



Government of South Australia

South Australian Arid Lands Natural
Resources Management Board



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South Australian Arid Lands Natural Resources Management Board

WATER ALLOCATION PLAN FOR THE FAR NORTH PRESCRIBED WELLS AREA



Cover photograph

Cullyamurra Waterhole by L. Brake

Bubbler by T Gotch

Natural Resources Management Act 2004

Water Allocation Plan

for the

Far North Prescribed Wells Area

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



Hon Jay Weatherill MP
Minister for Environment and Conservation

Date: 16/2/15

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Shortened forms

BRS	Bureau of Rural Science
d	day
DWLBC	Department of Water, Land and Biodiversity Conservation
EIR	Environmental Impact Report
FNPWA	Far North Prescribed Wells Area
GAB	Great Artesian Basin
km	kilometre
L	litre
Ma	million years
mg/L	milligrams per litre
ML	megalitre
m	metre
mm	millimetre
PEL	Petroleum Exploration License
PIRSA	Primary Industries and Resources South Australia
PPL	Petroleum Production License
SEO	Statement of Environmental Objectives
WAP	Water Allocation Plan
y	year

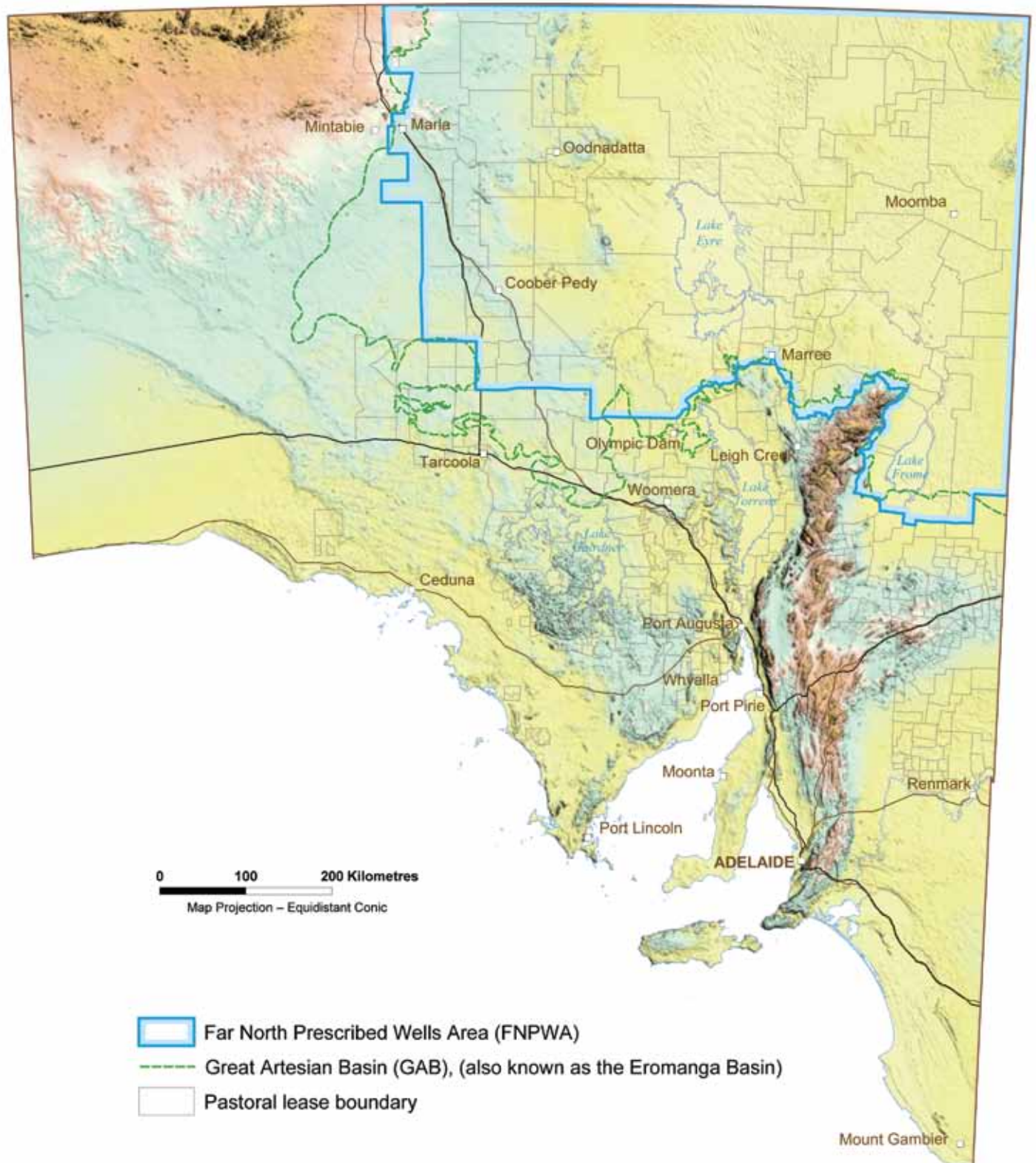


Figure 1 Location plan of the FNPWA

The Far North Prescribed Wells Area

This Water Allocation Plan (WAP) for the Far North Prescribed Wells Area (FNPWA) has been prepared pursuant to part 2, division 2, of the *Natural Resources Management Act 2004*.

The FNPWA was prescribed under the *Water Resources Act 1997* on 27 March 2003, in order to achieve responsible use of underground water, eliminate wasteful practices, ensure ecosystem health and to clarify the rights and responsibilities of users of the Great Artesian Basin (GAB) resources in South Australia. These objectives are consistent with those of the GAB Strategic Management Plan, the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and the 2004 Intergovernmental Agreement on a National Water Initiative.

The FNPWA, which covers an area of ~315 000 km² in the northeast corner of South Australia (~32% of the state), lies outside the state's surveyed Hundreds, and within the unincorporated areas of South Australia (with the exception of Coober Pedy). It includes the towns and settlements of Coober Pedy, Oodnadatta, William Creek, Marla and Innamincka. Other services are Cadney Homestead on the Stuart Highway and the Mungerannie Roadhouse–Hotel along the Birdsville Track. Santos Ltd maintains a large service infrastructure and camp at Moomba, but this is a restricted company settlement that excludes public access.

The boundaries of the FNPWA are shown in Figure 1.

The FNPWA is located in the arid zone of South Australia where rainfall is infrequent, erratic and low, averaging 100–200 mm/y with high annual variability. Long dry periods occur. Evaporation is extremely high, ranging from 2400 to over 3700 mm/y, and significantly exceeds rainfall. As fresh water is scarce, it is inextricably entwined with the livelihoods and social structure of the inhabitants of the land. This is particularly evident with the Aboriginal people who have a strong connection with their land and the associated resources.

The GAB springs, essentially surface discharge points of the GAB aquifer, support populations of unique and threatened fauna and flora and are of immense cultural and ecological importance.

Underground water, particularly from the GAB, is therefore critical to the health of ecological communities and the viability of the pastoral, mining and tourist industries in the region. Two critical components associated with the artesian underground water from the GAB are water pressure and temperature, which provide environmental and economic benefits in their own right.

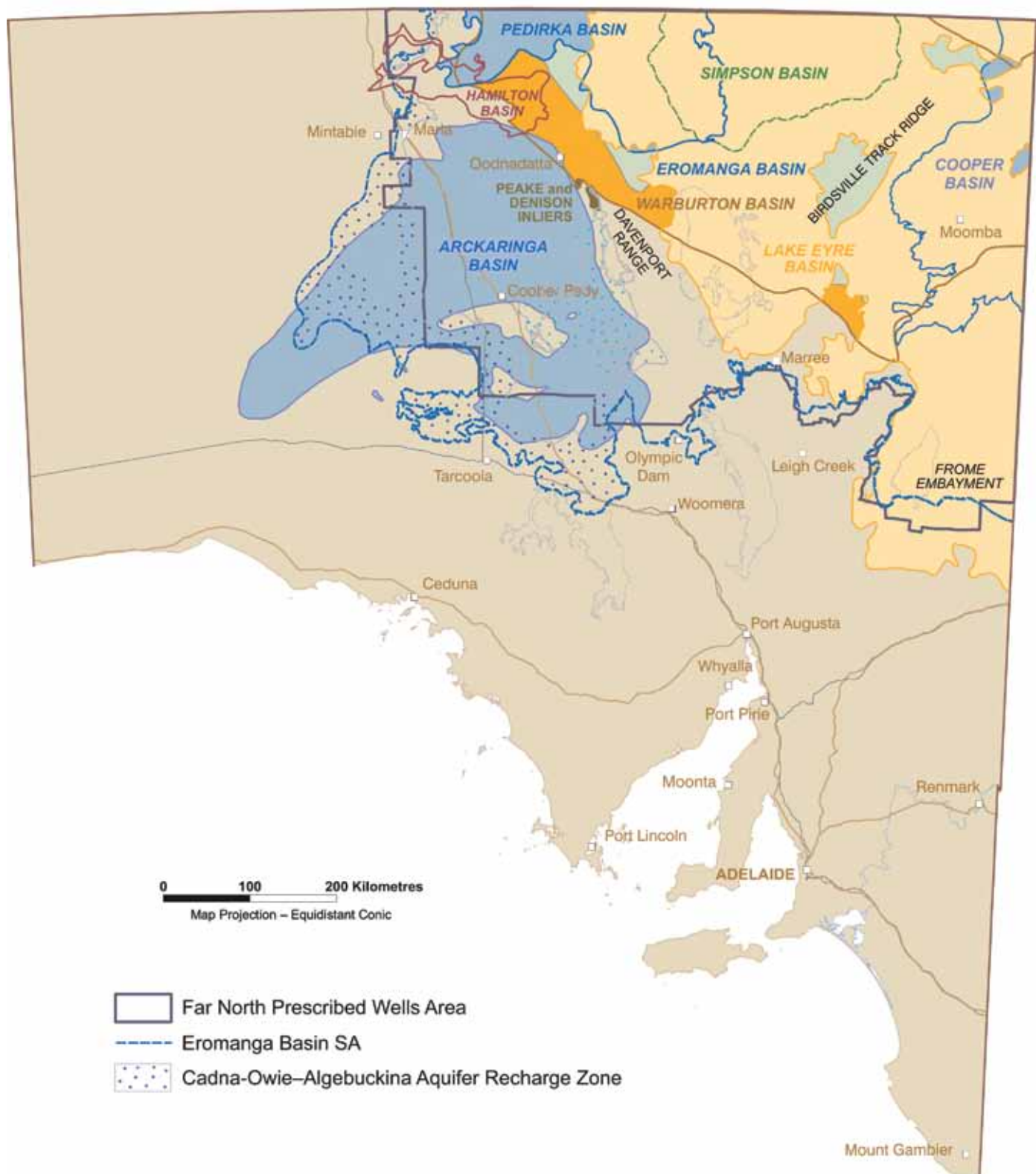


Figure 2 Geological setting, FNPWA

The prescribed resource

As the FNPWA covers such a large area, the hydrogeological regime is very varied and in places little understood. Simplified representations of the geological and hydrogeological settings are shown in Figures 2 and 3, respectively.

The hydrogeology of the FNPWA can be associated with four major rock successions, each separated in time from each other by hundreds of millions of years. The oldest sedimentary strata were formed, and then folded, between 850–480 million years (Ma) ago. Folded parts of these sedimentary strata are now exposed in the FNPWA as the Davenport Range and the Peake and Denison Inliers.

Between 290–275 Ma, a thinner sedimentary blanket was deposited, mainly known as the Arckaringa Basin. Other basins that underlie the GAB include the Cooper, Warburton, Simpson and Pedirka Basins.

The next cycle of deposition occurred between 160–90 Ma, with the deposition of the Jurassic–Cretaceous sedimentary formations of the geological Eromanga, Surat and Carpentaria Basins which collectively comprise the GAB succession. The succession was deposited in a broad depression that extended far to the north across much of Queensland to the present day Gulf of Carpentaria. The succession is well exposed over much of the Lake Eyre South Catchment.

A thin sedimentary blanket extending in age from 55 Ma to the present, known as the Lake Eyre Basin, in turn overlies most the GAB sediments.

All the above sediments contain numerous types of aquifers. For example, the GAB aquifer system consists of artesian aquifers (wells intersecting an artesian aquifer are free flowing) and non-artesian aquifers, and within the non-artesian aquifer system there are confined, semi-confined and unconfined aquifers.

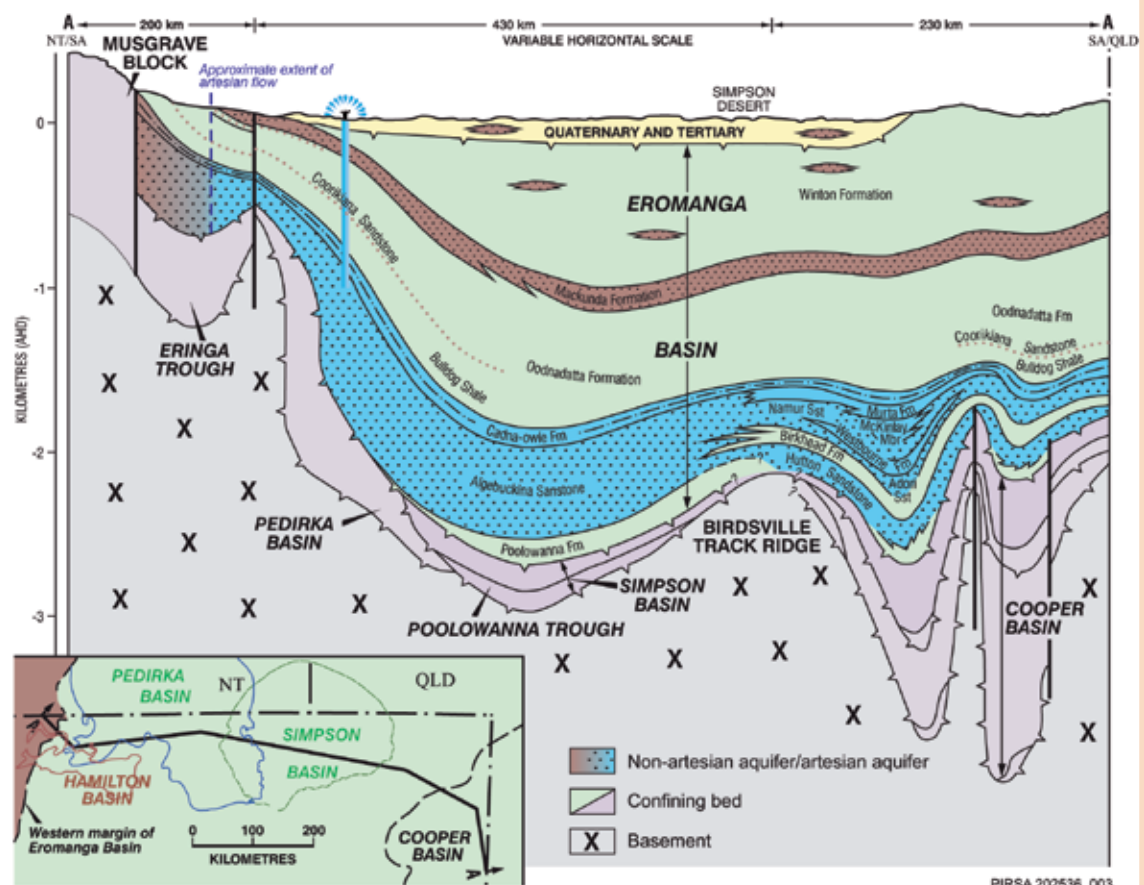
1.1 Non-artesian aquifers

Sub-artesian waters can be obtained from the aquifers described below, listed from oldest to youngest .

Fractured rock aquifers

Underground water may be obtained from fractures within rocks of the Davenport Range and the Peake and Denison Inliers, but little is known of well yields and water quality.

In the south and southwestern margins of the FNPWA, stock quality water may be sourced from the shallow underlying basement rocks, particularly near major creeks. Small claypans and ephemeral swamps also allow useful accumulation and recharge of water.



Sediments within the Permian Arckaringa Basin

Permian sediments are accessible at the edge of the Arckaringa Basin, and can provide an important source of stock water where there is localised recharge. Elsewhere these sediments are prohibitively deep and too saline for stock use, but may be useful for other purposes such as mining and road maintenance.

Non-artesian aquifers within the Jurassic–Cretaceous Eromanga Basin

The Eromanga Basin is the largest and most central of three depressions that together comprise the GAB (the other two being the Carpentaria and Surat Basins in Queensland). Only the southwestern third of the Eromanga Basin extends into South Australia, occurring as an almost continuous blanket, partly overlapping the sharply elevated Adelaidean rocks of the Northern Flinders Ranges and the Peake and Denison Inliers.

In South Australia, two major confined aquifers occur within the Eromanga Basin sediments:

- i) the more important lower Cadna-Owie Formation and Algebuckina Sandstone; and
- ii) the upper confined aquifer consisting of sediments of the Winton and Mackunda Formations.

A discrete saline aquifer of limited extent, the Coorikiana Sandstone, occurs within the confining beds separating the two major confined aquifers.

Cadna-Owie Formation and Algebuckina Sandstone

The Cadna-Owie Formation and Algebuckina Sandstone together are the major water-bearing aquifers in the FNPWA. This aquifer system is both artesian (refer to Section 1.2 of this document) and non-artesian. The southwestern limit of artesian conditions corresponds approximately with the line of the old Ghan Railway. To the west-southwest, this aquifer system becomes generally semi to unconfined and may be recharged through rainfall.

At the southwest extremity of the FNPWA, generally south of Coober Pedy, almost all wells completed in this aquifer system yield water that is too saline for stock, although limited useful yields may be accessible where recharge occurs via surface runoff and infiltration in low-lying areas. The saturated thickness of the Algebuckina Sandstone tends to be <10 m, and watertables can be shallow enough for evapotranspiration to occur. This leads to salinity increases in less well flushed portions of the aquifer.

North of Coober Pedy, useful supplies may be accessible from the Cadna-Owie–Algebuckina aquifer system (e.g. wells completed in this system supply the Coober Pedy and Marla Town Water Supplies).

Coorikiana Sandstone

Where confined, the Cadna-Owie–Algebuckina aquifer system is overlain by the Bulldog Shale. Along the southwestern margin of the Eromanga Basin, the Bulldog Shale is in turn overlain by the Coorikiana Sandstone, which forms a discrete aquifer of high salinity and low yield. While the sandstone outcrops on the western–southwestern edges of the Eromanga Basin, it is generally confined by the Oodnadatta Formation. Artesian pressures have been recorded in this aquifer.

Due to its high salinity and low yield, this aquifer is generally not exploited.

Winton and Mackunda Formations

The upper confined aquifer of the GAB consists of sediments of the Winton and Mackunda Formations. It is separated from the lower confined Cadna-Owie–Algebuckina aquifer system by shale of the Oodnadatta Formation and Bulldog Shale, and is generally overlain and confined by Tertiary sediments of the Lake Eyre Basin, and may be an unconfined aquifer around margins of the basin. It is not as important in resource terms as the lower aquifer, particularly where the lower aquifer is artesian (refer to Section 1.2 of this document), because water quality is poor and supplies are less easily obtained. There is no information on aquifer parameters for this formation in South Australia.

Sediments of the Lake Eyre Basin

The Eyre Formation

The Tertiary Eyre Formation is widespread throughout the Lake Eyre Basin. These sediments are not part of the GAB and consist of sand, commonly with beds of lignite and clay. The sand–sandstone beds can form useful aquifers for stock purposes, particularly in the southeast part of the FNPWA (Callabonna Sub-basin and over the central and western margins of the Frome Embayment, where water salinity ranges between 3000 and 12 000 mg/L).

Alluvial sands and gravels

Underground water can be obtained from unconsolidated sediments: wind blown sands, alluvium, lacustrine and fluvial sands, silts and clays, and occasional limestone beds. These may be cemented at the surface by silica, iron or gypsum. Generally they are unconfined, with the depth to watertable up to 90 m. Water quality is highly variable, from 1000 mg/L to >100 000 mg/L, and quantities are generally low.

There is often a layer of fresh underground water overlying more saline water. In the sandy dune country, good quality underground water can be found at shallow depths adjacent to the major water courses.

1.2 Artesian aquifers

The GAB is one of the world's largest underground water basins, covering some 20% of the continent, and is one of the largest underground reservoirs in the world. It is a multi-aquifer system comprising Jurassic and Cretaceous sediments of the geological Eromanga, Surat and Carpentaria Basins — these are structurally separate depocentres, but are stratigraphically and hydraulically interconnected. Aquitards may be absent or comprise sandier facies across the regional basement highs that separate the basins. The uppermost component of the aquifer system, the Cadna-Owie–Hooray Aquifer, (in South Australia, it is known as the Cadna-Owie –Algebuckina Aquifer) extends throughout the entire region of the GAB, including the shallow basement ridges separating the constituent geological basins. Most of the flowing artesian bores intercept this aquifer system, providing the shallowest flowing artesian water supplies in much of the GAB.

The basement to the GAB comprises an overlapping mosaic of fold belts and igneous and metamorphic rocks, and sedimentary basins which range in age from Precambrian to Triassic. In the South Australian part of the GAB, these underlying basins include the Cooper, Arckaringa, Pedirka, Simpson and Warburton Basins (Fig. 3).

In South Australia, the GAB sequence is composed entirely of Eromanga Basin sediments, which comprise two major confined aquifers:

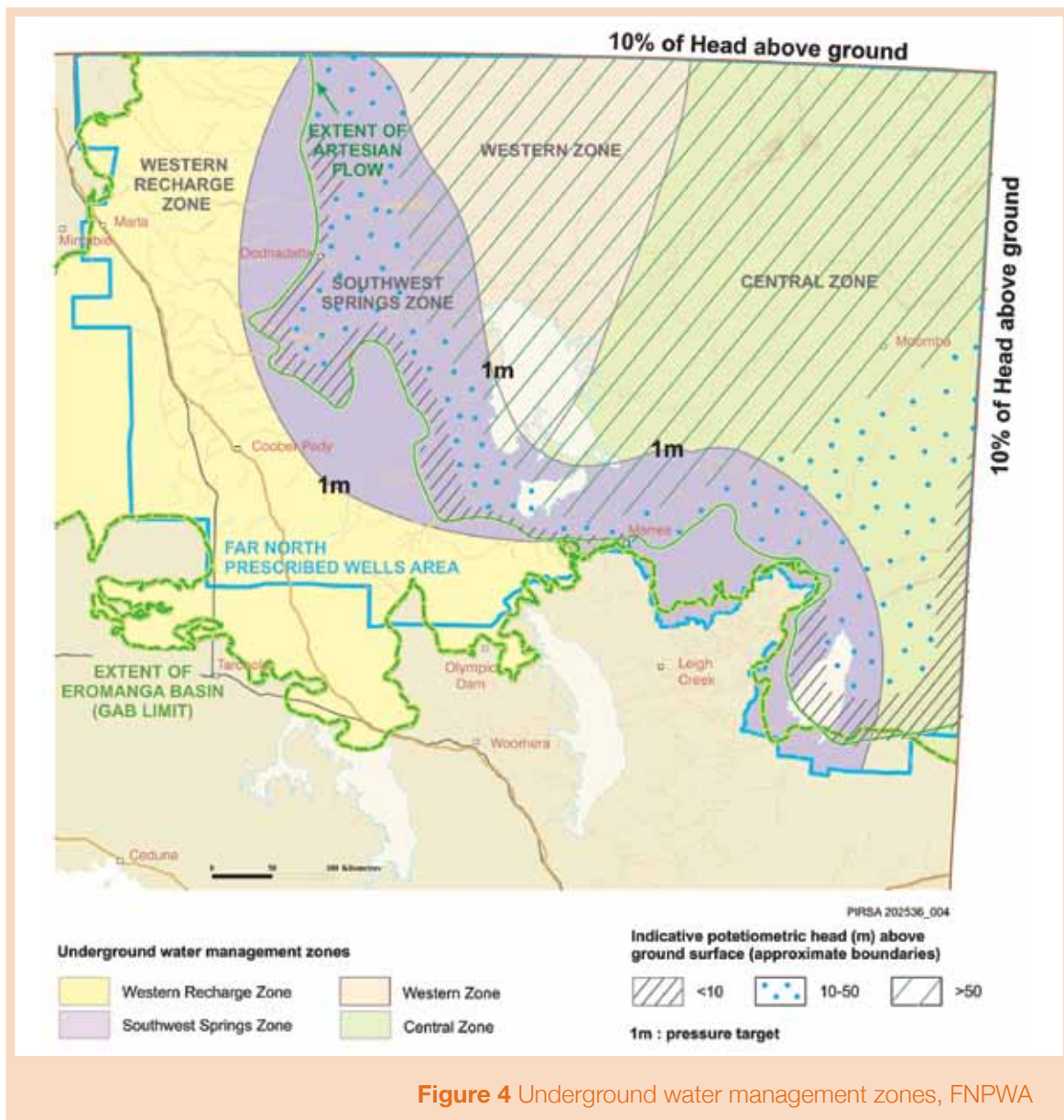
- i) the lower confined, predominantly artesian Cadna-Owie Formation and Algebuckina Sandstone aquifer, which is described in more detail below; and
- ii) the upper confined, non-artesian Winton and Mackunda Formations aquifer, which has been briefly described in the previous section.

In the South Australian context, the Cadna-Owie–Algebuckina aquifer is therefore known as the GAB aquifer, sourcing most of the demand in the FNPWA and supporting the ecologically significant GAB spring ecosystems.

To the east of the Birdsville Track Ridge, the Cadna-Owie–Algebuckina aquifer includes sediments of the Murta Formation and Namur, Adori and Hutton Sandstones (Fig. 3). West of the Birdsville Track Ridge, the Hooray, Adori and Hutton Sandstones merge into the Algebuckina Sandstone, as the separating aquitards lens out near the ridge.

The GAB aquifer (Cadna-Owie–Algebuckina aquifer)

Aquifer thickness of the Cadna-Owie Formation and Algebuckina Sandstone ranges from <50 m around the western margin to >500 m in the deeper parts of the basin. In South Australia, maximum thickness is on the southern margin of the Poolowanna Trough, where the Algebuckina Sandstone reaches over 450 m (Fig. 3).



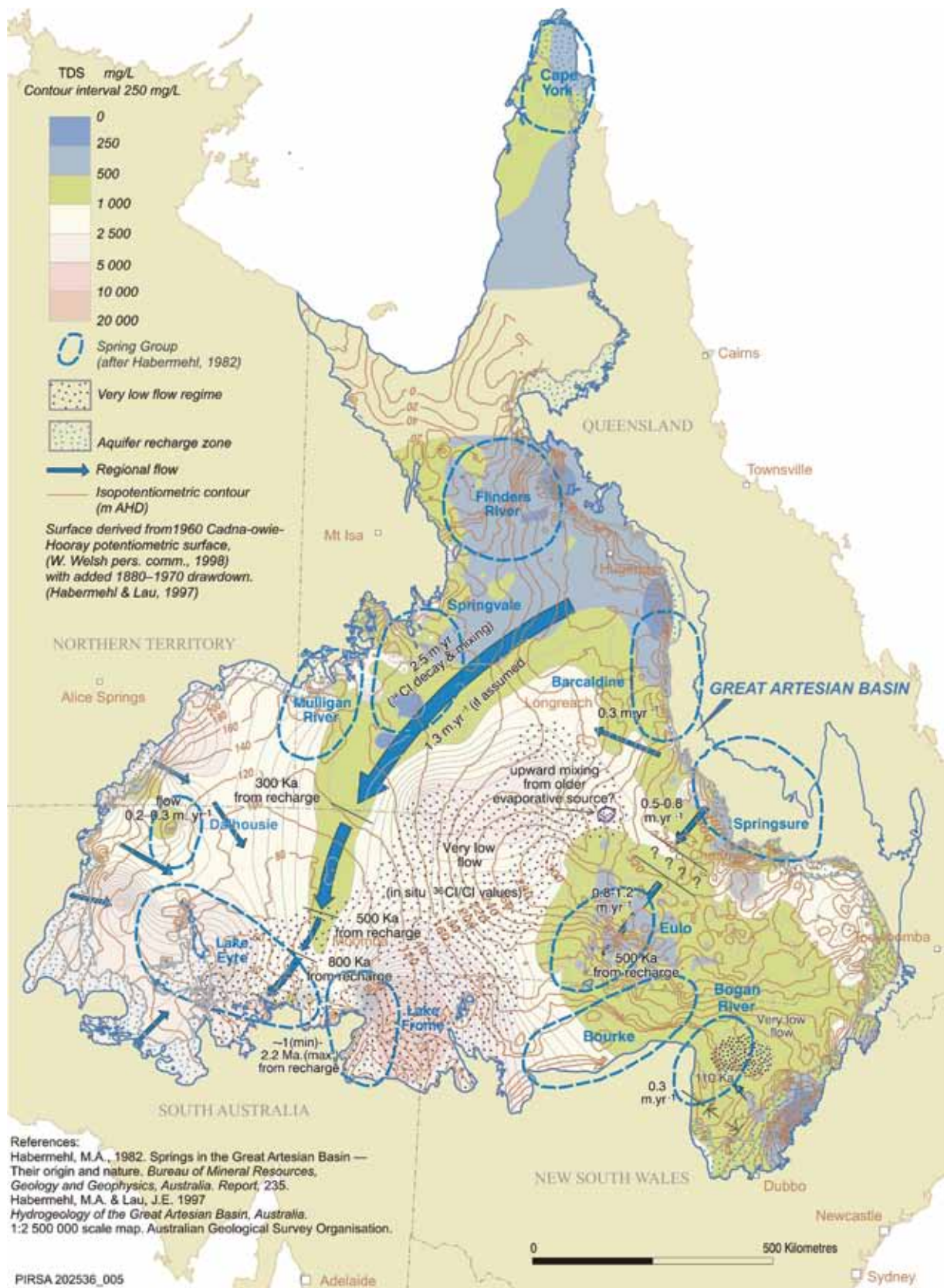


Figure 5 Hydrogeological aspects of the GAB (after Habermehl and Lau, 1997)

It is artesian throughout much of the basin, including large areas of South Australia. The southwestern limit of artesian conditions corresponding approximately with the line of the old Ghan Railway, beyond the Denison–Willouran Divide (Fig. 4).

Contained underground water within the artesian component of the aquifer system is generally fresh to brackish (<3,000mg/L). In the deeper parts of the Eromanga system, up to 3,000 m below ground, these same aquifers contain relatively higher salinity underground waters (up to 10,000mg/L) and host commercially exploited oil and gasfields.

Recharge and flow rates

Recharge of the aquifers is by infiltration of rainfall into outcropping sandstones of the aquifers, by leakage through surficial unconsolidated sediments over the aquifers in limited areas, and by localised inputs from surface drainage systems. Upward leakage of more saline underground water from the deeper Cooper Basin is also inferred.

Most of the recharge is effected along the elevated eastern margin of the basin, on the western slopes of the Great Dividing Ranges. Smaller intake regions are the western and northwestern Eromanga recharge zones.

In South Australia, recharge occurs along the western edge of the Eromanga Basin, where the unconfined aquifer is generally overlain by sandy sediments. Seasonal recharge along main drainage systems such as the Finke River is considered to be significant, not only over aquifer outcrop but also basinward through highly fractured Bulldog Shale into the underlying Algebuckina Sandstone aquifer.

Along an assumed flow line from Marla to Oodnadatta, horizontal flow rates of 0.2–0.3 m/y have been inferred, compared to 2.5 m/y near the eastern intake beds (Fig. 5).

Various isotope and hydrogeochemical studies support the concept of an open system and of continuing recharge from geological to modern times, with a rainfall origin of the underground water and flow from recharge areas downgradient to discharge zones. The age of the water can be up to two million years for underground water discharging at springs in the southwestern part of the basin.

Initiation of the basinal flow system is attributed to tectonism and then uplift of the intake beds somewhere between 10 to 15 Ma and 5 Ma ago.

Volume in storage

The total volume of water in storage in the major aquifers has recently been estimated at 64 900 000 000 ML, based on some 19 000 formation porosity measurements obtained from petroleum drilling records.

Discharge

Discharge from the GAB occurs by spring discharge, diffuse vertical leakage towards the regional watertable, subsurface outflows into the neighbouring Carpentaria Basin (not in South Australia), and by free-flowing wells or pumped extraction from wells completed in sub-artesian and unconfined aquifers.

In South Australia, springs are abundant in the marginal areas of the basin, generally concentrated in groups covering relatively small areas. Many springs in the southwestern region of the basin occur on intersections of basement faults, whilst others occur in areas where the aquifer sediments are near the surface.

Upward vertical leakage from the aquifers through the semi-pervious confining beds occurs throughout the basin. Where the difference in hydraulic heads between the Cadna-Owie-Hooray system and the Winton-Mackunda Aquifer is modest (<80 m) but consistent, widespread leakage may be occurring. Despite the presumed low-percolation rates, this leakage constitutes a considerable volume of water, of the order of 220 000 ML/y, comparable to that of the basin-wide well discharge of 440 500 ML/y. Where the head differences are >100 m, the intervening aquitard is relatively tight, with little or no leakage occurring.

In South Australia, this vertical leakage is the main discharge component of the water balance, being >50% of the inflow into the state, and is accordingly considered to be a key factor in minimising the regional impact of underground water withdrawals on the potentiometric surface. The diffuse discharge towards the regional table occurs mainly at the marginal areas where the confining beds are relatively thin and pressures are high. At the margins, discharge rates of 2–4 mm/y have been measured.

Upward leakage of underground water from the southwestern part of the Cooper Basin, particularly at the southern margin of the Central Eromanga Depocentre, is also inferred. Hydrocarbon fields that exist within Eromanga Basin aquifers, mainly the Hutton Sandstone, are indicative of upward migration of both hydrocarbons and underground water occurring in this region.

Water balance

In 2001, the basin-wide water balance components were reported as:

- natural recharge ~1340 ML/d (490 000 ML/y)
- discharge ~1940 ML/d
 - o springs ~140 ML/d (50 000 ML/y)
 - o vertical leakage and subsurface flow ~600 ML/d (220 000 ML/y)
 - o wells ~1200 ML/d (440 500 ML/y)

Based on these estimates, basin-wide the outflows still exceed the inflows.

Potentiometric surface

The potentiometric surface of the GAB aquifer system is above the ground surface throughout much of the basin, and large parts of South Australia. In terms of management zones (refer to Section 5.2 of this document and Fig. 4), the potentiometric surface in the Western and Central Zones in South Australia is generally >50 m above ground level and in places >130 m. In the Southwest Springs Zone, it ranges from <1 m at the western margins of the zone, to up to 70 m above ground in places near the Western and Central Zones (Fig. 4).

Regional underground water movement has been interpreted from the potentiometric surface maps of the aquifers.

Flow directions in South Australia are generally towards the southwest from the recharge region in the northeast part of the basin. There is also a smaller flow component from the western margin of the basin (Fig. 5). The eastward moving high sulphate waters converge with the westward moving water of high alkalinity near Lake Eyre, where they are mixed within the main aquifer and discharge near the southwestern basin margin.

Areas with higher underground water flow rates are relatively limited to the regions adjoining recharge zones in Queensland and where the aquifer has shallow burial, in contrast to the deeper depocentres of component basins with very low flowing underground waters. In essence, two flow regimes have been identified, with flow rate differing by an order of magnitude.

In South Australia, the moderate flow regime (1.2–2.5 m/y) is associated with the Birdsville Track Ridge (Fig. 5). Flow in the deeper parts of the basin and from the Western Recharge Zone is very low (generally <0.3m/y).

Residence times range from several thousand of years near the recharge areas, to up to two million years for underground water discharging at springs in the southwestern part of the basin.

2

Assessment of the needs of underground water dependent ecosystems

For the purpose of this assessment, the needs of ecosystems dependent on underground water are such as to maintain, and where appropriate improve, the condition in which they are currently found. This is consistent with the objectives of the State Natural Resources Management Plan 2006, the *Natural Resources Management Act 2004*, the GAB Strategic Management Plan, the 2004 Intergovernmental Agreement on a National Water Initiative and the *Environment Protection and Biodiversity Conservation Act*.

The FNPWA is characterised by a diverse and dynamic range of ecosystems and land types. These are reflected in the number and descriptions of the bioregions present, namely the Channel Country, the Simpson Strzelecki Dunefields, the Stony Plains and the Finke. The area includes the extensive floodplains of the Cooper Creek and Warburton-Diamantina River.

Only those ecosystems dependent on underground water are considered in this document, namely the GAB springs and bore-fed wetlands. It is also likely that vertical leakage from the deep aquifers into the shallow watertable aquifer supports saline discharge into the salt lakes of the region — these salt lakes, specifically Lake Eyre (South and North) and Lake Frome, in turn support a number of endemic terrestrial invertebrates. The significance of this underground water discharge on the salt lake ecosystems with respect to salt input, through base flow in creeks, is not known.

Classification of ecosystems possibly dependent on shallow underground water systems is difficult and has not been documented to date.

Although the role of underground water and the interaction between surface and underground water in supporting terrestrial vegetation in these arid areas are poorly understood, any additional significant development of the underground water resources in the FNPWA will be sourced from the deeper parts of the artesian aquifer and will not impact on the shallow underground water systems. This is because the pressure targets adopted in the Plan will always result in the potentiometric surface of the artesian aquifer being always above ground level, except locally at the wellfield. Where pressure heads have dropped below ground surface, the numerous confined aquifers occurring above the GAB aquifer system will provide an effective buffer to any drawdowns observed in the artesian aquifer.

Macro-invertebrate and microbial communities (hypogene life forms) can exist in aquifers, in spaces between grains or, more commonly, in underground water caves. For any hypogene ecosystem to be affected, aquifer conditions such as water salinity, level of oxygenation and depth would need to change. As these conditions are not expected to change for the artesian aquifer, this will therefore not be an issue for the artesian system in the FNPWA, whilst in the non-artesian component, there is no evidence of hypogene ecosystems, and as such an assessment of the needs for water of those ecosystems is not required.

GAB springs

There are 12 spring supergroups located across the entire GAB, with some 1700 individual springs in 23 spring complexes identified within South Australia (Fig. 5).

The GAB springs occur where faults provide a pathway for the deep artesian waters to reach the surface through the confining beds overlying the aquifer, where the aquifer abuts against impervious bedrock, and where the pressurised water breaks through thin confining beds near the discharge margins of the basin.

GAB springs are highly dynamic systems that vary in hydrology, geomorphology, ecology and size. They are generally located along the margins of the basin, except for Dalhousie Springs, where because the relatively impermeable confining beds are thin and often broken by faulting they act as a natural escape outlet for the artesian waters. The combination of the artesian pressure and the thin confining beds and/or pathways provided by faulting results in a leakage rate exceeding the evaporation rate, thus water occurs at the surface. Depending on the flow rate and the shape of the mounds, pools may form over a spring site, some feeding streams several kilometres long.

The classical mound spring, a South Australian terminology, is formed by wind erosion of loose material around the saturated soil associated with the spring – the ground surface may thus be lowered around a spring but the saturated soil immediately surrounding the outlet remains in place as a mound, often cemented by lime or gypsum precipitated from the spring water.

The springs in the FNPWA have been a focus for human activity throughout history. They are of immense cultural importance and are a focus for the growing tourist industry.

A number of springs in South Australia are recognised for their ecological and social value – namely the Dalhousie, Coward, Hermit Hill and Neales River Spring Complexes, all of which have been listed on the register of the National Estate, reflecting their national significance.

The springs support populations of unique and threatened crustaceans and gastropods, and some rare plants (e.g. the Salt Pipewort). These communities of native species that are dependent on natural discharge of underground water from the GAB have been listed as Endangered under the *Environment Protection and Biodiversity Conservation Act*. The listing includes springs within the GAB discharge area that are the natural surface discharge points of aquifers in the Triassic, Jurassic and Cretaceous sedimentary sequences of the GAB.

There is also a need to ensure that the GAB springs are protected against pollution, erosion and habitat destruction as a result of activities such as grazing, destroying of vegetation and excavation or removal of sediments at or in the immediate vicinity of the springs.

Whilst current activities will not be affected under this WAP, these will be reviewed over the period of the WAP with the aim of regulating any activities that may affect the spring ecology.

Water requirements

Pre-development flow estimates are not known, but natural discharge from GAB springs in South Australia was estimated at 66 ML/d in 1996, and flow rates from individual springs ranging from near zero to 14 ML/d, with the majority under 0.5 ML/d.

It is difficult to quantify the minimum spring flow necessary to sustain the extent and biodiversity of spring ecosystems. This is exacerbated by the general inability to measure spring flow accurately, and whilst a reduction in the aquifer pressure in the vicinity of a spring would result in a reduction in the spring flow, the resulting reduction in flow for any drop in pressure is generally not known a priori for any one spring, again exacerbated by the inability in determining aquifer pressure at the location of a spring. Notwithstanding anthropogenic impacts, flows from springs are also very variable, and to date no satisfactory explanation for this natural variation is apparent. The number of springs in a group, rather than the total flow of water, has been recognised by research as an important factor for maintaining biodiversity.

A decline of flows has been observed in some springs near BHP Billiton's Olympic Dam Wellfield A, as identified in the environmental impact statement for the Olympic Dam project — this decline has stopped, and in some cases has been reversed due to the transfer of part of the extraction from Wellfield A to Wellfield B. The well rehabilitation program in South Australia has also seen an improvement in the flow from some springs.

One of the key objectives of the management regime adopted by this WAP is to protect environmental assets, such as the underground water dependent spring ecosystems. To that end, the taking of water shall not have unacceptable impact on spring ecology. Given the inherent difficulties in establishing and monitoring the relationship between flow, pressure in the vicinity of the spring (pressure at the spring generally cannot be measured), and impact on spring ecology, the following adaptive management approach that protects the springs and provides some flexibility, particularly at low risk or low value springs, is required:

1. There shall be no new wells for the purpose of the taking of water within 5 km of any springs.
2. The taking of water shall not result in any unacceptable drop in pressure in the vicinity of springs due to the taking of water.
3. A decline in pressure in the vicinity of springs may be acceptable if the proponent can demonstrate that any drop in pressure will not have any unacceptable impact on the spring ecology.
4. The potential of a pressure drop due to the taking of water would trigger the requirement for a proponent to prepare an Environmental Impact Report (EIR) which will result in appropriate management conditions relevant to the level of potential environmental impact.

The (predicted) pressure drawdown values that will trigger the need for an EIR are as follows:

- Exceeding the 1 metre cumulative drawdown at the boundaries of the Southwest Springs Zone (refer figure 4)
 - Exceeding the 0.5 metre cumulative drawdown at the boundary of the 5 km exclusion zone around a spring
5. Additionally if in the opinion of the Minister, where the extraction of water may cause an unacceptable risk to spring resources, an EIR will be required.
 6. The EIR shall be in a form prescribed by the Minister administering the *Natural Resources Management Act 2004*.
 7. In assessing the EIR, the Minister will ensure applicants are made aware of the requirements for possible referral of the application for the taking of water and resulting EIR to other acts, such as the *Environmental Protection and Biodiversity Conservation Act 1999*.

Prediction of the drawdown at the regional boundaries due the proposed taking of water shall be initially based on a model that is acceptable to the Minister.

Prediction of the drawdown at the boundary of the 5 km exclusion zone around a spring shall be initially determined by a set of distance-drawdown plots determined by the de Glee steady state leaky aquifer equation.

Bore-fed wetlands

Bore-fed wetlands, some of which are over 100 years old, are man made habitats resulting from flowing artesian bores. The physical nature of these wetlands is variable, with many forming in natural depressions and drainage lines.

Some bore-fed wetlands have high social and recreational values that are very important to landholders, regional visitors and tourists. These values are generally enhanced by the wildlife associated with the wetlands. Wildlife (plants and animals) sustained in artificial wetlands near homesteads make a significant contribution to the quality of life of the landholders. These wet areas provide important educational and leisure settings for children and families, and also provide an important emotional refuge during drought. Some wetlands provide a focus for visitors to experience attractive natural and cultural features of the area.

Current scientific evidence suggests that justifying the maintenance of bore-fed wetlands on the basis of ecological values in an otherwise dry landscape is problematic. Although some wildlife populations benefit from the maintenance of wetlands, others that are adapted to a landscape without permanent water are displaced. Increased total grazing pressure around wetlands can impact on plant diversity, and wetlands can provide a refuge for feral animals and spread weeds. The discharge of large artesian flows may also have a negative impact on the flow regime of nearby natural springs. All jurisdictions within the GAB have now agreed that the use of bore drains as a method to deliver water to stock can no longer be justified.

Water requirements

Some wetlands have amenity values to landholders and visitors that warrant the continued allocation of water, even though mounting a scientific case for water allocation to maintain ecological values in bore-fed wetlands is difficult. In making decisions about the maintenance or closure of bore-fed wetlands and determining the required water allocation, it is necessary to consider the biological, social and recreational values that may accompany significant bore-drain flows and wetlands on a case-by-case basis. This is because the relative importance of the values placed on each wetland will depend on local and regional factors, and must be weighed up against values that may be sustained by alternative uses of the water.

The discharge rate is a major aspect for wetlands management as it can determine the level of impact of a bore drain on the flow rate of springs and obviously directly affect the size of the wetlands, and as a consequence the associated water-dependent ecosystems that enhance the recreational and/or social value of the wetlands. An adaptive management approach is proposed, particularly for the determination of the appropriate flow. Once the flow rate has been reduced, evaluation and monitoring should be established as a major component of the wetlands management program.

No distinction is made between bore-fed waterholes and bore-fed wetlands. Discharge of water from a bore into a wetland or waterhole will be subject to the provisions in this Plan for bore-fed wetlands.

3

Assessment of the effects on other water resources

Chapter 4, part 2, division 2, section 76 (4)(a) of the *Natural Resources Management Act 2004* requires the WAP to assess whether the taking or use of water from the prescribed water resource will have a detrimental effect on the quantity or quality of water that is available from any other water resource.

The other water resources in the FNPWA that can be described in this context are the major rivers and water courses draining the Lake Eyre Basin (Macumba, Arckaringa, Neales, Finke, Warburton and Coopers Creeks), salt lakes (e.g. Lakes Eyre, Frome and Callabonna), wetlands (e.g. Coongie Lakes and Strzelecki Creek Wetlands) and the aquifer systems extending across the border into Queensland, New South Wales and the Northern Territory.

Whilst the major rivers and water courses are normally dry, the occasional major semi-permanent to permanent waterholes provide important refuges. For these permanent water holes (e.g. the Algebuckina and Peak Creek waterholes) the underground water–surface water interaction is not understood.

Taking water from the deeper artesian system will not have any impact on the Coongie Lakes and the Strzelecki Creek Wetlands as the artesian aquifer and these natural wetlands are not hydraulically linked. If there is any interaction between the shallow underground water system and these natural wetlands, it is unlikely that there will be any impact at all on that interaction, given that the taking of water from the shallow underground water system is constrained by the use of the land, which is within the Innamincka Regional Reserve.

With respect to salt lakes, it is likely that vertical leakage from the deep aquifers into the shallow watertable aquifer supports saline discharge into the salt lakes of the region. The impact of reduced leakage (due to the taking of water from the artesian aquifer) on the water balance of the watertable aquifer and the significance of this underground water discharge on the salt lake ecosystems are not known.

The taking of water from the artesian aquifer can potentially have a detrimental effect on users of the same aquifer in the adjoining states, particularly where the artesian heads above ground surface are already low.

Cultural heritage values

The FNPWA is rich with both Indigenous and non-Indigenous cultural heritage. It is important that the cultural significance of water sites is recognised and addressed in the WAP.

Traditionally, Aboriginal people have a strong connection with their land and the resources found within it. Water is an important aspect of this connection, providing food in the form of fish, mussels and plants, a source of drinking water, and there are many water-related sites that were, and continue to be, of significance to Aboriginal archaeology, anthropology or history.

The mound springs played a particularly important role in the traditional Aboriginal economics of the region. Commonly associated with the mound springs are rich complexes of archaeological sites and intricately woven webs of myth and song, which demonstrate that these springs were, and are, a vital part of the cultural landscape.

European pastoral occupation of the FNPWA commenced in the 1850s, with the first pastoral leases introduced in 1851, initially relying on the limited natural surface water resources. The ring of mound springs discovered in 1858 initially supplemented the natural surface waters, including the semi-permanent waterholes. The springs and the scattered waterholes provided the only permanent sources of water for early settlers.

The availability of water from the springs determined the routes of the Overland Telegraph line in the 1870s, and the railway to Alice Springs in the 1880s.

Before the tapping of the GAB gave reliability to the waters along stock routes, drought effectively ensured the demise of large numbers of stock on the 'runs'. The implications of the discovery of the artesian waters for the fledging pastoral industry were therefore profound, particularly the drought-proofing of designated travelling stock routes by the drilling of government wells into the GAB. The biggest and best known of the four stock routes was the Birdsville Track, with 10 artesian wells drilled between 1890 and 1916 — these were sited two to three days cattle walking distance apart. Bore pressure is also important for the distribution of water for stock.

The history, distribution and lifestyle of people who live in the FNPWA has to a large extent been determined by their access to GAB water, with the location of many homesteads determined by access to free-flowing wells.

Domestic water supplies, gardens and water for recreational uses are essential to a quality lifestyle for people living in the area. The temperature and pressure of the GAB water are also important to domestic supplies. Gardens and plantings near homesteads and settlements are aesthetically and spiritually important, especially at times when the surrounding environment is very hot and dry. They also help to control dust.

As outlined previously, bore-fed wetlands, which are man-made habitats resulting from flowing artesian wells, generally have high social and recreational values for landholders, regional visitors and tourists.

Water for cleaning, maintenance and improving the amenity of living and working areas is a key factor in sustaining the infrastructure for all human activity in the arid FNPWA.

Springs also provide a refuge in a dry landscape for wildlife and travellers. The environmental and cultural attractions that have built up around springs are a focus for the growing tourist industry and provide the opportunity to increase people's understanding of groundwater and its importance in the landscape.

Assessment of the capacity of the resource to meet demands

The capacity of the underground water resources of the FNPWA to meet existing and future demands on a continuing basis is assessed in terms of two broad aquifer systems adopted in this WAP.

These are:

1. aquifers above and below the main artesian aquifer in the GAB.
2. main artesian aquifer (the Cadna-Owie – Algebuckina aquifer)

5.1 Aquifers below and above the GAB aquifer

The recharge–discharge processes for these aquifers are not well understood and the water balance has not been quantified.

For the shallow aquifers (eg alluvial sands and gravels, rocks of the Davenport Range and the Peake and Denison Inliers) the resource is considered in general to be limited, with individual well yields commonly <2 L/s. The groundwater is generally brackish to saline, except near major creeks and ephemeral swamps, which may allow useful accumulation and recharge of water. Current recharge is minimal (estimated at 0.1–0.25 mm/y), except occasional recharge along main drainage systems.

Sand and sandstone beds of the Tertiary Eyre Formation can form useful aquifers for stock water supply purposes.

The Coorikiana sandstone and sediments of the Winton and Mackunda Formations that also occur above the GAB aquifer are generally not exploited in South Australia due to the high salinities and low yields. There is no information on aquifer parameters for these formations in South Australia.

Older sedimentary basins that underlie the GAB aquifer include the Cooper, Warburton, Simpson and Pedirka Basins. There is a potential to obtain useful saline supplies from these deeper basins, particularly for mining purposes. The Cooper Basin is also important in term of its petroleum resources and the exploitation of these resources in turn utilise underground water at a rate in excess of 5 -10 ML/d. As for the shallower systems, little is known about these underground water resources.

5.2 The GAB aquifer (Cadna-Owie – Algebuckina aquifer system)

As previously described, this aquifer system is both artesian and non-artesian, with the southwestern limit of artesian conditions corresponding approximately with the line of the old Ghan Railway (figure 4).

West – southwest of the artesian boundary, the aquifer is confined to unconfined. Where unconfined, the aquifer is recharged through rainfall.

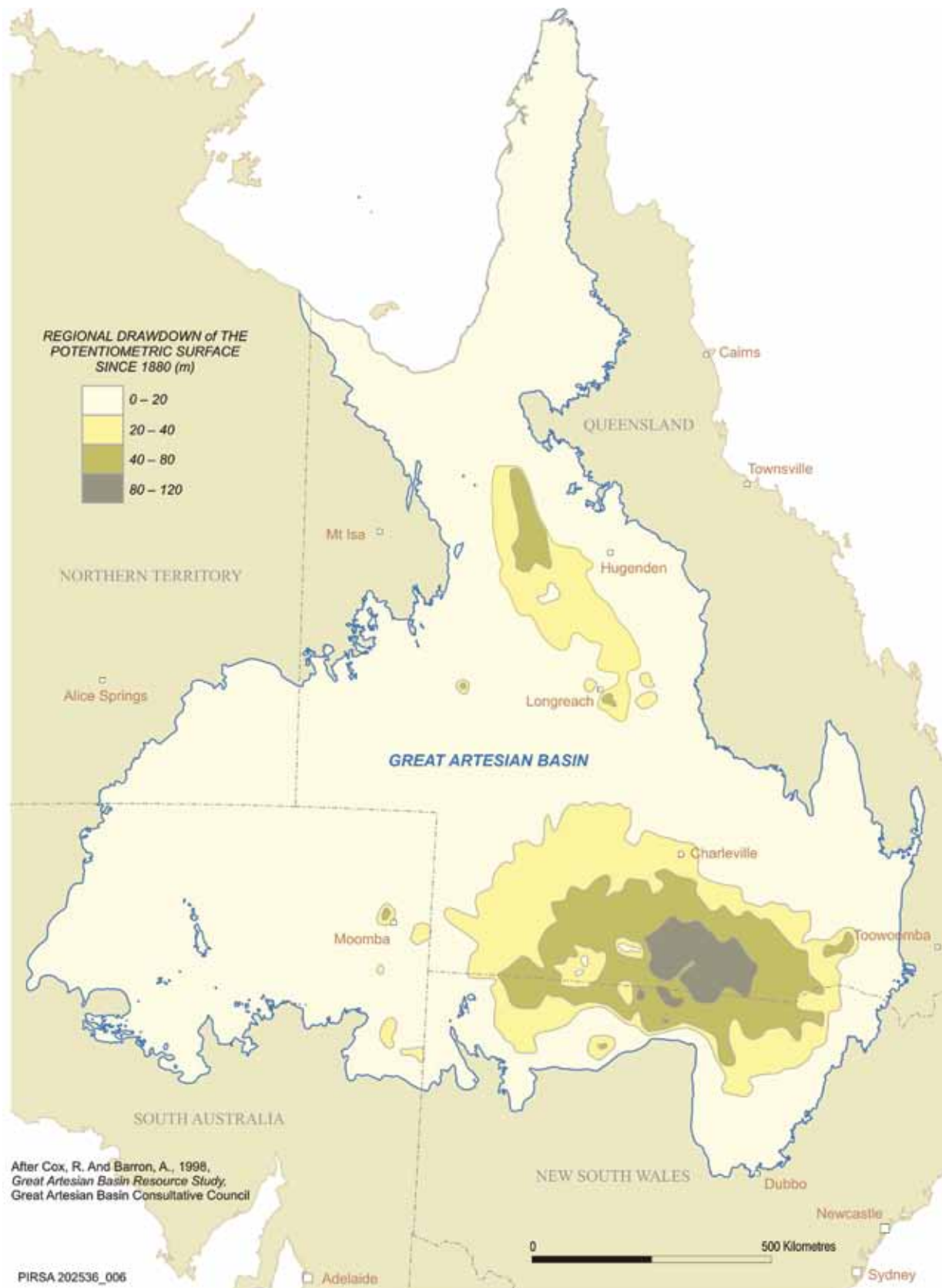


Figure 6 Regional drawdown of the potentiometric surface, GAB (pre 1989)

The water balance derived from the Bureau of Rural Science's numerical underground water model for the GAB aquifer, indicates the following flow volumes for the non-artesian part of the system (defined as the Western Recharge Zone, figure 4 and refer to Section 5.3.1)

	In (ML/d)	Out (ML/d)
Horizontal Flow	74	122
Wells	0	24
Recharge	163	0
Vertical Leakage	43	134 (evapotranspiration)
SUM OF ZONE	280 ML/d	280 ML/d

For the artesian part of the GAB aquifer, the regional drawdown of the artesian pressure throughout the basin due to water extraction during the period 1880–1970 is shown in Figure 6. Interpretation of more recent pressure trends is shown in Figure 7.

In the central part of the basin, exploitation of the artesian underground water resources has led to significant falls in pressure and flow – in parts of Queensland and New South Wales average pressure head losses of up to 40 m (with maximum losses of 120 m) have been recorded.

Development in South Australia has had relatively little effect on the potentiometric surface, except locally such as at the Olympic Dam and Moomba wellfields. It is therefore considered that the GAB aquifer system is at or close to equilibrium at the present.

Peak discharge in South Australia was estimated to be ~220 ML/d in 1980, with no evidence of regional impact on the potentiometric surface. It is believed this is due to the significance of the vertical leakage component of the water balance.

The Bureau of Rural Science's numerical underground water model suggests that inflow into the South Australian part of the GAB (including the non-artesian part) is of the order of 471 ML/d (171 915 ML/y) if contribution from the deeper Hutton Sandstone, which merges with the Algebuckina Sandstone in South Australia, is included.

In 2003, outflow from the aquifer system in South Australia has been estimated as follows:

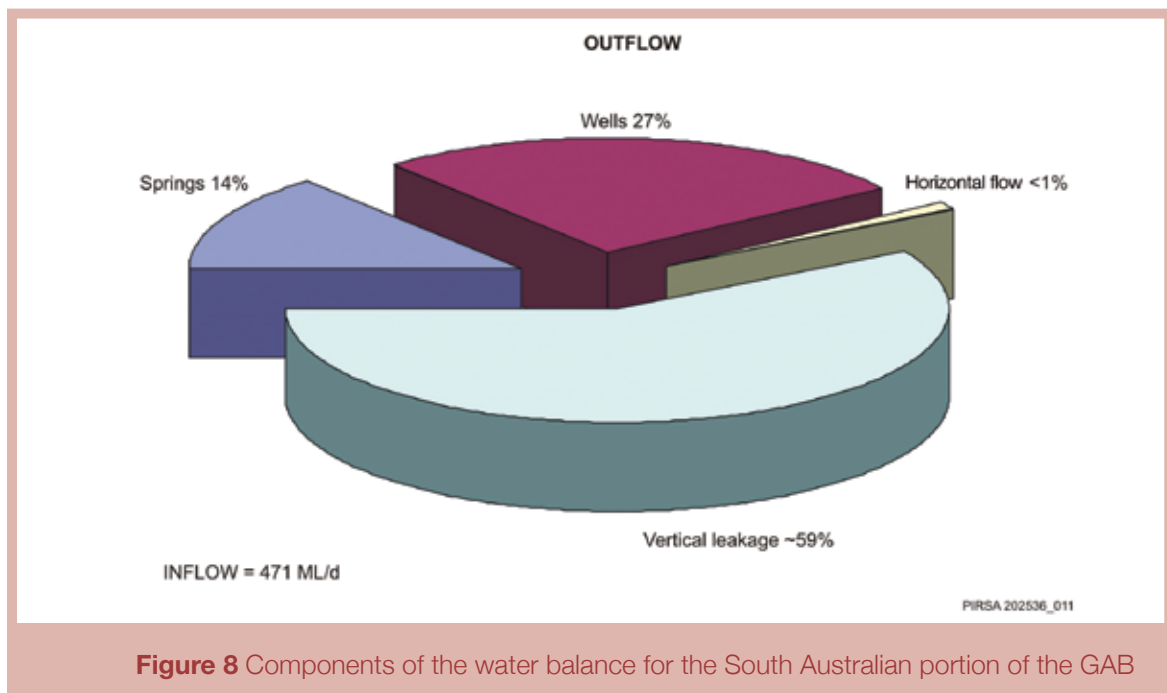
- springs ~66 ML/d
- wells ~128 ML/d
- vertical leakage ~274 ML/d
- flow ~ 3 ML/d

The components of the water balance in South Australia are illustrated in Figure 8.

The main discharge component of the water balance is vertical leakage, which is over 50% of the inflow. The key to management of the resource in South Australia lies in the careful harvesting of this vertical leakage.

In addition to the provision of large volumes of water, the artesian-aquifer system has two additional attributes, temperature and artesian pressure. These two attributes provide benefits to some users and costs to others. For example, high temperature is a cost to the pastoral industry (requirement for cooling ponds, high-temperature rated pipes and fittings), but a benefit for the potential power generation industry.

The hydrology of the artesian aquifer is discussed in more detail in Section 1.2 of this document.



5.3 Management approach

A management approach based on an acceptable fall in pressure head has been adopted in this WAP. Water will therefore normally be allocated by volume against pressure targets. This approach is based on:

- extent of the aquifer system and response time (because of the size of the basin, the relatively flat gradients and low permeability, travel times are such that recharge occurring in aquifer outcrop areas will not have any effect on the total volume in storage within a management time frame; additionally, as a consequence of generally low-hydraulic conductivity, the impact of any increase in discharge will tend to be localised — i.e. the ‘sustainable yield’ should not strictly be equated to the basin recharge).
- the importance of vertical leakage in South Australia
- the volume of water in storage that can buffer the impacts of temporary water needs (e.g. for mining).

Pressure, and hence spatial distribution of the discharge, is the key variable rather than the volume of discharge, as falling artesian heads, particularly in low-pressure areas near the basin margins, will:

- gradually reduce spring flows, to the point that flow will stop when the head locally falls below ground level
- significantly increase the cost of stock watering if pumps are required to supplement or replace the use of pressure to pipe water
- potentially allow the downward leakage of poorer quality water from overlying shallow aquifers into the main aquifer.

The discharge volume is defined as a volume that produces an acceptable fall in artesian head, and what is acceptable is spatially variable (concept of management zones) and dependent on acceptable impacts on the underground water resources, underground water dependent ecosystems and existing users — i.e. manage by pressure and allocate by volume.

5.3.1 Management zones

The above approach is in line with the concept of basin management zones proposed in the GAB Strategic Management Plan, where a target pressure distribution that is acceptable in terms of local impacts for each zone is adopted. The four zones identified in the Strategic Management Plan that cover the South Australian part of the GAB are the Western Recharge Zone, the Southwest Springs Zone, the Western Zone and the Central Zone. The same zones have been adopted for this WAP, but the western boundary of the Southwest Springs Zone has been modified to coincide approximately with the limit of the artesian conditions allowing for a buffer zone to reflect the transient nature of the artesian–non-artesian boundary (Fig. 4).

5.3.2 Judicious use of water

One key to the adopted management approach is the requirement to use water judiciously. Under the State legislation, as well as the Intergovernmental Agreement on a National Water Initiative, the Government has the responsibility to eliminate waste and to maximise social and economic benefits in a manner that is environmentally sustainable. All water users will be expected to incorporate new technologies and utilise best practices for use of the water that they are allocated.

5.3.3 Indicative water allocation volume

Notwithstanding the adaptive management approach based on acceptable drop in GAB aquifer artesian pressure, an initial indicative volume for the first WAP is proposed to provide an appreciation of the volume of water that may be available for allocation. The determination of this volume is based on harvesting part of the vertical leakage within the acceptable pressure targets set in this WAP for the artesian part of the Eromanga Basin.

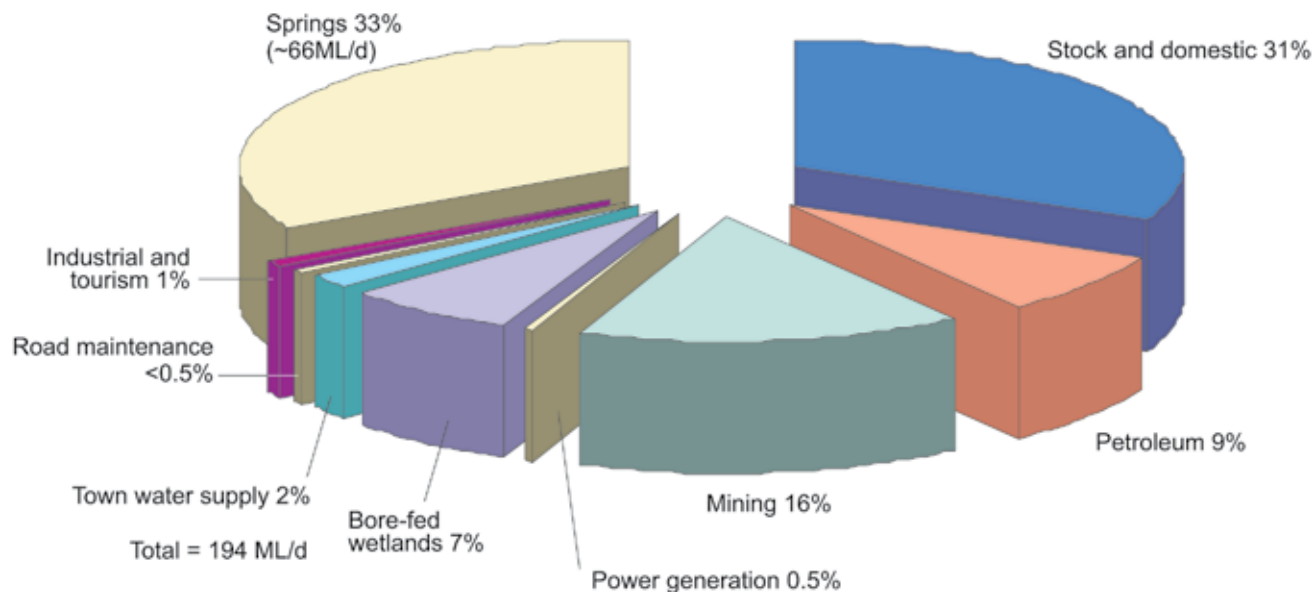
Results of scenario modelling with the Bureau of Rural Science's numerical GAB model 2000 clearly demonstrate that additional discharges from the basin in South Australia are largely derived from increased vertical leakage in the Central Management Zone, or reduced leakage loss in the basin marginal areas. There is a small risk that this increased vertical leakage may result in the relatively small influx of potentially higher salinity water into the base, and generally more saline part, of the producing aquifer. Under the proposed pressure targets set in the Plan, the flow regime will always be dominated by the horizontal flow component, and any salinity impact, if detectable, will be localized.

The results of scenario modelling accordingly indicate that the initial threshold volume for the Cadna-Owie–Algebuckina aquifer in the FNPWA is an order of magnitude estimate of 350 ML/d, indicatively apportioned as follows (rounded):

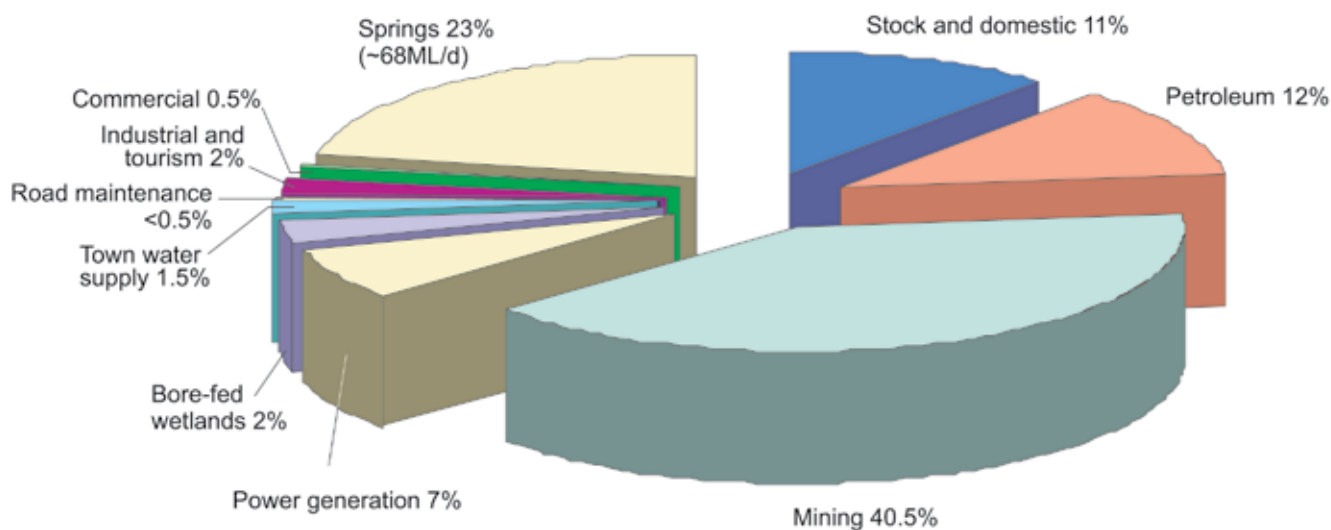
- Central Zone: 135 ML/d
- Western Zone: 15 ML/d
- Southwest Springs Zone: 170 ML/d (based on 2003 use), including spring flow, plus harvesting 50% of vertical leakage*
- Western Recharge Zone: 30 ML/d

This does not take into consideration the resources within the formations below and above the main GAB aquifer.

* 50% of vertical leakage (50% of 92 ML/d = 46 ML/d) is approximately equivalent to 50% of water saved to date under the Great Artesian Basin Sustainability Initiative (GABSI) in the Southwest Springs Zone



(a) Estimated water use 2003



Total = 299 ML/d

(b) Potential water use 2010

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Figure 9 Estimated and potential water use for the South Australian portion of the GAB

5.4 Present demands

Section 76(4)(c) of the Act requires that a WAP takes ‘into account the present and future needs of the occupiers of land in relation to the existing requirements and future capacity of the land, and the likely effect of those provisions on the value of the land’.

The present estimated demand for underground water resources in the FNPWA is summarised in Figure 9.

a) Stock and or domestic

Based on the maximum stock carrying capacity (as determined by the Pastoral Board), water requirements for stock of 100 L/head of cattle/d and 20 L/head of sheep/d (an average which allows for different stock breeds, age and condition, different stock feed and water salinity, and earth dam losses and pipe leakage), and including a 20% buffer for native and feral animals, the estimated stock and domestic use is of the order of 33.5 ML/d (12 250 ML/y). Of this total, ~22.3 ML/d is sourced from the artesian system and 11.2 ML/d from the non-artesian system. As use of surface water is insignificant compared to underground water, for the purpose of accounting for water use, it is assumed that all water used for stock and domestic is sourced from underground water.

b) Town water supplies

Table 1: Town water supplies, FNPWA

Town, settlement	ML/d
Cooper Pedy	1.300
Marla	0.035
Oodnadatta	0.090
William Creek	—
Roxby Downs	2.400
Andamooka	—
Total	3.825

Moomba is accounted for in the water allocation for mining and petroleum.

c) Petroleum

Water is used by the petroleum industry for the purposes outlined below.

Co-produced water

Petroleum wells in nearly all cases produce a mixture of petroleum and water, i.e. underground water from the artesian aquifers is inherently taken or 'produced' as part of petroleum exploration and production. This formation water mixed with the petroleum is commonly known as co-produced water. Usage peaked in 1994, with a total of approximately 34 ML/d (12 400 ML/y) from both the Eromanga (31 ML/d) and Cooper Basins (3 ML/d). Current use is ~17ML/d (6200 ML/y).

Some of the co-produced water is reused to construct and maintain roads within the exploration and production leases.

Water used for processing operations

Water taken from the aquifers is used for processing petroleum products at Moomba. Currently there is only one processor, utilising ~4 ML/d (1500 ML/y). This includes water used for Moomba township and associated outposts. Peak use in 1994 was approximately 8ML/d.

Water used for drilling

Water is required during drilling operations for petroleum exploration and production wells. The order of magnitude of consumption is estimated to be 0.5 ML per exploration/ production well drilled.

Based on an average of 30 wells drilled per year, total water taken would be of the order of 0.05 ML/d (15 ML/y) for this purpose.

d) Mining

As for the petroleum industry, water is used by the mining industry for drilling water, exploration camp domestic supplies, product processing and occasionally associated with mine dewatering. These uses are outlined below.

The *Roxby Downs (Indenture Ratification) Act 1982* provides for a special water license for the taking of water for the Olympic Dam Mine and associated operations. The provisions of this water license will continue unless changed by Parliament.

Drilling water and camp supply

The volume of water taken for this purpose has been estimated at ~0.02 ML/d (8 ML/y).

Processing

Current underground water usage for existing mines is estimated at 31.3 ML/d (11 425 ML/y; Olympic Dam 31 ML/d; Beverley 0.3 ML/d).

e) Power generation

Artesian well flow has historically been used to generate power for domestic purposes. Up to four such schemes were operated by pastoralists. Currently, only one scheme is operational, two have been replaced by diesel driven systems, and one has been decommissioned due to operational problems. The existing scheme utilises an artesian flow of ~1 ML/d (365 ML/y) to generate the power.

More recently, there has been a significant amount of interest in the use of geothermal energy to generate commercial-scale power supplies. Prior to the prescription of the FNPWA, two exploration companies were issued licenses under the *Petroleum Act 2000* to investigate the potential of geothermal power generation near Moomba and Innamincka, respectively. Preliminary estimate of water requirements for the two proposed schemes has been estimated at ~20 ML/d (7300 ML/y).

f) Industrial and tourism

Water for the mining and pastoral industries are treated separately in the Plan. Tourism is the other major industry in the region. Water is used by tourists at camping and caravan parks, hotels and for amenity features such as thermal baths. Some of the water for tourists is supplied through towns, but in addition access to water is required at a number of tourist sites. Special events often cause major stress on water delivery infrastructure in the region. The tourist industry can be expected to grow substantially. Total use has been estimated at 2 ML/d (730 ML/y).

g) Springs

As outlined in Section 2 of this document, total flow from the springs in the FNPWA has been estimated at 66 ML/d (24 000 ML/y). This is an order of magnitude estimate due to the inherent difficulties in measuring flows, and few spring flows have in fact been measured.

h) Road maintenance

Road construction and maintenance by Transport SA is an authorised activity under section 128 of the *Natural Resources Management Act*. The use of water for this purpose is accounted for.

Water is used by Transport SA to construct and maintain non-asphalt roads. Both underground water and surface water are used for this purpose. Order of magnitude estimate of underground water used is 0.8 ML/d (~300 ML/y).

Recognising that the use of tanks is not practical, earth dams may still be used to meet the demand rate for road maintenance. However, various means are to be used to improve use efficiency such as the use of portable plastic covers, which is being researched. The recently introduced “Unsealed Road Maintenance System” is part of Transport SA’s commitment to water wise use, including easier access to water usage data. Normal management of earth dams now includes fencing to exclude domestic livestock, plastic liners covered with clay, keeping dams empty when not in use and making dams deeper with smaller surface area to reduce evaporation.

Petroleum companies also maintain public roads in the Cooper Basin area, generally using co-produced water.

i) Wetlands and recreational

The total water from bore-fed wetlands has been estimated at some 12 ML/d (4380 ML/y).

5.5 Future demands

a) Stock and domestic

Although the number of stock is expected to stay the same, water use is expected to decline as the efficiency of the water distribution systems improves.

Water used for domestic purposes is expected to stay the same as current demand.

b) Town water supplies

Some increase in town water usage is expected in response to potential increases in tourism, but particularly in response to the anticipated improvement in the quality of the water provided to remote communities (e.g. by desalination). For this WAP, a 50% increase in water demand has been assumed.

c) Petroleum

Over the next five years, the level of petroleum exploration is expected to significantly increase. However, total water demand for the petroleum industry is not expected to be greater than ~60 ML/d (21 900 ML/y), based on the 1993-94 peak demand of ~40ML/d and a buffer of 20ML/d to allow for additional operators.

d) Mining

The Olympic Dam total water demand is expected to reach 42 ML/d (15 300 ML/y) by year 2010 under the current schedule of mining. Expansion of the mining development is currently being evaluated, and should this expansion go ahead, total demand is anticipated to be of the order of 80–120 ML/d, with the GAB aquifer system being one of the candidate sources of water. Whilst the taking of additional water over and above 42 ML/d is unlikely before 2010, under this scenario a water entitlement covering the additional demand would most likely be sought within the period of this WAP.

The Beverley uranium mine water demand will remain essentially the same for the duration of the mine, anticipated to cease operation by 2020, although current additional exploration may extend the life of the mine.

The Prominent Hill deposit, a medium-size Olympic Dam type deposit, is at the resource evaluation stage, and if mined will potentially source its estimated water demand of 26 ML/d (9490 ML/y) from aquifers within the FNPWA.

The Leigh Creek coalfield has another 10–15 year life expectancy. Coal for the Port Augusta Power Station may potentially be sourced from the known coalfield at Ingomar, within the FNPWA. Whilst mining per se will not utilise significant volumes of water, the dewatering of the deposits prior to mining may use significant water volumes.

e) Power generation

There are two potential power generation methods proposed for the FNPWA. One harvests the heat energy within deep granite rocks by circulating water through the fractured rock and is known as hot dry rock geothermal power generation. The other harvests heat from water circulated from wells drilled into the deeper GAB aquifers.

The lower the temperature of the circulated water, the higher the total water production rate required for a given power plant output. The hot dry rock concept would generate superheated water, and therefore would be expected to require less water than that needed by the circulation of geothermal GAB water.

Since the prescription of the FNPWA, some eight exploration licenses have been issued under the Petroleum Act for the development of hot dry rock power generation. It is unlikely that any of these would be at the production stage within the time frame of this WAP.

Nevertheless, the potential demand for water for geothermal power generation could well be in excess of 100–200 ML/d (36 500–73 000 ML/y) in the long term.

f) Industrial and tourism

There is a growing awareness within Australia and internationally about the attractiveness of visiting the outback areas of South Australia. Special events, media coverage and marketing are contributing to people's awareness and increasing tourism. Lake Eyre and the Cooper System along with the Birdsville and Oodnadatta Tracks have become outback tourist icons. The growing number of visitors to popular outback locations presents significant demands on infrastructure including water and waste disposal. Some investments are currently being made to improve infrastructure and policies for meeting the needs of outback tourism developed, but it is difficult to quantify future demands on water. For this WAP a 50% increase in water demand has been adopted.

g) Bore-fed Wetlands

In response to the proposed adaptive management approach and the development of associated wetlands management plans, it is anticipated that the volume of water required to maintain wetlands will reduce to less than 7 ML/d (2555 ML/y).

h) Springs

Spring flow is expected to slightly increase.

i) Road maintenance

The use of water by Transport SA to construct and maintain roads is expected to remain the same, with any efficiency gains in the storing of water balanced by the increased demand for wet road maintenance.

j) Commercial use

In future new industries requiring substantial water allocation will be developed within the region of the GAB. As technologies develop to capitalise on the economic value of the pressure and heat within the Basin, the allocation for these along with the water will have to be managed. There is desire by pastoralists and other small business users in the Basin to diversify into activities such as aquaculture or below ground irrigation to provide feed during dry periods. These new activities may require additional allocations to current users. The timing and quantity of water required for new developments and diversified activities is difficult to predict especially in times of changing technologies and economics. Water will be allocated for new developments within the guidelines set out in this Plan as long as it can be sustained within specified pressure drawdown targets.

5.6 Conclusion

The present and future needs for water by the occupiers of land in the FNPWA have been outlined above. The need for water for stock and domestic purposes is expected to remain stable, indeed slightly reduce in response to increasing efficiency in the water distribution systems. Petroleum use is expected to peak at the 1993–94 demand. The use of water to maintain bore-fed wetlands will decline slightly, whilst water for town water supplies and industrial and tourism uses is expected to slightly increase, relative to the total discharge from the resource. The need for water for mining is expected to increase significantly over the next 5–10 years, as is the demand for water for commercial power generation purposes. There may also be the potential for the development of irrigation projects for drought proofing purposes subject to compliance with the relevant regulations/policies under the *Pastoral Management Act 1989*.

Table 2 summarises the current and expected future uses of water. In the context of the threshold volume of 350 ML/d of this WAP, the overall capacity of the resource is sufficient to meet present and medium-term future demand on a continuing basis, in accordance with the criteria set out in Section 6 of this document.

There is also scope to utilise in excess of 350 ML/d within the acceptable pressure drawdown criteria of the Plan, the key being able to disperse the points of extraction, distally from underground water dependent ecosystems. Total allocation volumes approaching the threshold level of 350 ML/d would trigger a review of the capacity of the resource to meet additional demand, and hence a review of the threshold volume.

For the non-GAB aquifer system, existing demand can be sustained on a continuing basis and there is scope for limited additional development, particularly by utilising the more saline resources, in accordance with the criteria set out in Section 6 of this document.

Monitoring the actual performance of the aquifers under the increased extractions, combined with the resulting more accurate modelling predictions, will provide more confidence in the aquifer response management approach for the allocation of additional waters in the long term.

Table 2: Indicative water demand in the FNPWA (ML/d)

Purpose	Present (2003)		Future (2010)	Long term
	Artesian	Non-artesian		
Stock and domestic	50	10	33.5	33.5
Mining	33.3		120*	120*
Petroleum	17		60	60
Power generation	1	-	20*	150*
Wetlands	12	-	7	7
Town water supplies	2.49	1.34	4	5
Road maintenance	0.8		0.8	0.8
Industrial and tourism	2?		5	10
Commercial	–		1	20?
Springs	~66		~68	~68
Total	~185	~11	~319*	~474*

* Indicates order of magnitude estimate.

Water trading and water markets

In the long term, water for additional demands for consumptive purposes may not be available within acceptable pressure drawdown targets. There will however be limited potential for these future demands to be met by intra-state and, where additional developments have cross border impacts, inter-state transfers of water allocations.

During the period of this Plan cross-jurisdictional arrangements may need to be negotiated for water trading across State boundaries. Water markets for the GAB will then develop based on the economic values of the GAB water, pressure and temperature resources that are available for trade. Once the criteria are in place all trade shall be considered on technical merits and in compliance with the provisions of this Plan and the Intergovernmental Agreement on a National Water Initiative.

6

Water allocation criteria

In setting policies and criteria within this WAP, the South Australian Arid Lands Natural Resources Management Board has taken into account the current and potential future uses of water, the overall capacity of the water resources in the FNPWA and the following guiding objectives, in accordance with section 76(4)(b) of the Act, which provides for the allocation and use of water.

It is considered that the effects of implementing this Plan will not impact on land values, and will provide potential for economic growth in the region without compromising the condition of the resource.

Guiding objectives

- a. Provide adequate water for current users.
- b. Ensure a stock and domestic allocation for pastoral leases.
- c. Ensure petroleum production is not restricted by co-produced water restrictions.
- d. Maintain natural springs and soaks.
- e. Provide adequate water supplies for future development.
- f. Clearly define water supply rights and responsibilities.
- g. Ensure judicious use of water.

6.1 Objectives

By managing the allocation and use of underground water from both the artesian and non-artesian aquifer systems within the limits set by the WAP, the Plan aims to meet the following objectives:

- (1) Provide for the water needs of water-dependent ecosystems.
- (2) Maintain acceptable aquifer water pressure and water level.
- (3) Maintain water quality.
- (4) Promote active and efficient uses of the water resources.
- (5) Implement water allocation policies in line with the GAB Strategic Management Plan.
- (6) Minimise interference between licensed wells.
- (7) Enable further allocations within sustainable limits and optimise social and economic benefits.
- (8) Provide clear concise guidelines for the allocation and use of water.
- (9) Provide flexible and fair access to the underground water resources, having regard to the uniqueness of the FNPWA.

6.2 Principles

Basis of allocation

1. Water from the wells in the FNPWA will be allocated by the volume that may be taken for specific purposes and used, except water taken and used as a by-product of the production of petroleum.
2. Water taken as a by-product of the production of petroleum will be allocated by purpose, but within the specified consumptive pool of 60 ML/day set aside for the entire FNPWA for that purpose.

Active and expeditious use of water

3. All water allocations must be used with the minimum of delay and in any case within five years of endorsement of the allocation on the license or in the case of an allocation for the purpose of an authorised mining activity within the time period as specified under the relevant legislation.
4. For the purposes of Principle 6.2.3 the use of an allocation means the development of sufficient facilities, land or equipment that will enable the full annual water taking allocation to be used during the relevant water use year.
5. Without in any other way affecting the operation of 6.2.3 if exceptional circumstances apply to the licensee, the periods specified in Principle 6.2.3 may be increased at the discretion of the Minister.

Indigenous access to water

6. The principles in the WAP shall not derogate from the provisions of the *Pastoral Land Management and Conservation Act 1989* with regard to the taking of water for the traditional activities of the Aboriginal people.
7. The principles in the WAP shall not derogate from the provisions of the *Aboriginal Heritage Act 1988* with regard to the protection and maintenance of significant sites.
8. The principles in the WAP shall not derogate from the provisions of the *Commonwealth Native Title Act 1993* with regard to the allocation of water to native title holders for traditional cultural purposes, following the recognition of native title rights. Water allocated to native title holders for traditional cultural purposes will be accounted for.

Rights of existing users

9. Water shall only be allocated where a FNPWA proposed water use plan, in a form prescribed by the Minister, demonstrates that the proposed locations of the point of extraction and manner of use of the water will not interfere with the operation of wells that are subject to an existing licensed allocation.
10. A license holder can only take water from a well where that well has been endorsed on a license. Where approval is sought to take water from a well not currently endorsed on a license, the applicant is required to seek to vary the license to include the proposed well. Where the proposed well is a new well, a permit is required in accordance with Principle 8.2.1 of this Plan. Where the intent is to convert an existing petroleum well to a water well, a permit is required according to Principle 8.2.8 of this Plan. Where the intent is to convert an existing mineral well to a water well, a permit is required according to Principle 8.2.10 of this Plan.

Underground water dependent ecosystems

11. Water shall only be allocated where the proposed location and manner of use of the water has no unacceptable impact on underground water dependent ecosystems.
12. Water shall not be allocated for any new well established within a 5 km radius of any GAB springs (the exclusion zone), as identified in the SA Geodata data base.
13. The volume of water allocated for any proposed well or group of wells outside the exclusion zone shall be limited to that volume that shall not cause a predicted cumulative drawdown in excess of 0.5 m on the potentiometric surface of the Cadna-Owie–Algebuckina aquifer (as determined at adoption of this WAP) at the boundary of the exclusion zone.
14. Despite Principle 6.2.13, a volume of water greater than that determined in Principle 6.2.13 may be allocated, at the discretion of the Minister, for any proposed wells outside the exclusion zone where an Environmental Impact Report (EIR) has been prepared demonstrating, to the satisfaction of the Minister, that this activity shall not have an unacceptable impact on the spring ecology. Such water allocated shall only be used in accordance with specific conditions relevant to the findings of that assessment. The EIR shall be in a form determined by the Minister administering the *Natural Resources Management Act 2004*.

Allocations with expiry date

15. Water allocated for the purpose of conducting an authorised mining activity shall expire on the 30 June following the cessation of the activity authorised under either the *Petroleum Act 2000* or the *Mining Act 1971*.
16. For the purposes of 6.2.15 an authorised mining activity is any activity or operation that is required to be authorised under either the *Petroleum Act 2000*, or the *Mining Act 1971*.

Monitoring wells

17. Water, except for water allocated for stock and domestic purposes, shall only be allocated at an extraction rate of > 1ML/d/well where it has been demonstrated to the satisfaction of the Minister that sufficient monitoring wells have, or will be, constructed in accordance with the criteria set out in Section 8 of this Plan, at acceptable locations and depths to monitor the effect of extraction. A report on the impact of that extraction must be provided to the Minister in accordance with the requirements in Section 9.3 of this Plan.

Allocations from the Southwest Springs Zone

The following principles are in addition to those set out above in Section 6.2 of this document and apply to water allocated and used from the Southwest Springs Zone.

18. Water shall not be allocated from the Cadna-Owie–Algebuckina aquifer where the allocation would cause the total amount allocated on all licenses within the Southwest Springs management zone to exceed 104 ML/d. This is based on existing well use, plus reallocating 50% of water estimated to have been saved under the capping/piping program. The total allocation, including spring flows is therefore limited to 170ML/d.
19. The taking and use of water from new wells established in the Cadna-Owie–Algebuckina aquifer after the adoption of this Plan shall not:
 - a) cause or be likely to cause a mean (arithmetic) increase in salinity of the underground water resource greater than 10% (measured over the preceding 5 years) at the point of taking.
 - b) adversely affect the structural integrity of the aquifer.
20. Where the taking of water from a proposed new well(s) results in a predicted cumulative drawdown in excess of 10% of the potentiometric surface measured above ground level (as defined in appendix 1) at the state border with the Northern Territory, water shall only be allocated in consultation with the appropriate interstate jurisdiction, and the agreement of the South Australian Minister.

Allocations from the Western Zone

The following principles are in addition to those set out above in Section 6.2 of this document and apply to water allocated and used from the Western Zone.

21. Water shall not be allocated where the taking and use of water shall cause, or be likely to cause, a cumulative drawdown in excess of 1m on the potentiometric surface of the Cadna-Owie–Algebuckina aquifer (as determined at adoption of this WAP) at the boundary with the Southwest Springs Zone.
22. Despite Principle 6.2.21, where the taking of water from a proposed new well(s) results in a predicted cumulative drawdown greater than 1 m on the potentiometric surface of the Cadna-Owie–Algebuckina aquifer at the boundary with the Southwest Springs Zone, water may be allocated and used from that well if an EIR has been prepared demonstrating, to the satisfaction of the Minister, that this activity shall not have an unacceptable impact on the ecology of springs that may be located within the underground water zone of influence around that well. Such water allocated shall only be used in accordance with specific conditions relevant to the findings of that assessment.
23. Where the taking of water from a proposed new well(s) results in a predicted cumulative drawdown in excess of 10% of the potentiometric surface measured above ground level (as defined in appendix 1) at the state border with Queensland and the Northern Territory, water shall only be allocated in consultation with the appropriate interstate jurisdiction, and the agreement of the South Australian Minister.

Allocations from the Central Zone

The following principles are in addition to those set out above in Section 6.2 of this document and apply to water allocated and used from the Central Zone.

24. Water shall not be allocated where the taking and use of water shall cause, or be likely to cause, a cumulative drawdown in excess of 1 m on the potentiometric surface of the Cadna-Owie–Algebuckina aquifer (as determined at adoption of this WAP) at the boundary with the Southwest Springs Zone.
25. Despite Principle 6.2.24, where the taking of water from a proposed new well(s) results in a predicted cumulative drawdown greater than 1 m on the potentiometric surface of the Cadna-Owie–Algebuckina aquifer, at the boundary with the Southwest Springs Zone, water may be allocated and used from that well if an EIR has been prepared demonstrating, to the satisfaction of the Minister, that this activity shall not have an unacceptable impact on the ecology of springs that may be located within the underground water zone of influence around that well. Such water allocated shall only be used in accordance with specific conditions relevant to the findings of that assessment.
26. Where the taking of water from a proposed new well(s) results in a predicted cumulative drawdown in excess of 10% of the potentiometric surface measured above ground level (as defined in appendix 1) at the state border with Queensland and New South Wales, water shall only be allocated in consultation with the appropriate interstate jurisdiction and the agreement of the South Australian Minister.

Allocations from the Western Recharge Zone

The following principles are in addition to those set out above in Section 6.2 of this document, and apply to water allocated and used from the Western Recharge Zone.

27. Water shall not be allocated where the taking and use of water shall cause, or be likely to cause, a drawdown in excess of 1 m on the potentiometric surface of the Cadna-Owie–Algebuckina aquifer (as determined at adoption of this WAP) at the boundary with the Southwest Springs Zone.
28. Despite Principle 6.2.27, where the taking of water from a new well (s) results in a predicted cumulative drawdown greater than 1 m on the potentiometric surface of the Cadna-Owie–Algebuckina aquifer, at the boundary with the Southwest Springs Zone, water may be allocated and used from that well if an EIR has been prepared demonstrating, to the satisfaction of the Minister, that this activity shall not have an unacceptable impact on the ecology of springs that may be located within the underground water zone of influence around that well. Such water allocated shall only be used in accordance with specific conditions relevant to the findings of that assessment.

Judicious use of water

29. Water shall be used with water-efficient technologies and techniques appropriate for the particular purpose, in accordance with industry best-practice standards.

The following principles are in addition to those set out above in Section 6.2 of this document, and apply to water allocated and used for the purposes outlined below.

Allocations for stock and domestic purposes

30. Water for stock and/or domestic purposes must not be taken unless the water reticulation system is maintained as a water-tight delivery system.
31. Despite Principle 6.2.30, underground water allocations granted or applied for prior to 26 September 2003 must not be used through open drains, except where there is a plan approved by the Minister to use a water-tight delivery system(s) within five years of the date of adoption of this WAP. The plan shall be submitted to the Minister within 12 months of the date of adoption of this WAP.
32. Despite Principle 6.2.30, underground water allocations granted or applied for prior to 26 September 2003 for use through non-water-tight piped delivery systems, must be distributed through a water-tight delivery system within 10 years of the date of adoption of this WAP.
33. Despite Principle 6.2.30, water may be allocated and used in an alternative reticulation system approved by the Minister when it can be demonstrated to the satisfaction of the Minister that using water through a water-tight delivery system is technically not reasonable

Allocations for petroleum purposes

34. No more than 60 ML/d shall be set aside for water used as a by-product of petroleum production (known as co-produced water).
35. Operations of licensed wells shall be consistent with the provisions of the appropriate statement of environmental objectives (SEO), required under the *Petroleum Act*.
36. The taking and use of water as a by-product of petroleum production, shall be licensed by purpose in an area specified by the petroleum production license (PPL), subject to annual reporting of total volume used for that purpose by Primary Industries and Resources South Australia (PIRSA).
37. The taking and use of water as a by-product of petroleum exploration, shall be licensed by purpose in an area specified by the petroleum exploration license (PEL).

Allocations for mining

38. The taking of water for mining, including, but not limited to, processing, smelting and mine dewatering, shall be licensed, with an allocation expiry date linked to the term of the associated mining activity as per Principles 6.2.15 and 6.2.16, plus any associated subsequent licence as issued either under the *Mining Act 1971*, or the *Petroleum Act 2000*.

Allocations for bore-fed wetlands

39. From the date of adoption of this Plan water shall not be allocated for new artificial wetlands.

Allocations for power generation

40. Water shall not be allocated for the purpose of generating power. However a water allocation may be used for the purpose of generating power provided that the allocation continues to be used in accordance with its authorised purpose and that the power generation is a secondary usage to this authorised purpose.
41. Notwithstanding 6.2.40, water may be allocated for the purpose of providing a heat transfer medium for the production of electrical power in association with a regulated activity that is authorised under the *Petroleum Act 2000*.
42. An allocation under 6.2.41 shall expire on the 30 June following the cessation of the regulated activity authorised under the *Petroleum Act 2000*.

Allocations for town water supplies

43. A total allocation of up to 5 M/d shall be set aside for town water supply purposes, based on the existing demand of 3.8 ML/day and allowing for an approximate 50% increase in water demand, in response to anticipated improvement in quality and an increase in the number of tourists.

Other Uses of water

44. Where water is to be used for purposes other than those identified in Section 6 of this document, the allocation shall not exceed the amount that is reasonable, in accordance with industry best-practice standards current at the time of the assessment of the application, for the proposed purpose, at the discretion of the Minister in accordance with this Plan.

Transfer criteria

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

7.1 Objectives

- (1) Provide flexible and fair access to the underground water resources in the FNPWA.
- (2) Protect the artesian resource and existing users (including the environment) by ensuring that the taking and use of the underground water does not cause decreases in the aquifer potentiometric pressure and/or water level in excess of that defined in the WAP or cause vertical leakage of more saline water.
- (3) Prevent significant degradation of any other resource including soil, water and vegetation.
- (4) Promote the efficient use of water according to industry best-practice standards.

7.2 Principles

Effects of water use on the productive capacity of the land — land management purposes

- 1 Water allocated for stock and/or domestic purposes shall not be transferred unless the water allocation continues to be taken from the same well and water will be used by the transferee on the same allotment as the transferer had used it immediately prior to transfer.
- 2 Despite Principle 7.2.1, if water is allocated for stock and/or domestic purposes for use on a property that is completely destocked, all or part of that water allocation may be transferred for a limited period and may be used for a different purpose, provided the period of transfer does not exceed the period the property from which the allocation is transferred is destocked.

Applications to transfer water allocations — purpose of use

- 3 Water allocated for petroleum purposes under Principles 6.2.34 to 6.2.37 shall only be transferred for petroleum purposes.
- 4 Water allocated for bore-fed wetlands must not be transferred.

Applications to transfer water allocations — allocation criteria

- 5 Underground water shall only be transferred where the proposed transfer is consistent with the criteria for the allocation of underground water set out in section 6.2

Applications to transfer water allocations — judicious use of water

- 6 Water shall only be transferred where the water will be used with water-efficient technologies and techniques appropriate for the particular purpose, in accordance with industry best-practice standards (as defined by the *Environment Protection Act 1993* and associated policy).

Transfer of drained or discharged water

- 7 Water drained or discharged into a well shall only be transferred where the proposed point of extraction remains the same, and the land upon which the drained or discharged water is used remains the same.

8 Permits

Wells

The following objectives and principles apply to permits for activities pursuant to Chapter 7, Part 2, Division 3, section 127(3)(a)-(c) of the *Natural Resources Management Act 2004* comprising the drilling, plugging backfilling or sealing of a well; the repairing, replacing or altering the casing, lining or screen of a well; or the draining or discharging water directly or indirectly into a well.

8.1 Objectives

- (1) To ensure the drilling, plugging, backfilling or sealing of a well occurs in a manner that will minimise wastage and protect the quality of the underground water resources.
- (2) To protect the underground water resources from pollution, deterioration and undue depletion.
- (3) To ensure the integrity of the headworks of wells are maintained.
- (4) To protect the ecological functions of water resources and dependent biological diversity.
- (5) To minimise the impact of repair, replacement or alteration of the casing, lining or screen of wells on the underground water resources and groundwater dependent ecosystems
- (6) To ensure no discharge of waste or pollutants (as defined by the *Environment Protection Act 1993* and any associated policy) to the receiving underground water resource during the draining or discharging of water into a well.
- (7) To provide for the draining or discharging of water directly or indirectly into a well in a manner that does not adversely affect:
 - the quality of underground water resources;
 - the integrity of the relevant aquifer;
 - water dependent ecosystems or ecologically sensitive areas that depend on the underground water resource;
 - the ability of other persons to lawfully take from that underground water; or
 - the longevity of operations.

8.2 Principles

Approval to construct a new water supply well

- 1 Approval to construct a new water supply well will only be granted where a FNPWA proposed water use plan, in a form prescribed by the Minister, demonstrates that the proposed location(s) of the point of extraction and manner of use of the water will not interfere with the operation of wells that are subject to an existing licensed allocation.

Impact of well works on undue depletion and quality of the underground water resources

- 2 All artesian wells including monitoring wells are to be constructed in accordance with the conditions on the well permit for wells constructed into GAB aquifers.
- 3 If artesian, the well shall be fitted with headworks of an approved design, commensurate to the expected underground water temperature and aquifer pressure, and the well equipped in such a way to allow control of the natural pressure flow of water and to allow monitoring of the shut-in pressure.
- 4 Where a well passes, or will pass through two or more aquifers, an impervious seal must be maintained between such aquifers. For confined and artesian aquifers, the casing must be pressure cemented from the top of the producing aquifer to the surface.
- 5 The equipment, material and methods used in the drilling, plugging, backfilling or sealing of a well, or the replacement or alteration of the casing, lining or screen of a well shall not adversely affect the quality of the underground water resource.
- 6 Aquifers shall be protected during the drilling, plugging, backfilling or sealing of a well, or the replacement or alteration of the casing, lining or screen of a well, to prevent adverse impacts upon the integrity of the aquifer.

Conversion of petroleum wells to water wells

- 7 Due to very high pressures of aquifers within the Cooper Basin below the GAB, and the inherent greater risk of failure, petroleum wells completed below the Eromanga Basin sediments shall not be converted to water wells.
- 8 Petroleum wells completed in the Eromanga Basin may be converted to water wells in accordance with the requirements of the appropriate SEO (*Petroleum Act*) and approved water well construction standards for wells constructed into the GAB aquifers. In addition, approval to convert an existing petroleum well to a water well will only be granted where a FNPWA proposed water use plan, in a form prescribed by the Minister, demonstrates that the proposed location(s) of the point of extraction and manner of use of the water will not interfere with the operation of wells that are subject to an existing licensed allocation.

Conversion of mineral wells to water wells

- 9 Mineral wells are to be drilled and decommissioned in accordance with the PIRSA general specifications, "Mineral exploration drillholes — general specifications for construction and abandonment", *PIRSA Earth Resources Information Sheet*, M21 or any subsequent related document.
- 10 Mineral wells may be converted to water wells in accordance with approved water well construction standards. In addition, approval to convert an existing mineral well to a water well will only be granted where a FNPWA proposed water use plan, in a form prescribed by the Minister, demonstrates that the proposed location(s) of the point of extraction and manner of use of the water will not interfere with the operation of wells that are subject to an existing licensed allocation.

Maintenance of Headworks

- 11 The mechanism used to control artesian flows from the well (the well headworks) shall be properly maintained (as a non leaking mechanism).

Minimum distance from GAB spring

- 12 A well from which water may be taken for a licensed purpose shall not be drilled within a 5 km radius of any GAB spring.

Draining or discharging of water into a well

- 13 A permit is required for the draining or discharging of water directly or indirectly into a well, pursuant to section 127(3)(c) of the Act. Additional authorisations may be required under the *Environment Protection Act 1993*.
- 14 Water that is drained or discharged into a well must comply with the *Environment Protection Act 1993* and any associated policy.
- 15 A permit to drain or discharge water directly or indirectly into a well will not be issued unless a risk assessment is undertaken to the satisfaction of the Minister. This risk assessment must be consistent with the *National Water Quality Management Strategy – Australian Guidelines for Water Recycling: Managing Health & Environmental Risks, Phase 1 2006* and other related documents current at the time, and include:
 - a. an investigation into the suitability of the draining or discharging site, including but not limited to tests for transmissivity, maximum injection pressures and calculated likely impacts on the integrity of the well and confining layers, and impacts of potentiometric head changes to other underground water users.
 - b. an appropriate operation or management plan demonstrating that operational procedures and monitoring regime are in place to protect the integrity of the aquifer, minimise the wastage of water and protect the discharge site on an ongoing basis.
 - c. a water quality assessment which identifies hazards in the source water.
 - d. a report on the consequences and impacts to the native underground water resource where the water quality characteristics (salinity and chemistry composition) of the water to be discharge differs to that of the native underground water.
- 16 Water that is drained or discharged into a well only by means of gravity is exempt from meeting the requirements of Principle 8.15(a).
- 17 Roof runoff (surface water) that is drained or discharged into a well via a closed system of capture and transport is exempt from meeting the requirements of Principles 8.15(a), (c) and (d), provided that the system is equipped with a mechanism to divert first flush water.
- 18 Further to Principle 8.15(b), continuation of draining and discharge is dependent on an annual report that addresses the impacts to the native underground water at the draining or discharge site. Roof run-off (surface water) captured in a closed system and then drained or discharged into a well is exempt from this Principle.

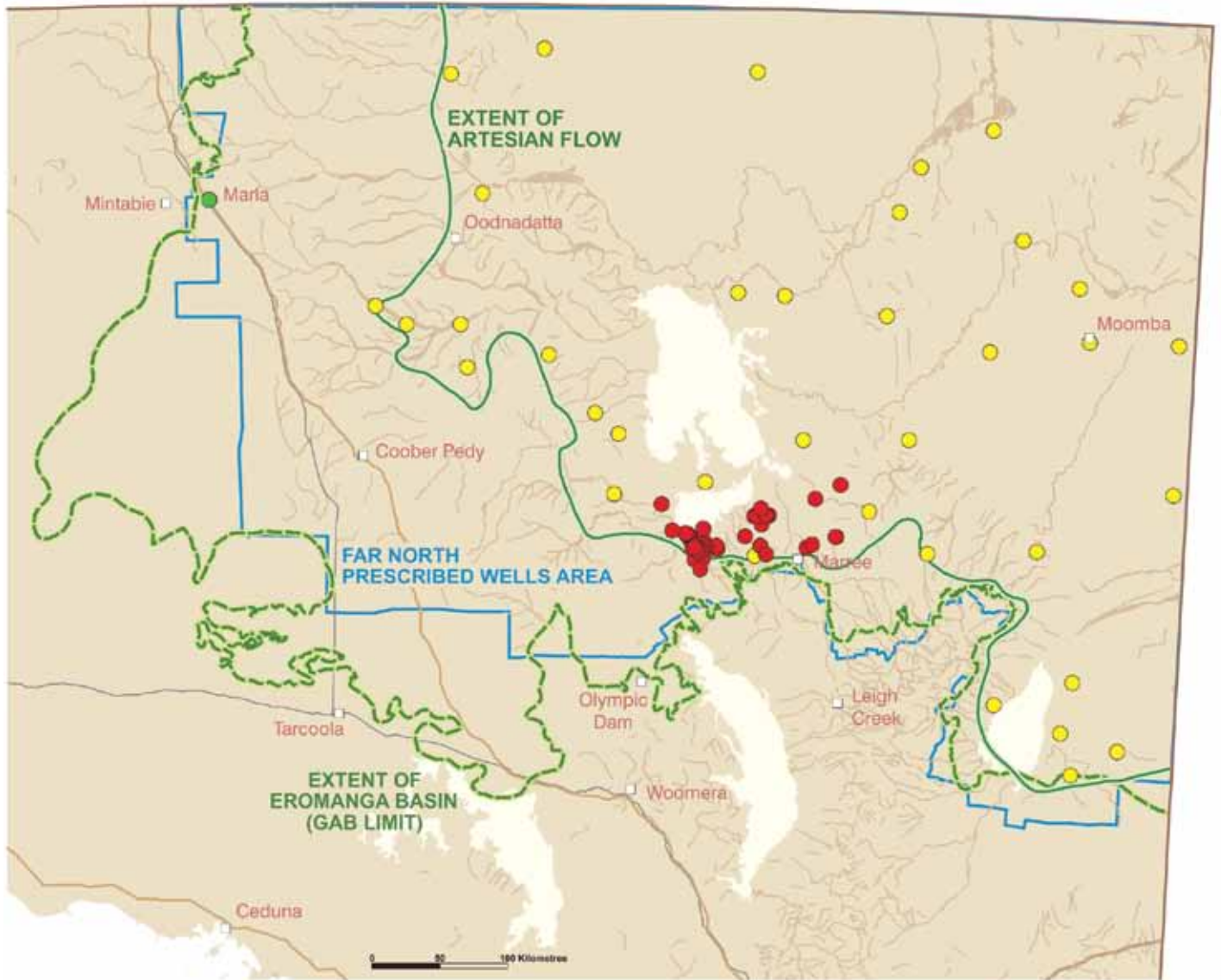
- 19 For the purposes of Principles 8.2.13, 8.2.14, and 8.2.15, the relevant concentrations, levels or amounts shall be measured in sufficient representative samples of:
- a. the water to be drained or discharged; and
 - b. native underground water collected from the proposed point of injection, or as near as possible to the proposed point of injection.

Where “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.

- 20 For the purposes of this Plan, the term “native underground water” means water occurring naturally below ground level that exists in the relevant aquifer absent of any such water drained or discharged to that aquifer by artificial means.
- 21 The draining or discharging of water directly or indirectly into a well must not detrimentally affect the ability of other persons to lawfully take from that underground water, or degrade ecosystems dependent on the underground water.

Wells for draining or discharge of water

- 22 The headworks for the draining or discharge of water shall be constructed so that extraction and draining and discharge operations can be metered without interference.
- 23 The headworks for the draining or discharge of water shall be constructed so that water cannot leak if the well becomes clogged.
- 24 For the purposes of this Plan, the term “headworks” means any assembly on top of a well and located between the well casing and the water delivery system.
- 25 Wells constructed for the draining or discharge of water at pressures greater than gravity, must be pressure cemented along the full length of the casing. This does not exempt the need to follow the general specifications for well construction.



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- Marla observation well network
- BHP Billiton observation well
- Pastoral well

Figure 10 Monitoring Wells, FNPWA

Monitoring

9

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

9.1 Monitoring the capacity of the artesian aquifer system

Monitoring of the artesian well shut-in pressure, and generally water temperature and electrical conductivity, has been undertaken by DWLBC and its predecessors on a regular basis since the 1970s. Over 41 wells are monitored, and the locations of most of these wells are shown in Figure 10. Due to the cost of monitoring resulting from large distances from Adelaide and between sites, time required to take a reliable reading, typically 4–8 hours per site, and occupational health and safety issues (high water temperature and pressure, and isolation requiring two person teams), the network is monitored bi-annually, except for the wells associated with the BHP Billiton Wellfields A and B, which are monitored annually by DWLBC.

Flows, salinity and pH of the main spring at the Dalhousie Springs are monitored twice annually.

The current network monitored by DWLBC is not a dedicated observation well network, but consists essentially of most of the existing pastoral wells. Although dedicated monitoring wells have been established in the GAB, these are associated with localised, large underground water developments, such as water used for mineral mining.

There are a number of significant issues associated with the current network, namely:

- variations of shut-in pressures due to well usage history prior to monitoring
- headwork completion of some wells is not conducive to measuring shut-in pressure
- some wells may be leaking below ground
- not all the wells can be measured during any one monitoring run, due to the unpredictable condition of the headworks and/or wells, thus preventing a pressure reading
- the conversion of bore drains to piped systems may remove the capacity to allow a well to flow to temperature prior to shut in
- although the free-flowing discharge has generally been measured for each well monitored, regular monitoring of flows is generally not carried out.

With respect to water-quality monitoring, the electrical conductivity (measure of salinity) is monitored at the same frequency as the shut-in pressures. Regular monitoring for the standard major ions is generally not carried out, and some wells have not been tested at all for the standard full chemistry.

Recommended monitoring

The establishment of regional, strategically located, key observation wells to complement the privately established observation wells would provide the most reliable network. Until these are established, it is proposed to continue to utilise existing pastoral wells for the regional network. The Bureau of Rural Sciences has recommended a rationalised GAB-wide network consisting of 200 bores, including 41 within South Australia. Where appropriate, these 41 wells will be part of the formal South Australian regional network. Headworks of these wells should also be designed and standardised to facilitate monitoring.

There should be regular monitoring of all stock and domestic wells to ensure that well headworks and distribution systems are maintained in operating order.

A one-off sampling program to characterise the water quality from all wells without water quality data should also be carried out to establish baseline conditions as at the adoption of this WAP.

9.2 Monitoring the capacity of the non-artesian aquifer systems

Monitoring of the non-artesian aquifers in the FNPWA is not carried out on a regular basis, if at all, apart from an existing network around the Marla region, which is generally monitored (water levels) at six-monthly intervals. (It should be noted that the Marla network monitors the non-artesian part of the GAB aquifer.)

Recommended monitoring

An appropriate monitoring regime will be formulated and implemented through the investigations program outlined in the South Australian Arid Lands Natural Resources Management Regional Plan and in consultation with DWLBC.

9.3 Annual water use reporting

Except for stock and domestic purposes and petroleum exploration, an annual water-use report is to be prepared by each licensee, or by PIRSA in the case of activities regulated under the Petroleum Act, at the end of each water-use year (1 July to 30 June) and is to be submitted to the Department of Water, Land and Biodiversity Conservation by 30 September of that water-use year. The following information shall be provided in the Annual Water Use Report:

1. The volume of water on the license, where applicable.
2. The total volume of water used.
3. The volume of water used from each licensed well and the well number.
4. The underground water salinity measurement taken from each licensed well, date of sampling and well number.
5. The purpose(s) for which water has been taken.
6. The resulting impact on aquifer pressure, when monitoring wells are required as per Principle 6.2.17.

10

Miscellaneous

In preparing this WAP, the South Australian Arid Lands Natural Resources Management Board has had regard to the issues set out in section 7(1), (2) and (3) of the *Natural Resources Management Act 2004*, the GAB Strategic Management Plan and the *Environment Protection and Biodiversity Conservation Act 1999*.

The WAP also shows relevant benefits of consistency with the following plans and policies developed under the legislation as listed in section 75(5) of the Act. Furthermore, the South Australian Arid Lands NRM Board has considered the following in the production of this Plan:

1. Relevant management plans under the *National Parks and Wildlife Act 1972*.
2. Relevant policies under the *Pastoral Land Management Act 1989*, the *Aboriginal Act 1988* and the *Commonwealth Native Title Act 1993*.
3. Guidelines relating to the management of native vegetation adopted by the Native Vegetation Council under the *Native Vegetation Act 1991*.
4. State Natural Resources Management Plan 2006.
5. Intergovernmental Agreement on a National Water Initiative.

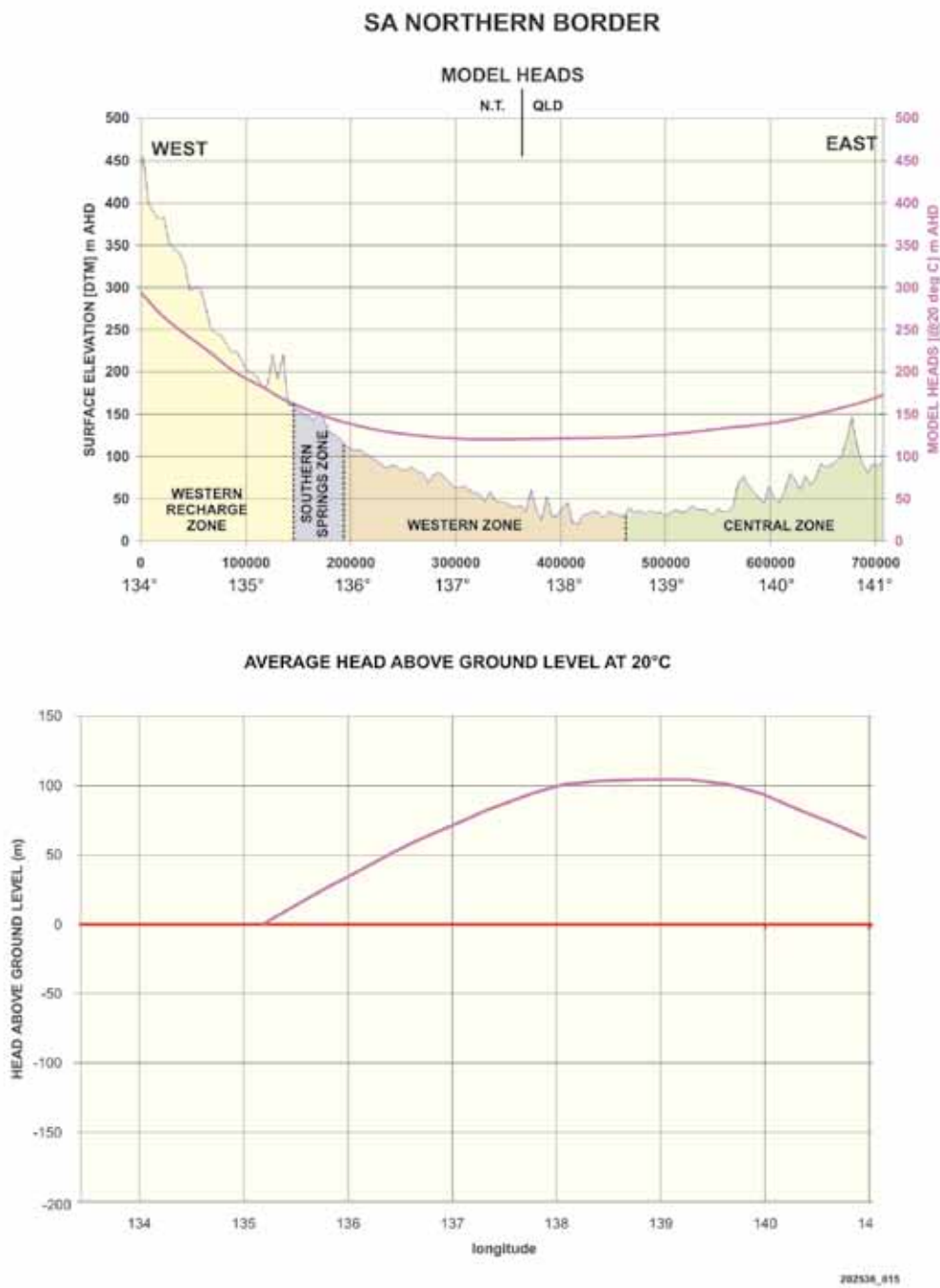
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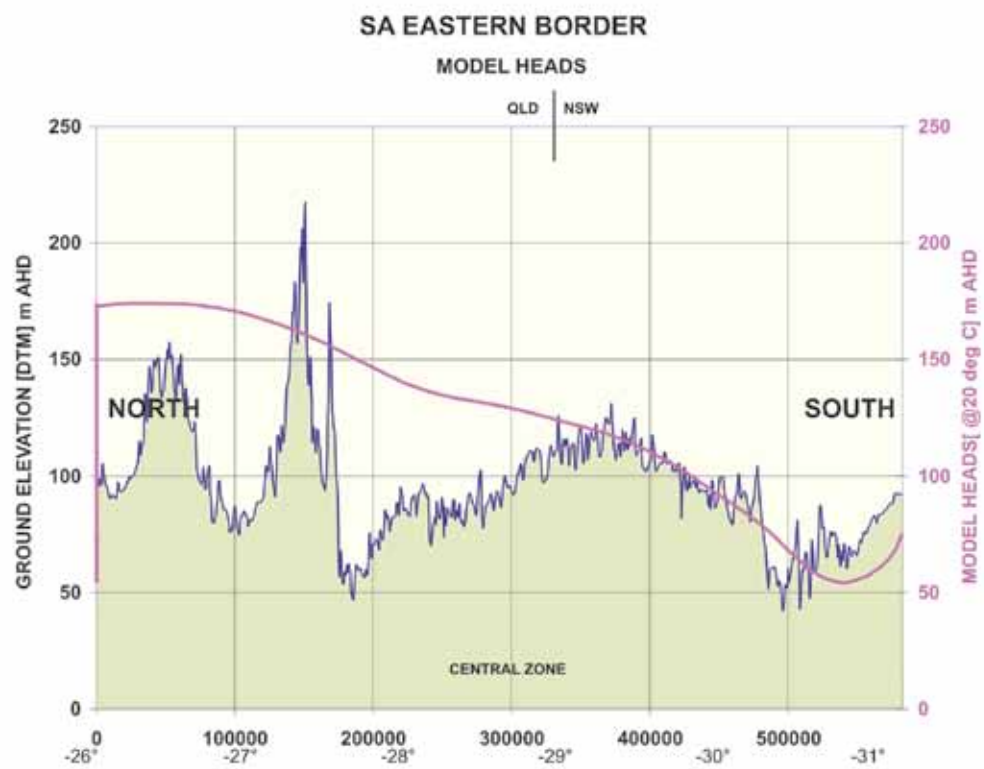
Act	Natural Resources Management Act, 2004.
Aquifer	An underground layer of rock or sediment that holds water and allows water to percolate through.
Aquitard	A low-permeability clay layer separating two aquifers.
Artesian aquifer	A confined aquifer with a potentiometric level that is above ground surface. An artesian well is therefore a free-flowing well completed in an artesian aquifer.
Cone of depression	The radial decline of potentiometric levels or underground water levels around a point of water extraction from an aquifer.
Confined aquifer	An aquifer that is bound above and below by an impermeable confining bed (aquitard). The pressure in confined aquifers is greater than atmospheric pressure, resulting in water levels in wells rising above the top of the aquifer.
Date of adoption	The date when a water allocation plan is adopted by the Minister for Environment and Conservation.
Drawdown	A reduction in water level and/or pressure level in an aquifer as a result of underground water extractions.
GAB spring	Natural point discharge to the surface of underground water from the GAB aquifer. Therefore identified in the SA Geodata database which is progressively updated.
Hydraulic gradient	Spatial variation in the effective elevation of watertable and/or potentiometric level, which drives lateral flow of underground water.
Hypogean ecosystem	Macro-invertebrate and microbial communities that occur within the water filled spore spaces of the saturated zone.
Lithology	The physical character of rock or sediments.
Megalitre (ML)	One million litres or 1000 cubic metres or kilolitres.
Minister	The Minister who is responsible for administering the Natural Resources Management Act, 2004.
Petroleum Well	Any well described under the Petroleum Act.

Potentiometric level	The level to which the water rises in a well due to water pressure in the confined aquifer. May also be referred to as the 'potentiometric surface' or 'potentiometric head'.
Recharge	Water that replenishes the aquifer by infiltration from the land surface.
Saturated zone	The zone in which voids within the soils and rocks are completely filled with water, also known as the phreatic zone.
Tectonism	A general term for all movement of the crust produced by Earth forces, including the formation of ocean basins, continents, plateaus, mountain ranges etc.
TDS	Total dissolved solids is a term that expresses the quantity of dissolved material in a sample of water, typically measured in milligrams per litre (mg/L).
Unconfined aquifer	An aquifer which has the watertable as its upper surface which may be recharged directly by infiltration from the ground surface.
Watertable	Upper surface of saturation in the unconfined aquifer.
Water-tight delivery system	A self enclosed water reticulation piped system with no leaks, including within the well headworks.

Appendix 1

Estimated pressure heads above ground —
Cadna-Owie–Algebuckina aquifer





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For more information contact:

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