from one point and transporting it by pipe or other means to be used at another point at least 2 kilometres from the point of taking, both the taking and use shall comply with principles 7.2.7 to 7.2.9 (Hydrogeological effects). The 4 kilometre square test shall only apply at the point of taking. Where the proposed point of taking and point of use is the same as those being utilised prior to transfer, the proposed transfer of water shall be deemed to have complied with the 4 kilometre square test at both the extraction and discharge sites without further assessment.

Applications to transfer water (taking) allocations – Destinations

13. A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation may be transferred either permanently or temporarily where the proposed location of the point of extraction lies within the same management area as the existing location of the point of extraction from which the allocation may lawfully be taken.

14. A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation may be permanently transferred into another management area, as follows:

(a) A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation may be permanently transferred out of Stewart management area into Ormerod management area, where the transfer will not cause the Volume for Licensed Allocation (VLA) in the receiving management area to be exceeded; or

(b) A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation may be permanently transferred out of Hacks management area into Moyhall management area, where the transfer will not cause the Volume for Licensed Allocation (VLA) to be exceeded.

15. A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation may be transferred from a management area to an adjacent management area, where the proposed point of extraction and use is less than or

equal to a maximum of 2 kilometres inside that adjacent management area, on an allotment which adjoins the management area boundary, consistent with the following criteria:

(a) The maximum period of transfer shall be 5 years;

(b) The provisions of this clause shall not apply where the receiving management area lies within the area designated under the *Groundwater (Border Agreement) Act 1985* or in the Padthaway PWA;

(c) The allocation shall continue to be deemed to be taken from and accounted for in the management area of its origin;

(d) Water transferred for extraction and use up to a maximum of 2 kilometres into an adjacent management area will not then be available for subsequent transfer elsewhere in the receiving management area except to other allotments adjoining the same management area boundary and where the proposed point of extraction and use lies less than or equal to a distance of 2km from the boundary of the original management area;

(e) Use and extraction shall be consistent with the relevant Water Allocation Plan for the receiving management area.

(f) The transfer of a licence endorsed with a water (taking) allocation, or the whoe or part of a water (taking) allocation up to 2 kilometres into an adjacent management area shall not cause the total allocations that may be used in the receiving management area to exceed 110% of its Volume for Licensed Allocation (VLA). An application to transfer a licence endorsed with a water (taking) allocation, or the whole or part of the water (taking) allocation up to 2 kilometres into an adjacent management area, which would cause the total allocations that may be used in that adjacent management area to exceed 110 % of its VLA, shall not be permitted and subsequent applications to transfer a licence endorsed with a water (taking) allocation, or the whole or part of a water taking allocation up to 2 kilometres into that adjacent management area, shall not be permitted unless and until the total allocations that may be used in that management area become less than or equal to 105 % of its VLA.

(g) The transfer shall be subject to principles 7.2.2 (Transfers of water (taking) allocations), 7.2.3 & 7.2.4 (Purpose of use), 7.2.5 and 7.2.6 (Efficient use of water), 7.2.7 - 7.2.9 (Hydrogeological effects), 7.2.10 & 7.2.11 (Ecosystems dependent on underground water*)* and 7.2.16 (Development of allocation before transfer).

For the purposes of this principle, an “adjacent management area” includes all management areas that adjoin the management area from which the allocation and/or licence was initially granted, including those that may lie within an adjoining prescribed wells area.

Applications to transfer water (taking) allocations – Development of allocation before transfer

16. For licences granted by the Minister with a condition or conditions imposed requiring the expeditious use of water (including a requirement that the equipment, or land by which or on which the water is used be developed in a certain time), the following applies:

    (a) The allocation (or part thereof), or licence may be transferred where the equipment or land has been fully developed to allow use of the water at its maximum lawful rate;

    (b) Where the expeditious use conditions have not been fully satisfied, only the portion of the allocation that may be used in accordance with the extent of development at the date of receipt of the application to transfer by the Minister may be transferred; or

    (c) Where the licence or allocation is to be transferred in its entirety, but will be taken and used on the same allotment, it may be transferred whether or not the land or equipment has been fully developed in accordance with the condition(s), provided that the new landholder fully develops the land and equipment to allow use of the allocation at its maximum lawful rate, in accordance with the original conditions.

Applications to transfer water allocated from aquifer storage and recovery schemes

17. Water allocated from aquifer storage and recovery schemes may only be transferred where the water will continue to be taken from the same point of extraction, or the proposed well of extraction is within a 500 metre radius of the well to which the imported water was discharged.

8 Allocation Criteria - Confined Aquifer

8.1 Objectives

1. To ensure that underground water extractions remain within the sustainable limits of the confined aquifer by preventing over allocation of the underground water resource at the local, and management area scale and throughout the entire Prescribed Wells Area;

2. To protect the resource locally, throughout each management area and the entire Prescribed Wells Area, by ensuring that the taking and use of underground water does not cause a significant decrease in the elevation of the potentiometric level of the confined aquifer.

3. To cautiously manage the confined aquifer, due to it being an ancient resource, with limited recharge;

4. To ensure that underground water from the unconfined aquifer is allocated and used in precedence to underground water from the confined aquifer;

5. To protect ecosystems dependent on underground water by ensuring that the taking and use of underground water from the confined aquifer does not significantly degrade the ecology and biodiversity of the region;

6. To protect the environment generally by ensuring that the taking and use of underground water from the confined aquifer does not significantly degrade any other resource, such as soils or other water resources;

7. To manage the confined aquifer underground water resource so that it may continue to be utilised by future generations;

8. To encourage and expedite an active water market so that water allocations are readily available for future economic development; and

9. To promote the efficient use of water according to industry best practice standards.

8.2 Principles

Except where otherwise expressly stated, all of the following principles apply to the allocation of water (taking) allocations from the confined aquifer.

Limit to total allocation

1. Water shall not be allocated from the confined aquifer where the allocation would cause the total amount allocated on all licences for the relevant management area plus the Irrigation Extraction Factor to exceed the Volume for Licensed Allocations (VLA) for the relevant management area (as shown in Figure 4.5), except where:

   (a) Water is to be allocated to existing unlicensed users in accordance with principles 8.2.2 and 8.2.3 (Unlicensed pre-existing water use); or

   (b) The total amount allocated on all licences plus the Irrigation Extraction Factor exceeds the VLA in the relevant management area at the **date of adoption**, in which case the taking of the water will not cause significant adverse impacts on

the confined aquifer within the relevant management area and provided that where the total amount allocated on all licences plus the Irrigation Extraction Factor exceeds the VLA within the relevant management area, the total amount allocated on all licences plus the Irrigation Extraction Factor does not exceed the PAV for that management area (see Table B).

Unlicensed pre-existing use

2. Water may be allocated to existing non-licensed water users where:

   (a) It can be demonstrated that the water use in its present form at the date of application, was also in existence during the year prior to 10 April 1997;

   (b) Water is used for the following:

   - Operation of a dairy licensed by the Dairy Authority of South Australia at date of application, (including wash down, washing up and milk cooling);
   - Intensive animal keeping;
   - An intensive plant production system such as greenhouses, hydroponics or nurseries;
   - Industry; or
   - Recreation;

   (c) The source aquifer nominated on the application is the aquifer from which the unlicensed water was taken at 12th February 2001; and

   (d) Applications for a water allocation are received by no earlier than 5p.m. on 30th June 2002 and no later than 31st July 2002.

3. Water shall be allocated for unlicensed pre-existing water use in the following manner:

   (a) The water allocation shall meet the applicant's reasonable requirements up to 10 megalitres per annum, except for dairies which milk in excess of 300 cows in which case the allocation shall meet the applicant's reasonable requirements;

   (b) In the case of dairies, the water allocation shall be calculated as whichever is the greater of, the reasonable requirements of the water user at the time of application, or the average of the reasonable requirements over the preceding three year period; and

   (c) Allocations granted under principles 8.2.2 and 8.2.3 are exempt from principles 8.2.5 (Taking and Use of water), 8.2.13 (Quantity for allocation), 8.2.16 to 8.2.20 (Active and expeditious use of water) and 8.2.21 to 8.2.23 (Hydrogeological effects).

Taking and use of water

4. Until 5 p.m. 2 October 2001 water may be allocated from the Lucindale confined aquifer management area within the boundary of the Naracoorte Ranges Prescribed Wells Area where:

    (a) The applicant has established a development, project or undertaking that uses water from the confined aquifer; and

    (b) He or she needs water for the expansion of that development, project or undertaking, which expansion he or she was legally committed or in respect of which he or she had committed significant financial or other resources after 5 p.m. 1 January 1998 but before 5 p.m. 13 June 2001; and

    (c) There is written evidence of the intent to expand the said development, project or undertaking, recorded in the file relating to the applicant held in the Department for Water Resources; and

    (d) Water will be taken from the same well as that used for the established development, project or undertaking; and

    (e) The unconfined aquifer is unable to supply the quality or quantity of water sufficient for the applicant's needs.

5. Subject to principle 8.2.4, there shall be no further allocations of confined aquifer water in the Naracoorte Ranges PWA, except:

    (a) Where principle 8.2.2 and 8.2.3 (Unlicensed pre-existing water use) apply; or

    (b) For the purpose of public water supply.

Underground water resource condition

6. The taking and use of water shall not cause or be likely to cause a mean (arithmetic) decrease in the potentiometric level of the confined aquifer within the vicinity of the point of taking (including neighbouring properties and the nearest potentiometric level monitoring wells), or within the relevant confined aquifer management area, of greater than 0.1 metres per year (measured over the preceding 5 years).

Water (holding) allocations

7. No water (holding) allocation shall be endorsed on a licence after **adoption date** except where a water (taking) allocation, either in whole or part, endorsed on a licence, is converted to a water (holding) allocation, with the exception that any water (taking) allocation on a licence that is subject to a condition or conditions requiring the expeditious use of water (including a requirement that the equipment, or land by which or on which the water is used be developed in a certain time), shall not be converted to a water (holding) allocation if that condition has, or conditions have, not been satisfied.

Basis of allocation

8. Allocations of confined aquifer water granted after 5 pm on **adoption date** will be expressed volumetrically, except for:

   (a) Allocations that have been obtained through transfers, which shall be expressed in the same units of measure as those used prior to transfer;

   (b) Allocations varied through conversion from a water (taking) allocation to a water (holding) allocation, which shall remain expressed in the same units of measure as those used prior to conversion; and

   (c) Allocations varied through conversion from a water (holding) allocation to a water (taking) allocation, which shall remain expressed in the same units of measure as those used prior to conversion.

9. All allocations of confined aquifer water will be expressed volumetrically by 1 January 2005.

Purpose of use

10. Water shall not be taken and used for the purposes of wild flooding.

11. Water shall not be taken from the confined aquifer and used for the purpose of aquaculture unless:

   (a) The volume of tail water produced for disposal does not exceed an amount reasonably produced according to current industry best practice;

   (b) Disposal of tail water will not result in an increase (above seasonal fluctuations) in underground water levels in the unconfined or confined aquifers at the boundary of the allotment where the tail water is disposed of, or at the boundary of any adjoining allotment held by the same owner, whichever is the greater distance from the point of disposal;

   (c) Disposal of tail water will not result in an accelerated increase in salinity of the unconfined or confined aquifers, or result in pollution of these aquifers by any other substance; and

   (d) The ponds, tanks, vessels, or other places for the keeping of any water for the aquaculture process have no significant hydraulic connection with the unconfined or confined aquifers.

Quantity of allocation

12. Where water is to be used for irrigation purposes, the allocation shall not exceed the amount reasonably required to irrigate the area of the particular crop type, on the dominant soil type and given the local average meteorological conditions applicable to the relevant allotment.

13. Where water is to be used for purposes other than irrigation, the allocation shall not exceed the amount reasonably required (applying current industry best practice standards) for the purpose proposed.

Efficient use of water

14. Water shall be used and applied using water efficient technologies and techniques appropriate for the particular purpose and circumstances for and in which the water is to be used in accordance with current industry best practice standards.

15. For the purposes of principle 8.2.14, the relevant circumstances for the use of water for irrigation include (but are not limited to) the:

    (a) Plant type;

    (b) Climate, dominant soil type and topography of the allotment;

    (c) Location of remnant native vegetation and/or other permanent structures such as powerlines, which may limit the method of application of water; and

    (d) Salinity of the water to be used.

Active and expeditious use of water

16. All water (taking) allocations granted after adoption date, excluding allocations which have been obtained through transfers shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation.

17. All water (taking) allocations granted before **adoption date**, with a condition requiring active and expeditious use, shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation.

18. All water (taking) allocations granted after **adoption date**, resulting from the conversion of a water (holding) allocation, shall be used with the minimum of delay and in any case within 3 years of the granting of the allocation.

19. For the purposes of principles 8.2.16, 8.2.17 and 8.2.18 the use of an allocation includes the development of the land and equipment upon or by which the water is used, to a capacity that enables the water (taking) allocation to be utilised at its maximum lawful rate.

20. Without in any other way affecting the operation of principles 8.2.16, 8.2.17 and 8.2.18, where exceptional circumstances apply to the licensee, the maximum period may be increased to 4 years from the granting of the allocation.

Hydrogeological effects

21. The taking and use of water shall not adversely affect to a significant extent:

    (a) The quality of water in the confined aquifer by (including but not limited to) an increase in salinity;

    (b) The potentiometric level of the confined aquifer by causing or contributing to a long term decline in the potentiometric level by exceeding the rate specified in principle 8.2.6;

    (c) The structural integrity of the aquifer;

(d) Any other water resource (including but not limited to the unconfined aquifer, or any relevant surface water resource), both within and outside the Naracoorte Ranges Prescribed Wells Area; and

(e) Ecosystems dependent on underground water.

22. The taking of water from the confined aquifer shall not cause a seasonal draw-down at any point beyond the 2 km radius from the proposed well(s) of greater than 2.0 metres, except where water is taken to be used for the purpose of public water supply by SA Water Corporation or a Local Government Authority, and that Corporation or Authority had supplied the public with water from the well(s) on or before **adoption date**.

23. The taking of water from the confined aquifer shall not occur if it is likely to cause the potentiometric level in the confined aquifer to permanently fall below the potentiometric level in the unconfined aquifer in areas where the existing potentiometric level of the confined aquifer is greater than the potentiometric level of the unconfined aquifer.

Piping of water more than 2km

24. Where water is to be taken from one point and transported by pipe or other closed vessel to be used at another point at least 2 kilometres from the point of taking, the taking of water shall comply with principles 8.2.21, 8.2.22 and 8.2.23 and use of the water shall comply with principle 8.2.21.

25. Confined aquifer water (taking) allocations granted after **adoption date** shall not be transported from the point of taking by means of an open channel.

9 Transfer Criteria – Confined Aquifer

9.1 Objectives

1. To protect ecosystems dependent on underground water by ensuring that the taking and use of underground water from the confined aquifer does not degrade the ecology and biodiversity of the region;

2. To protect the environment generally by ensuring that the taking and use of underground water from the confined aquifer does not significantly degrade any other resource, such as soils or other water resources;

3. To promote the efficient use of water according to industry best practice standards;

4. To manage the underground water resource of the confined aquifer so that it may continue to be utilised by future generations;

5. To ensure that extractions remain within the sustainable limits of the confined aquifer by limiting the concentration of water use that may result through the transfer of water allocations;

6. To enable permanent transfers out of the Kingston management zone.

9.2 Principles

Except where otherwise expressly stated, all the following principles apply to the transfer of a licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation from the confined aquifer.

Transfer of a water (holding) allocation

1. A licence endorsed with a water (holding) allocation, or the whole or a part of a water (holding) allocation may be transferred to any person or legal entity, but will continue to be recognised as being held from the same management area from which the allocation was originally granted.

Transfer of water (taking) allocations – Purpose of use

2. A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation shall not be transferred where water is to be taken and used for wild flooding.

3. A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation may only be transferred for the purpose of flood irrigation where the water will continue to be taken from the same well (or a well that replaces the original well, but lies within 1 kilometre of the original well) and is to be used on the same allotment or allotments.

4. The transfer of a licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation that is to be taken from the confined aquifer for the purpose of aquaculture will not be granted unless:

   (a) The volume of tail water produced for disposal does not exceed an amount reasonably produced according to current industry best practice;

(b) Disposal of tail water will not result in an increase (above seasonal fluctuations) in underground water levels in the unconfined or confined aquifers at the boundary of the allotment where the tail water is disposed of, or at the boundary of any adjoining allotment held by the same owner, whichever is the greatest distance from the point of disposal;

(c) Disposal of tail water will not result in an accelerated increase in salinity of the unconfined or confined aquifers, or result in pollution of these aquifers by any other substance; and

(d) The ponds, tanks, vessels, or other places for the keeping of any water for the aquaculture process have no significant hydraulic connection with the unconfined or confined aquifers.

Transfer of water (taking) allocations

5. A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation from the confined aquifer may be transferred either permanently or temporarily only where the proposed point of extraction is in the same confined aquifer management area as the existing point of extraction from which the allocation may lawfully be taken.

Applications to transfer water (taking) allocations – Efficient use of water

6. A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation shall only be transferred where the water shall be used and applied using water efficient technologies and techniques appropriate for the particular purpose and circumstances for and in which the water is to be used in accordance with current industry best practice standards.

7. For the purposes of principle 9.2.6, the relevant circumstances for the use of water for irrigation include (but are not limited to) the:

   (a) Plant type;

   (b) Climate, dominant soil type and topography of the allotment;

   (c) Location of remnant native vegetation and/or other permanent structures such as powerlines, which may limit the method of application of water and

   (d) Salinity of the water to be used.

Applications to transfer water (taking) allocations – Hydrogeological effects

8. A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation shall only be transferred where the taking and use of water shall not adversely affect to a significant extent:

   (a) The quality of water in the confined aquifer by (including but not limited to) an increase in salinity;

   (b) The potentiometric level of the confined aquifer by causing or contributing to a long term decline in the potentiometric level by exceeding the rate specified in principle 8.2.6;

(c) The structural integrity of the aquifer;

(d) Any other water resource (including but not limited to the unconfined aquifer, or any relevant surface water resource), both within and outside the Naracoorte Ranges Prescribed Wells Area;

(e) Ecosystems dependent on underground water.

9. The transfer shall not cause the taking of water from the confined aquifer from the proposed well(s) of extraction to result in a seasonal draw-down at any point beyond the 2 km radius from the proposed wells(s) of greater than 2.0 metres.

10. The transfer shall not occur where the taking of water from the confined aquifer from the proposed well(s) of extraction is likely to cause the potentiometric level in the confined aquifer to fall permanently below the potentiometric level in the unconfined aquifer in areas where the existing potentiometric level of the confined aquifer is greater than the potentiometric level of the unconfined aquifer.

11. A transfer application shall be deemed to have complied with principles 9.2.9 and 9.2.10 without further assessment where:

(a) A licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation is to be transferred but will continue to be taken from the same well or is replaced by a new well within 1 kilometre of the original well and is to be used on the same allotment or allotments; or

(b) An application to renew a temporary transfer (of the same quantity) that proposes taking the water allocation from the same well (or a well that replaces the original well, but lies within 1 kilometre of the original well), and use of the allocation on the same allotment or allotments, is received and processed prior to the date and time of expiry of the original temporary transfer.

Applications to transfer water (taking) allocations – Piping of water more than 2km

12. Where an application to transfer water proposes taking water from one point and transporting it by pipe or other closed vessel to be used at another point at least 2 kilometres from the point of taking, the taking of water shall comply with principles 9.2.8, 9.2.9 and 9.2.10, and use of the water shall comply with principle 9.2.8.

13. Transfer applications that propose transporting confined aquifer water from the point of taking by means of an open channel shall not granted.

Applications to transfer water (taking) allocations – Development of allocation before transfer

14. Licences from the confined aquifer, with a condition or conditions imposed requiring the expeditious use of water (including a requirement that the equipment, or land by which or on which the water is used be developed in a certain time):

(a) The allocation (or part thereof), or the licence may be transferred where the equipment or land has been fully developed to allow use of the water at its maximum lawful rate;

(b) Where the allocation has not been fully developed, only the portion of the allocation that may be used in accordance with the extent of development at the date of receipt of the application to transfer by the Minister may be transferred; or

(c) Where the licence or allocation is to be transferred in its entirety, but will be taken and used on the same allotment, it may be transferred whether or not the land or equipment has been fully developed in accordance with the condition(s), provided that the new landholder fully develops the land and equipment to allow use of the allocation at its maximum lawful rate, in accordance with the original conditions.

10 Permits

10.1 Wells

The following objectives and principles apply to permits for activities pursuant to section 9(3)(a) & (b) of the *Water Resources Act 1997* comprising drilling, plugging, backfilling or sealing a well and the repairing, replacing or altering the casing, lining, or screen of a well.

10.1.1 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 the headworks of wells are maintained.
5. To ensure that wells are constructed in the correct aquifer system.

10.1.2 Principles

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

1. The equipment, materials and method 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.
2. 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 an aquifer.

Seals between aquifers

3. 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

4. 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 artificial recharge

5. The headworks of a well for the draining or discharge of recharged water shall be constructed so that recharge and draining or discharge operations can be metered without interference.

Minimum distance between licensed wells and the border between South Australia and Victoria

6. Wells in the area designated under the *Groundwater (Border Agreement) Act, 1985* must be located a distance greater than one kilometre from the border between the State of South Australia and the State of Victoria, unless the Border Groundwaters Review Committee has first considered the matter and determined that such an application may be granted.

10.2 Draining or Discharging of Imported Water into a Well – Artificial Recharge

10.2.1 Objective

To provide for the draining or discharging of imported water directly or indirectly into a well in a manner that does not adversely affect the underground water quality, the aquifer or any ecosystem that depends on that water.

10.2.2 Principles

The following principles apply to permits, pursuant to section 9 (3) (c) of the Act, for the activity of draining and discharging of **imported water** directly into a well.

1. Imported water may be drained or discharged into the unconfined or confined aquifers.

2. Subject to principles 10.2.2.4 and 10.2.2.5 imported water may be drained or discharged into a well for the purpose of aquifer storage and recovery where the concentrations, levels or amounts of the substances, materials or characteristics set out in principle 10.2.2.4 below, in the water to be drained or discharged, do not exceed the concentrations, levels or amounts of those substances, materials or characteristics in the native underground water.

3. For the purposes of principles 10.2.2.2, 10.2.2.4 and 10.2.2.5, the relevant concentrations, levels or amounts shall be measured by sufficient representative samples of:

   (a) The water to be drained or discharged, collected either from an existing dam or directly from the source; and

   (b) Native underground water collected from the proposed point of injection, or as near as possible to the proposed point of injection, and from the same aquifer as that in which storage is proposed.

   "Sufficient representative samples" 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.

4. Imported water may be drained or discharged directly or indirectly into a well (despite principle 10.2.2.2) where the concentrations, levels and amounts of the substances, materials or characteristics of, or in the water set out in principle 10.2.2.6 are not sufficient to degrade the ecosystems dependent upon underground

water within the prescribed water resource or to reduce the suitability of the underground water for other purposes for which it might reasonably be used.

5. The draining or discharge of imported water directly or indirectly into a well may not be granted (despite principles 10.2.2.2 and 10.2.2.4) where the cumulative effects of the discharge of water to the aquifer are considered sufficient to degrade the ecosystems dependent upon underground water within the prescribed water resource, or to reduce the suitability of the underground water for other purposes for which it might reasonably be used.

6. For the purposes of principles 10.2.2.2, 10.2.2.4 and 10.2.2.5 above, the list of substances, materials and characteristics comprises substances, materials and characteristics that may reasonably be expected to be present in the imported water to be drained or discharged and have the potential to degrade the native underground water and the ecosystems that depend upon the native underground water, including where relevant (but not limited to):

   (a) pH, TDS, turbidity, ammonia, nitrate, nitrite, total phosphorus, sodium, chloride, sulphate, calcium, magnesium, bicarbonate, iron, total arsenic, total boron, total cadmium, total chromium, total lead, total manganese, total zinc, total coliforms and faecal coliforms; and

   (b) Pesticides, *Giardia, Cryptosporidium*, volatile organic compounds and petroleum hydrocarbons (including but not limited to water from land used for intensive agriculture or industrial purposes) those substances, materials and characteristics likely to be present in the source of the water; and

   (c) Trihalomethanes where the water to be drained or discharged has been treated by chlorination.

7. The draining or discharging of imported water directly or indirectly to a well must not detrimentally affect the ability of other persons to lawfully take from that underground water or damage any ecosystem that depends on the underground water.

8. Draining or discharging imported water directly or indirectly into a well may only occur where:

   (a) The headworks of the well are constructed such that both recharge and recovery operations can be metered without interference;

   (b) Continued recharge of water at the site will not result in detrimental impacts on water quality or on the integrity of the aquifer, for example, but not limited to:

      (i) Unacceptable interference with the water supply from neighbouring wells constructed to current industry standards;

      (ii) An increase in salinity of the underground water;

      (iii) Secondary water quality issues such as increased susceptibility to dryland salinity;

(iv) Increased secondary porosity, which may affect the stability of the aquifer and result in land subsidence;

(v) Perched water tables; or

(vi) Waterlogging.

9. For the purposes of this plan the term "native underground water" means the underground water (as that term is defined in the *Water Resources Act 1997*) that exists in the relevant aquifer absent any such water drained or discharged to that aquifer by artificial means.

10. Licence or permit holders draining or discharging imported water into a well will be required to implement an ongoing water quality monitoring program, with the following minimum analysis of the water to be drained or discharged into the well:

(a) Minimum of four (4) samples per season during which the drainage or discharge to the well occurs; and

(b) At least one sample per ten (10) megalitres of water drained or discharged to the well.

Parameters to be analysed will be determined after assessment of the quality of the water to be drained or discharged directly or indirectly into the well and of the underground water into which the drainage or discharge is to occur, as undertaken at 10.2.2.6.

10.3 Importation of Water

Except for the purpose of public water supply, a permit is required for the activity prescribed by the Regulations pursuant to section 9(4)(k) of the *Water Resources Act 1997* comprising using water in the course of carrying on a business at a rate that exceeds 1 megalitre/annum where the water has been brought into a management area by means of a pipe or other channel ("use of imported water").

10.3.1 Relevant Authority

The relevant authority for determining a permit application for the activity of using water in the course of carrying on a business at a rate that exceeds 1 megalitre per annum where the water has been brought into the management area by means of a pipe or other channel is the Minister responsible for the administration of the *Water Resources Act 1997*.

The following objectives and principles apply to the use of imported water:

10.3.2 Objective

To ensure that the use of imported water occurs in a manner that does not adversely affect the prescribed underground water resource, or groundwater dependent ecosystems.

10.3.3 Principles

1. Use of imported water shall not cause a rise in the underground water levels that detrimentally affects a structure or ecosystem.
2. For the purposes of principle 10.3.3.1, “structure” is defined as, but is not limited to, a building, fence or wall.
3. Use of imported water shall not adversely affect the quality of the prescribed underground water resource.
4. Use of imported water shall not adversely affect the productive capacity of the land by causing salinity, waterlogging or perched watertables or other such impacts.
5. The salinity of imported water shall not exceed native background underground water salinity levels or 1500 mg/L, which ever is the lower.

11 Monitoring

Section 101 (4) (e) of the Act requires the Plan to assess the capacity of the resource to meet the demands for water on a continuing basis and provide for regular monitoring of the capacity of the resource to meet those demands.

11.1 Monitoring the capacity of the underground water resource - The Water Level and Salinity Monitoring Network

The Department for Water Resources and its predecessors have undertaken regular water-level and confined aquifer pressure monitoring in the Naracoorte Ranges PWA since 1970. A more comprehensive network of water level monitoring and salinity monitoring wells was established specifically for the Naracoorte Ranges PWA in 1987.

Unconfined Aquifer

At December 2000 the unconfined aquifer water level monitoring network in the Naracoorte Ranges PWA consisted of 73 wells. A number of these wells, east of Naracoorte have been monitored for over 30 years, providing an invaluable database. The unconfined aquifer salinity monitoring network in the Naracoorte Ranges PWA consisted of 79 wells, at December 2000. This network is made up of 43 wells that have been installed and are monitored by the Department for Water Resources. The remaining 36 salinity monitoring wells are privately owned wells that are sampled on an irregular basis. Monitoring is generally undertaken quarterly for both salinity and water level.

Confined Aquifer

At December 2000, 5 confined aquifer water-level monitoring wells existed within the PWA. None of the confined aquifer water-level monitoring wells are regularly sampled for underground water salinity, although one of these wells has been sampled at irregular intervals in the past

Table 11.1: Underground water monitoring

What	Where	When
Underground water levels in the unconfined aquifer	Unconfined aquifer water level monitoring network locations in the Prescribed Wells Area	Quarterly
Underground water salinity in the unconfined aquifer	Unconfined aquifer salinity monitoring network locations in the Prescribed Wells Area	Quarterly
Underground water level/pressure in the confined aquifer	Confined aquifer water level/pressure monitoring network locations in the Prescribed Wells Area	Every six months
Underground water salinity in the confined aquifer	Confined aquifer salinity monitoring network locations in the Prescribed Wells Area	Every six months

11.2 The strategy for regular monitoring of the demands placed on the underground water resource

The strategy for regular monitoring of the demands placed on the underground water resource is provided below. The monitoring program will include:

11.2.1 Annual Water Use Report

An Annual Water Use Report is to be prepared by each licensee and submitted to the Department for Water Resources, Mount Gambier office, on or by 5 pm 31 July each year. Each licensee will provide the following information in the Annual Water Use Report:

(a) The volume of water and/or HaIE allocated on the licence;

(b) For licences expressed volumetrically, the volume of water actually used by the licensee and recorded on each meter during the water-use year (i.e. opening and closing meter readings);

(c) The period of water use (eg. from 12 November to 30 April);

(d) The purpose for which water has been taken;

(e) The salinity reading, date and bore number of any underground water salinity measurement taken during each water use year;

(f) The total amount of imported water recharged for each meter for the purpose of Aquifer Storage and Recovery in the water-use year (where applicable); and

(g) Where the water taken by the licensee is used for irrigation:

(i) The area of each crop type irrigated;

(ii) An estimate of the quantity of water taken from each licensed well (in megalitres) and a description of the method used to calculate extraction(s);

(iii) A sketch plan of the area irrigated, the plant type, and how many hectares were irrigated;

(iv) The number of irrigations;

(v) The irrigation method; and

(vi) The nature of services used to schedule when irrigation is required. (eg. neutron probes, external irrigation scheduling service, tensiometer etc)

Table 11.2: Monitoring the use of underground water

What	Where	When
Underground water use and extraction	The wells used by all licensed users by way of an annual water use report	Submitted by 5.00pm 31 July each year
The salinity of underground water	The wells used by all licensed users by way of an annual water use report	Submitted by 5.00pm 31 July each year

11.2.2 Monitoring of the Water Needs of Ecosystems Dependent on Underground Water

The water needs of ecosystems dependent on underground water are described in Table 2.1. Monitoring arrangements must be established to evaluate whether the policies in this Plan protect the water needs that have been identified.

This requires monitoring of critical hydrogeological and ecosystem parameters that can be used for this evaluation. These parameters include:

- Mean underground water levels;
- Seasonal underground water fluctuations;
- Underground water salinity;
- Species composition and abundance;
- Species recruitment; and
- Specific vegetation health measures such as canopy density.

A detailed program to monitor the parameters listed above will be formulated and implemented through the investigations program detailed in the Catchment Water Management Plan.

12 Miscellaneous

The preparing the policy, the Board has had regard to the issues set out in section 6 (2) of the *Water Resources Act 1997,* the *Groundwater (Border Agreement) Act 1995* and the *South Easter Water Conservation and Drainage Act 1992*.

The Plan also shows relevant benefits of consistency with the following plans and policies as listed in Section 101(9) of the Act:

(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) Relevant district plans under the *Soil Conservation and Land Care Act 1989*;

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

(g) State Water Plan.

Table A: Volume for Licensed Allocation (VLA) for the unconfined aquifer management areas of the Naracoorte Ranges PWA.

Management Area	PAV ML	VLA[(a)] ML	Total Licensed Allocations at 23/05/01[(b)] ML	Difference (a - b) ML	Volume Reserved for Allocation to Unlicensed Pre-Existing Use ML	Volume Available for Allocation to other uses at 23/05/01 ML
Struan	3,700	3,260	4,097	-837	0	0
Joanna	10,000	8,670	10,223	-1,553	0	0
Zone 5A	18,500	16,145	18,955	-2,810	0	0
Bangham	4,170	3,598	4,796	-1,198	0	0
Frances	4,680	4,072	4,710	-638	0	0
Western Flat	952	827	964	-137	0	0
Bool	3,200	2,479	1,795	684	200	484
Hacks	3,700	3,202	3,686	-484	0	0
Moyhall	4,800	3,768	2,310	1,458	200	0
Ormerod	6,095	4,860	360	4,500	200	0
Stewarts	7,140	6,341	13,521	-7,180	0	0
Hynam West	4,000	3,530	4,008	-478	0	0
Hynam East	5,000	4,360	4,543	-183	0	0
Beeamma	5,000	4,395	5,688	-1,293	0	0
Total	**80,937**	**69,507**	**79,656**	**N/A**	**600**	**484**

Note: Water is not available for allocation from management areas Moyhall and Ormerod due to the levels of over-allocation in Stewarts and Hacks management areas. This Plan enables allocations from Stewarts management area to be transferred into the Ormerod management area, and allocations from Hacks management area to be transferred into Moyhall management area. Therefore remaining water in management areas Moyhall and Ormerod has been reserved specifically for this purpose.

Please Note: The PAV and VLA figures in this table cannot be altered during the life of this Plan. The figures shown in the Total Allocations, Difference and Volume Available for Allocation columns may change during the life of this Plan.

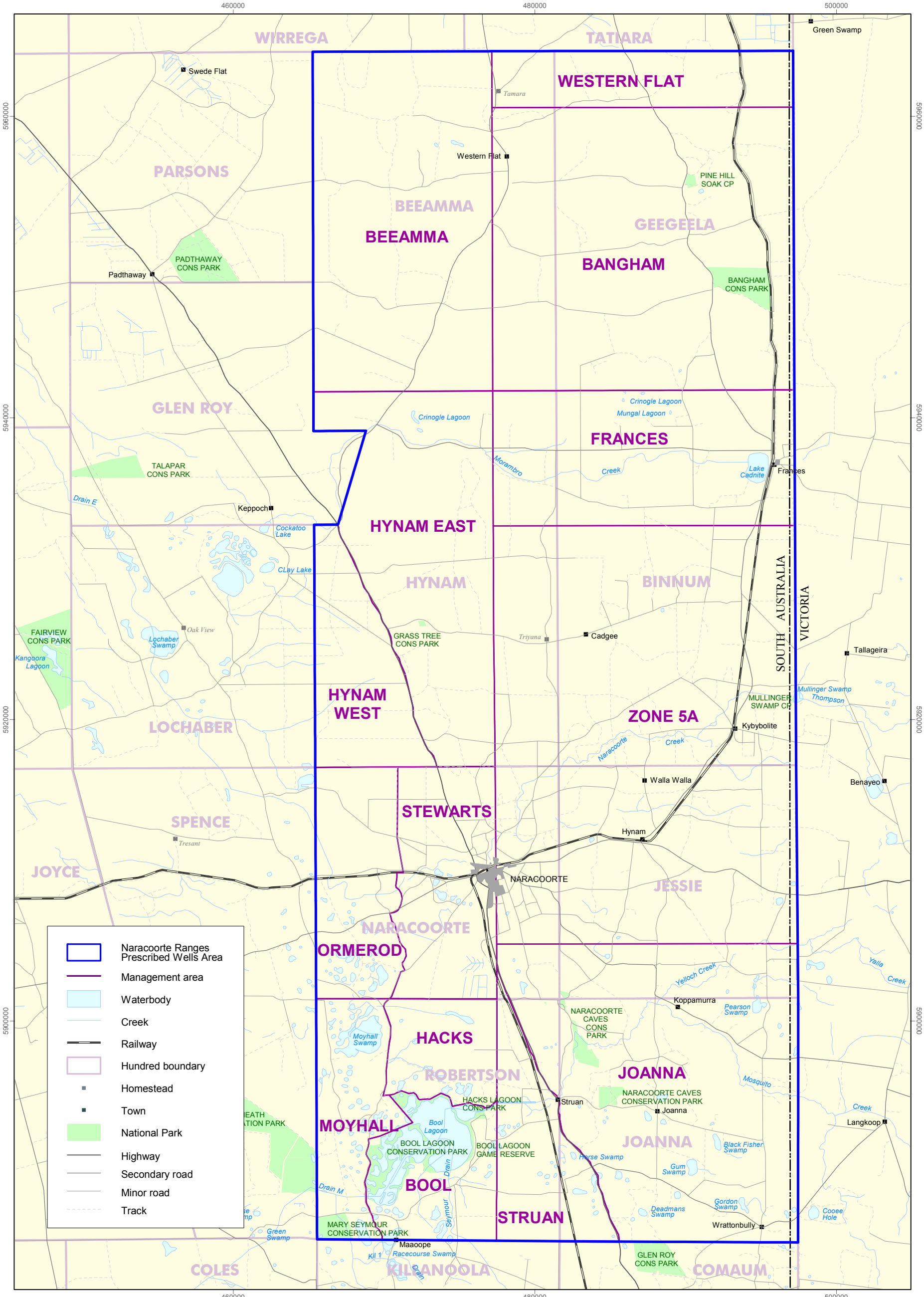
Table B: Volume for Licensed Allocation (VLA) for the confined aquifer management areas in South Australia (all in ML)

Management Area	PAV	VLA (a)	Total Licensed Allocations at 23/05/01 (b)	Irrigation Extraction Factor (c)	Difference (a)-(b)-(c)	Volume available for allocation at 23/05/01
Fairview	290	284	0	0	284	284
Kalangadoo	3,900	3,822	1,993	386	1,443	1,443
Keith	2,500	2,450	130	0	2,320	2,320
Kingston	25,000	22,379	19,755	2,935	-311	0
Lucindale	3,600	3,438	1,325	123	1,990	1,990
Millicent	10,800	10,584	4,376	676	5,532	5,532
Taratap	330	323	16	3	304	304
Wirrega	960	941	300	0	641	641
Zone 1A	9,200	8,806	404	81	8,321	8,321
Zone 2A	2,900	2,842	50	0	2,792	2,792
Zone 3A	1,900	1,862	0	0	1,862	1,862
Zone 4A	710	696	280	56	360	360
Zone 5A	540	529	0	0	529	529
Zone 6A	360	353	0	0	353	353
Zone 7A	350	343	0	0	343	343
Zone 8A	340	333	0	0	333	333
Zone 9A	570	559	0	0	559	559
Total	**64,250**	**60,544**	**28,629**	**4,259**	**N/A**	**27,967**

Table C: Annual average vertical recharge rates for the unconfined aquifer management areas outside the designated border zones.

Management Area	Annual Average Vertical Recharge Rate (mm)
Beeamma	20
Bool	75
Hacks	75
Hynam East	25
Hynam West	50
Moyhall	75
Ormerod	75
Stewarts	75

Figures



NARACOORTE RANGES PRESCRIBED WELLS AREA

UNDERGROUND WATER MANAGEMENT AREAS FOR THE UNCONFINED AQUIFER

Figure1.1

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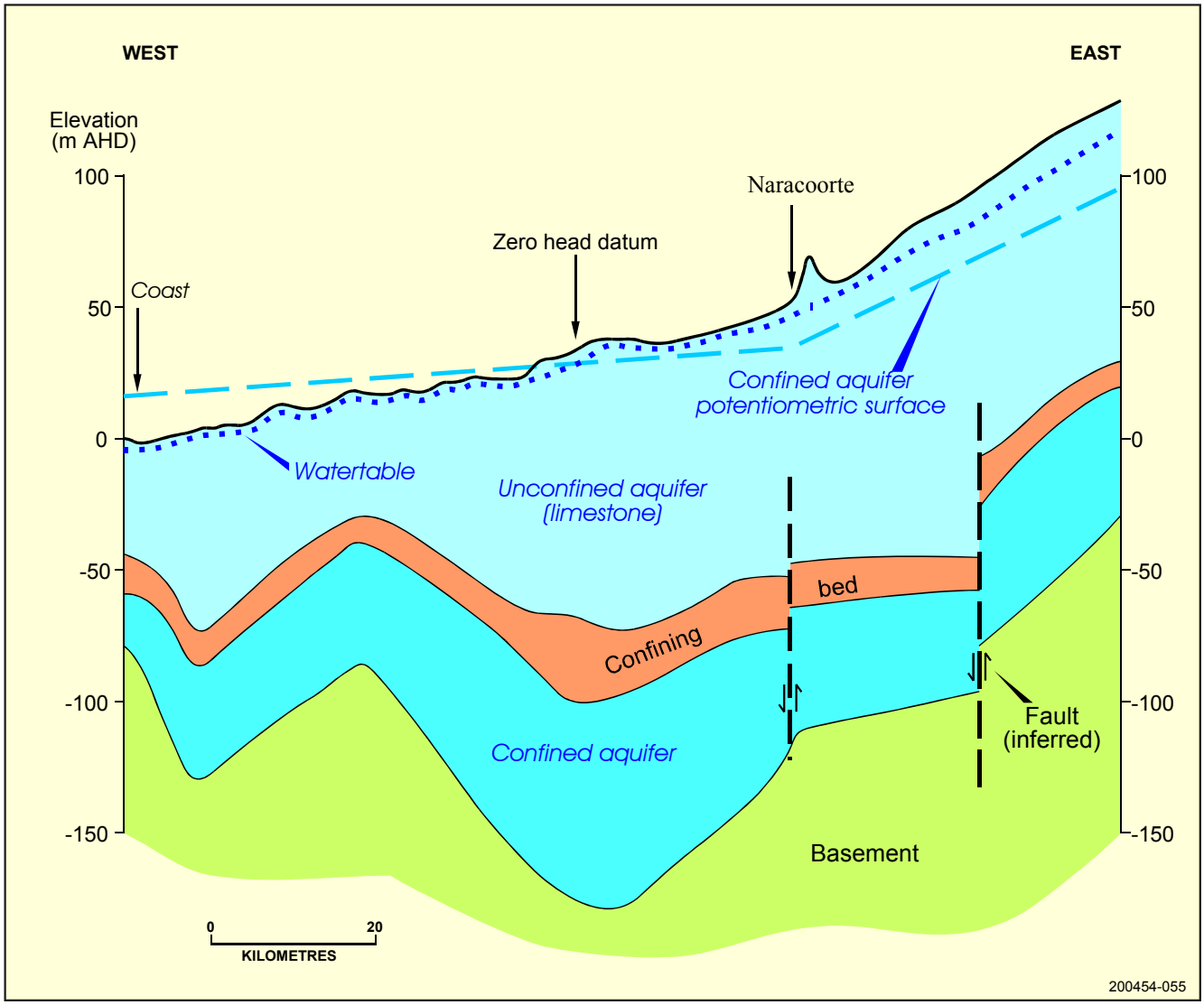
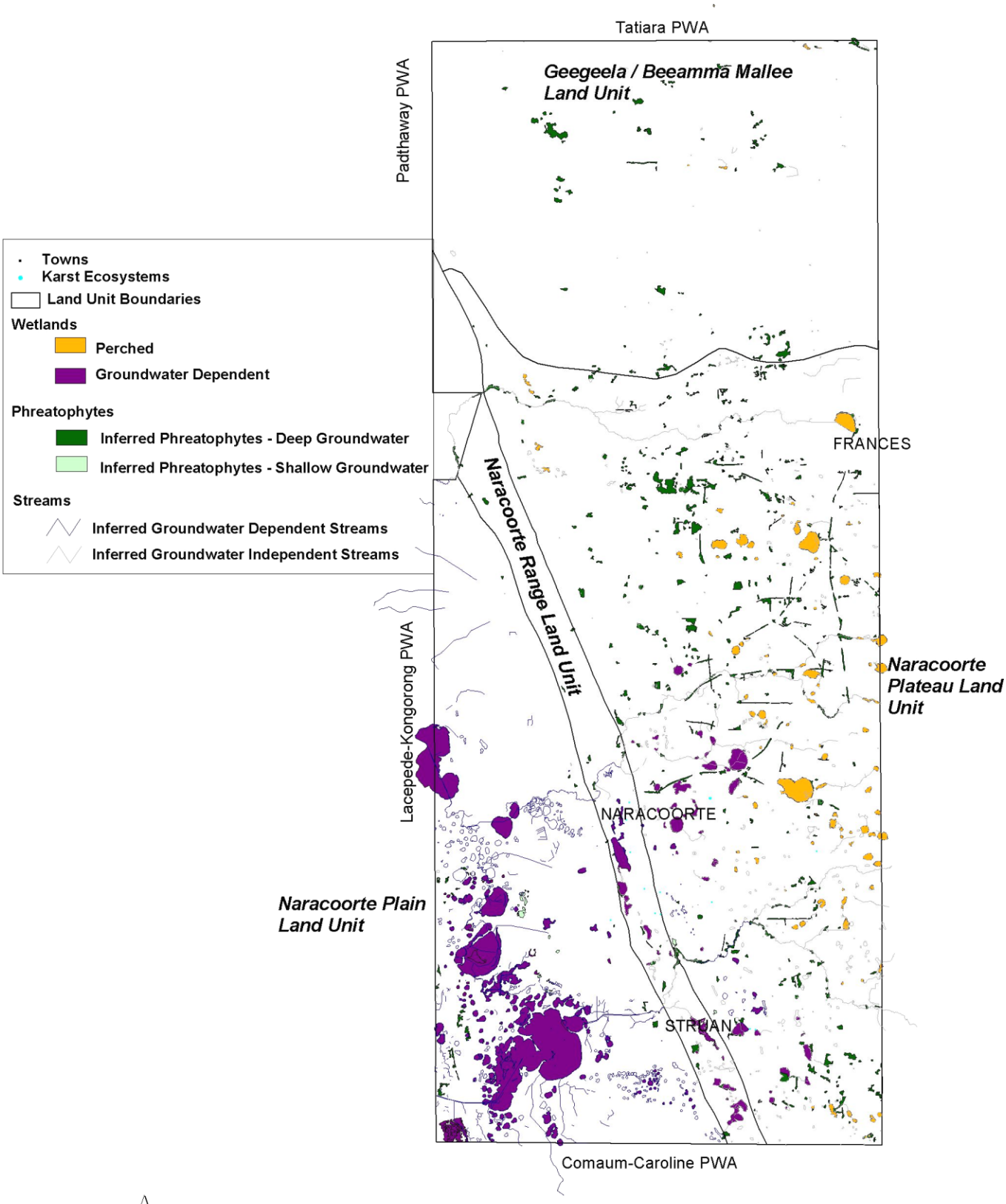


Figure 1.2 *East-west geological cross section through the Naracoorte Ranges PWA*



SOUTH EAST CATCHMENT WATER MANAGEMENT BOARD

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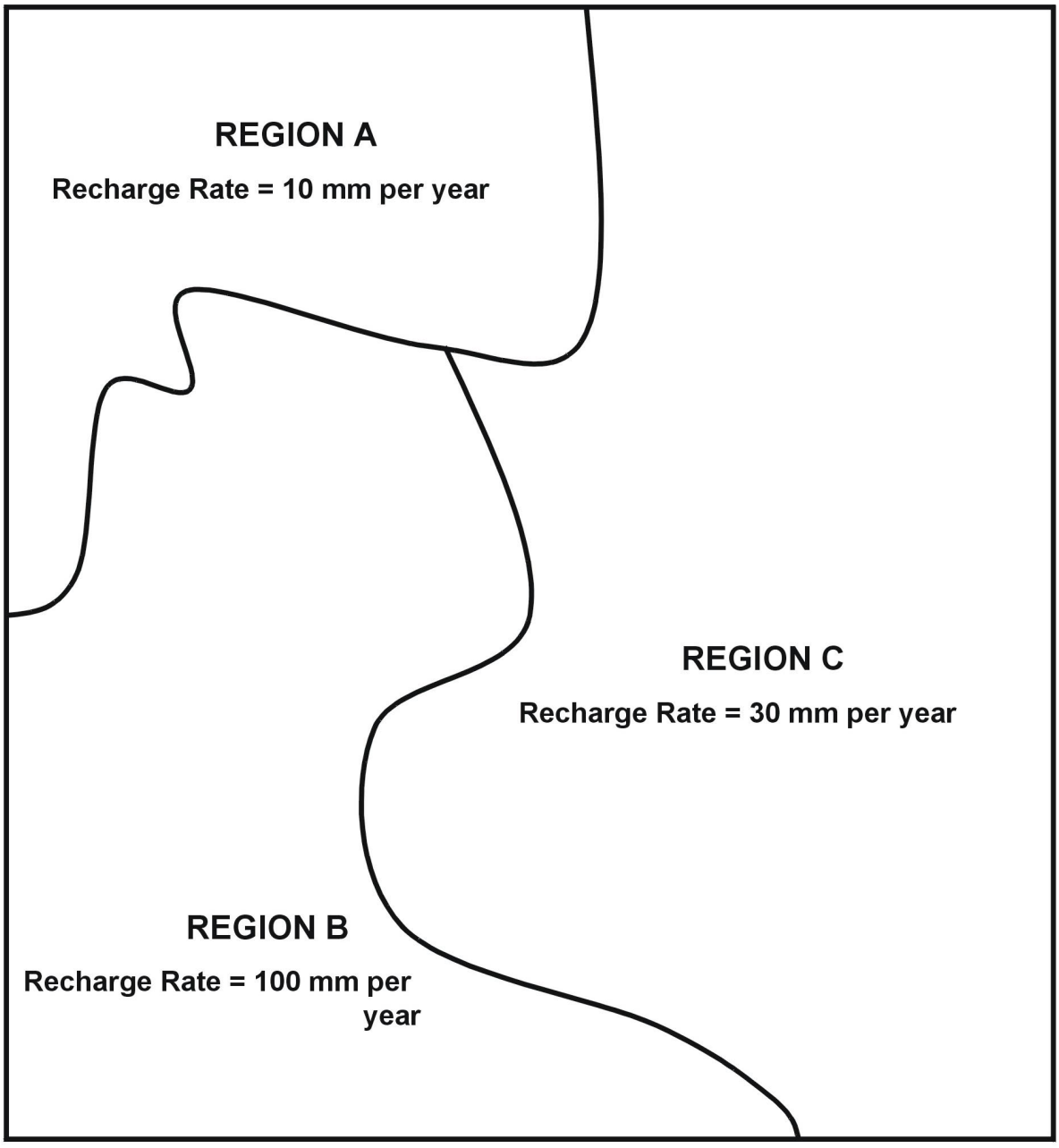
Figure 2.1:
Ecosystems Dependent on Underground Water
Naracoorte Ranges PWA

Figure 4.1: Example Determination of Permissible Annual Volume (PAV) for the Unconfined Aquifer in an Example Management Area

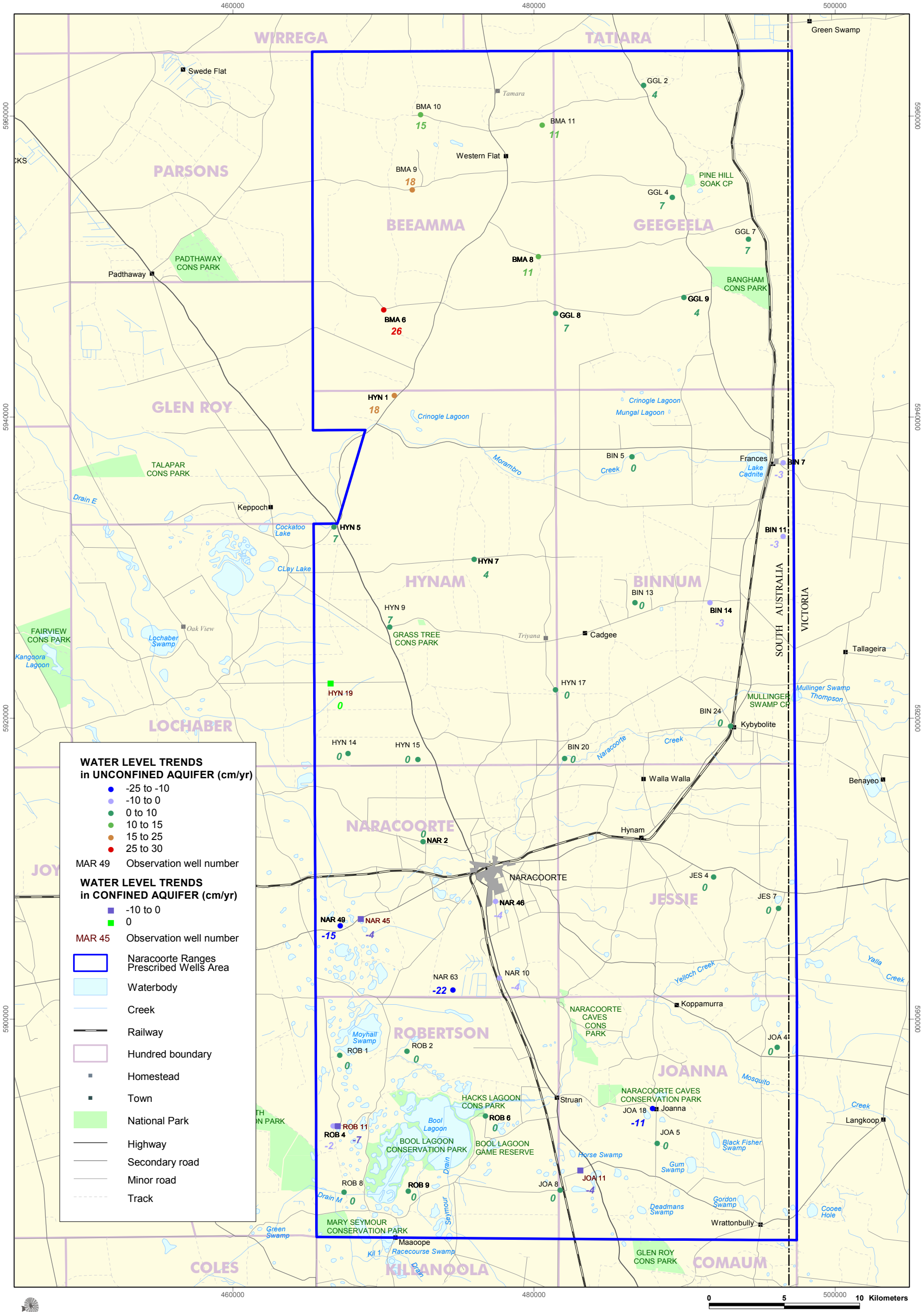


PAV (in ML per year)

= (Sum of all recharge in regions A, B and C) x Salinity factor

= ((Land area of A (km^2) x 10) + (Land area of B (km^2) x 100)

+ (Land area of C (km^2) x 30)) X Salinity Factor



Datum GDA 94 - Projection UTM MGA Zone 54

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NARACOORTE RANGES PRESCRIBED WELLS AREA

WATER LEVEL TRENDS to JUNE 2000

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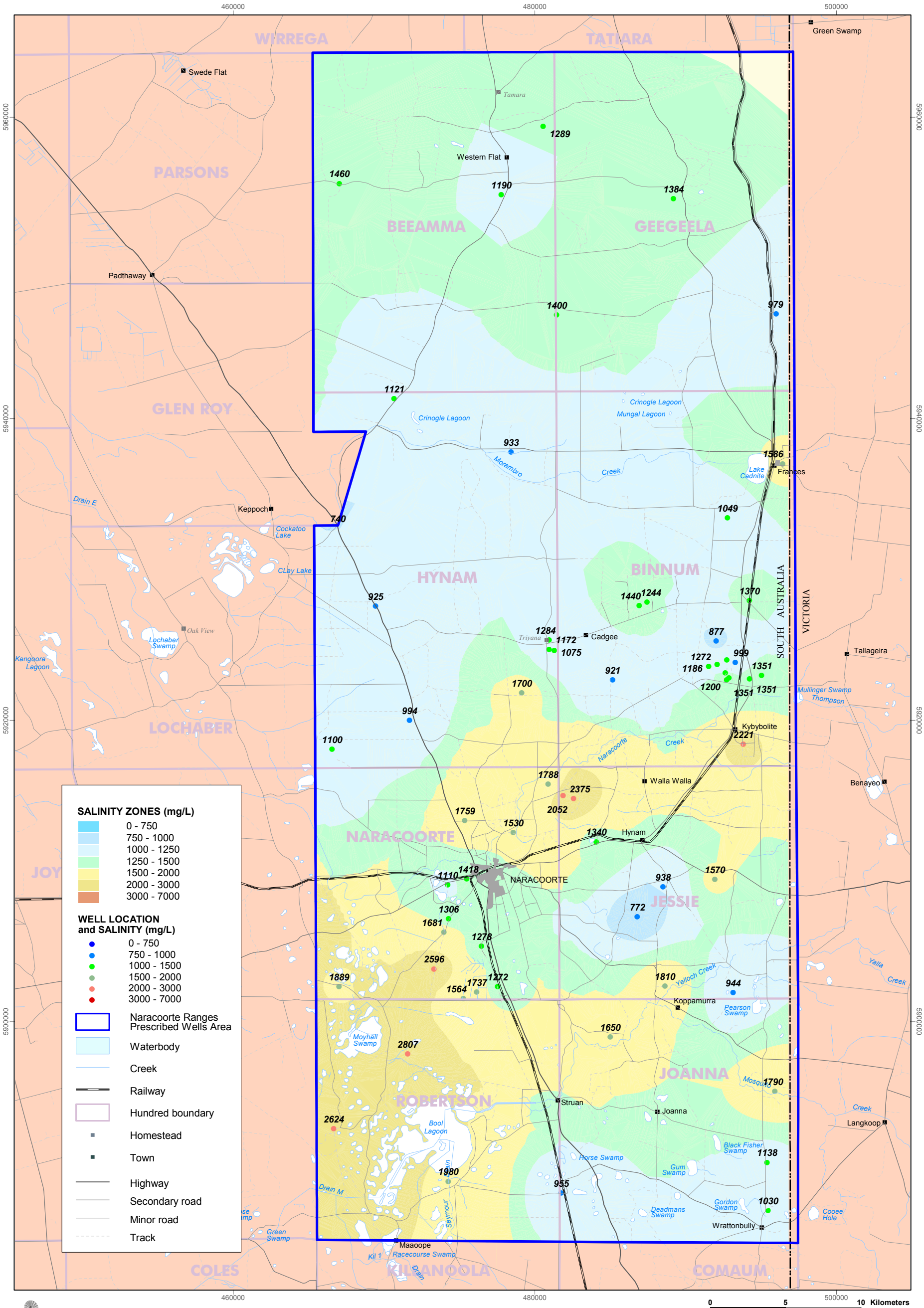
Figure 4.2



Datum GDA 94 - Projection UTM MGA Zone 54

Prepared September 2000

NARACOORTE RANGES PRESCRIBED WELLS AREA

GENERALISED SALINITY DISTRIBUTION IN THE UNCONFINED AQUIFER

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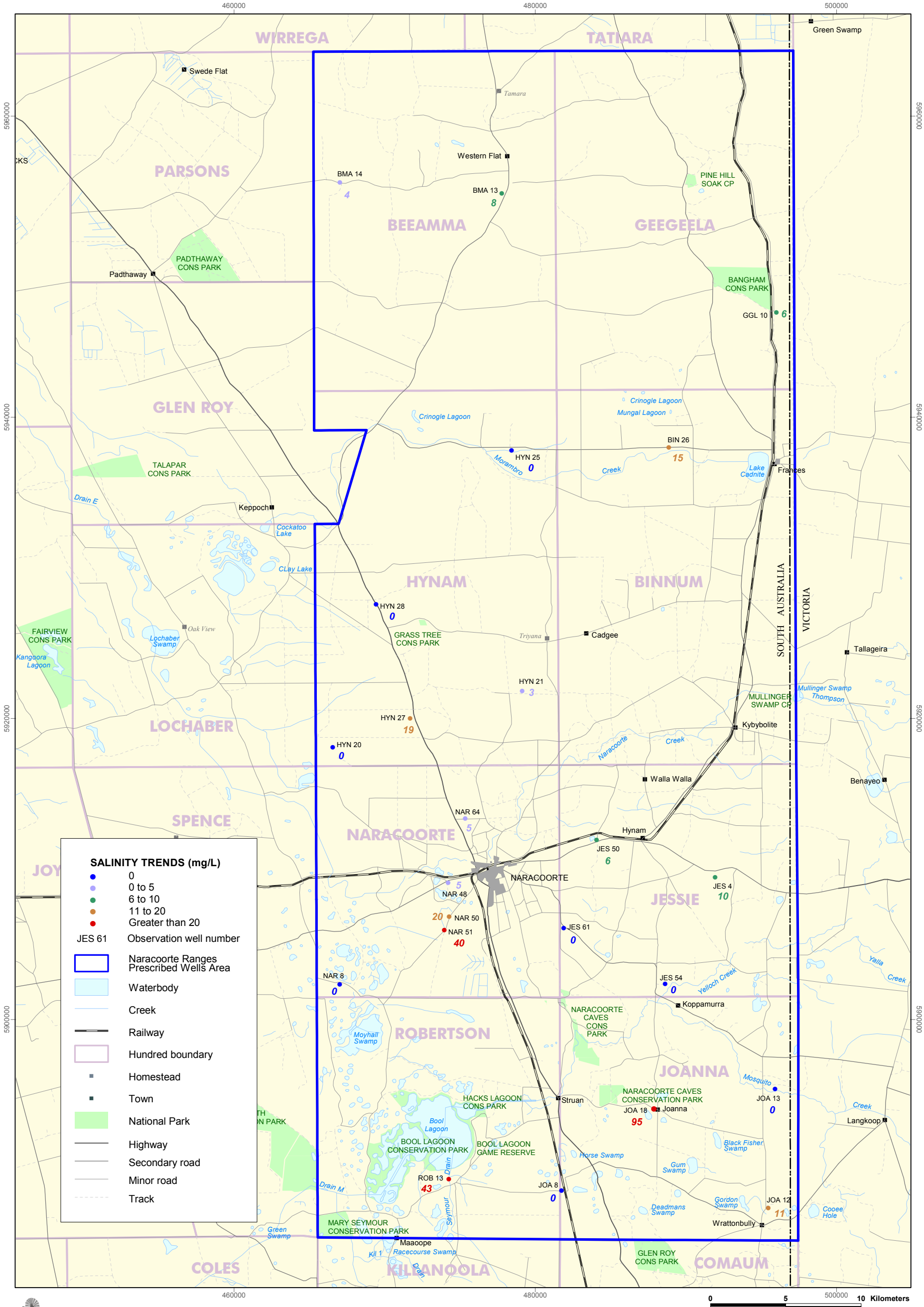
Figure 4.3



Datum GDA 94 - Projection UTM MGA Zone 54

Prepared September 2000

NARACOORTE RANGES PRESCRIBED WELLS AREA

SALINITY TRENDS to JUNE 2000

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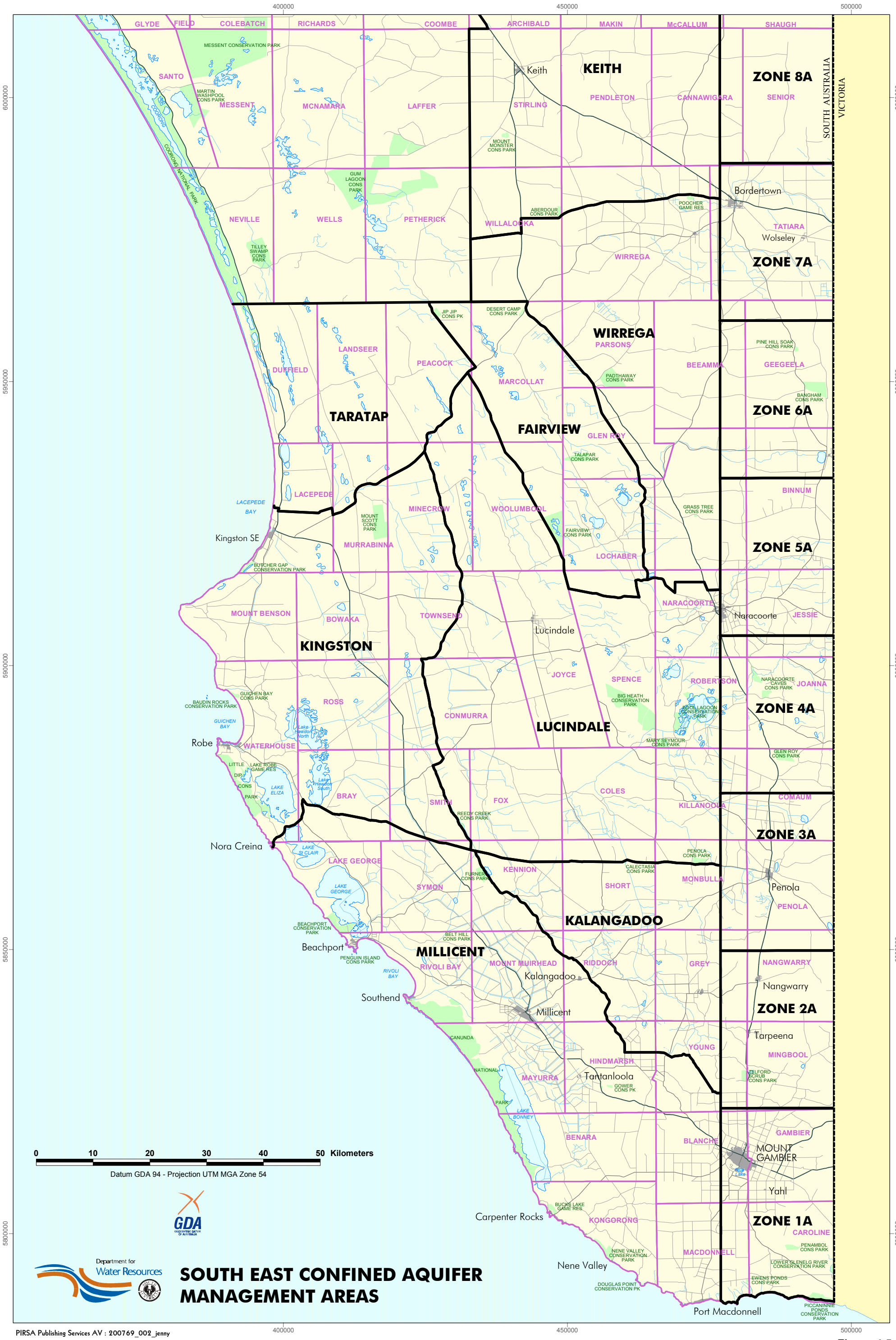
Figure 4.4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McCALLUM
SHAUGH
MESSENT CONSERVATION PARK
SANTO
MARTIN WASHPOOL CONS PARK
MESSENT
MCNAMARA
LAFFER
STIRLING
Keith
KEITH
PENDLETON
CANNAWIGARA
ZONE 8A
SENIOR
SOUTH AUSTRALIA
VICTORIA
THE COORONG
COORONG NATIONAL PARK
MOUNT MONSTER CONS PARK
GUM LAGOON CONS PARK
Bordertown
POOCHER GAME RES
ABERDOUR CONS PARK
NEVILLE
WELLS
PETHERICK
WILLALOOKA
TATIARA
Wolseley
TILLEY SWAMP CONS PARK
WIRREGA
ZONE 7A
JIP JIP CONS PK
DESERT CAMP CONS PARK
WIRREGA
PARSONS
LANDSEER
PEACOCK
DUFFIELD
MARCOLLAT
BEEAMMA
PINE HILL SOAK CONS PARK
GEEGEELA
PADTHAWAY CONS PARK
BANGHAM CONS PARK
ZONE 6A
TARATAP
FAIRVIEW
GLEN ROY
TALAPAR CONS PARK
LACEPEDE
LACEPEDE BAY
MINECROW
WOOLUMBOOL
MOUNT SCOTT CONS PARK
GRASS TREE CONS PARK
FAIRVIEW CONS PARK
BINNUM
Kingston SE
MURRABINNA
LOCHABER
ZONE 5A
BUTCHER GAP CONSERVATION PARK
NARACOORTE
Naracoorte
JESSIE
MOUNT BENSON
BOWAKA
TOWNSEND
Lucindale
KINGSTON
JOYCE
SPENCE
ROBERTSON
NARACOORTE CAVES CONS PARK
JOANNA
GUICHEN BAY CONS PARK
BAUDIN ROCKS CONSERVATION PARK
ROSS
CONMURRA
BIG HEATH CONSERVATION PARK
POOL LAGOON CONSERVATION PARK
ZONE 4A
GUICHEN BAY
LUCINDALE
Robe
WATERHOUSE
MARY SEYMOUR CONS PARK
GLEN ROY CONS PARK
LITTLE DIP CONS PARK
LAKE ROBE GAME RES
LAKE ELIZA
BRAY
SMITH
FOX
COLES
KILLANOOLA
COMAUM
REEDY CREEK CONS PARK
ZONE 3A
Nora Creina
LAKE ST CLAIR
LAKE GEORGE
KENNION
SYMON
SHORT
MONBULLA
PENOLA CONS PARK
CALECTASIA CONS PARK
FURNER CONS PARK
Penola
PENOLA
KALANGADOO
BEACHPORT CONSERVATION PARK
BELT HILL CONS PARK
Beachport
MILLICENT
PENGUIN ISLAND CONS PARK
RIVOLI BAY
MOUNT MUIRHEAD
RIDDOCH
GREY
NANGWARRY
Kalangadoo
Nangwarry
Southend
Millicent
ZONE 2A
Tarpeena
CANUNDA
YOUNG
MINGBOOL
HINDMARSH
TELFORD SCRUB CONS PARK
NATIONAL PARK
MAYURRA
Tantanloola
GOWER CONS PK
LAKE BONNEY
BENARA
BLANCHE
GAMBIER
MOUNT GAMBIER
Yahl
BUCKS LAKE GAME RES
Carpenter Rocks
KONGORONG
ZONE 1A
CAROLINE
PENAMBOL CONS PARK
NENE VALLEY CONSERVATION PARK
MACDONNELL
LOWER SLENELG RIVER CONSERVATION PARK
Nene Valley
EWENS PONDS CONS PARK
DOUGLAS POINT CONSERVATION PK
Port Macdonnell
PICCANINNIE PONDS CONSERVATION PARK
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Department for Water Resources
SOUTH EAST CONFINED AQUIFER MANAGEMENT AREAS
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Figure 4.5