Water Allocation Plan

for the Tatiara

Prescribed Wells Area

Prepared by the

South East Natural Resources Management Board

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Government of South Australia

South East Natural Resources Management Board

Amendment to the Tatiara Water Allocation Plan

This plan was amended by the Limestone Coast Landscape Board on 26 August 2021 pursuant to section 62(3)(a) of the *Landscape South Australia Act 2019,* to correct an error within the plan.

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1. The Tatiara Prescribed Wells Area

1. 1 The Prescribed Wells Area

1.1.1 Location

The Tatiara Prescribed Wells Area (PWA) is located approximately 200 kilometres north of Mount Gambier, and covers an area of some 350,000 hectares (Figure 1, *Appendix of Figures and Tables*). The PWA includes the Hundreds of Stirling, Pendleton, Cannawigara, Shaugh, Senior, Tatiara, Wirrega, Willalooka, and a small part of McCallum It incorporates the major towns of Keith in the west and Bordertown in the east, both of which lie on the main Adelaide-Melbourne highway.

1.1.2 Underground Water Resources

The underground water of the South East flows through two major aquifer systems: a regionally unconfined limestone aquifer and an underlying confined quartz sand aquifer. The two aquifers are separated by a low permeability aquitard (or confining bed), which consists of the Ettrick Formation and the Buccleuch Beds (Figure 2, *Appendix of Figures and Tables*). The Ettrick Formation (maximum thickness 31 m) consists of dark green/grey marl with sand interbeds, is glauconitic and fossiliferous, with minor carbonaceous clay and occasional thin, cemented limestone and dolomite interbeds. The Buccleuch Beds (maximum known thickness 40 m) consist of fossiliferous dark grey to brown carbonaceous clays and quartz sand, with interbeds of limestone (Stadter and Love 1987). The combined thickness of the aquitard is generally more than 20 metres.

1.1.3 Unconfined Aquifer

The unconfined aquifer is a multi-lithological system consisting of calcareous sandstone and limestone deposited from about 30 million years ago to the present. It incorporates the Tertiary Limestone Aquifer (Murray Group Limestone), Coomandook, Bridgewater and Padthaway Formations (Figure 2, *Appendix of Figures and Tables*) (Cobb and Brown 2000).

The unconfined aquifer is hydraulically continuous across the PWA. In the east, in the uplifted Pinnaroo Block, underground water flows through the Murray Group Limestone Formation. Limestone is absent west of the uplift. Underground water flow thereafter passes through a remnant dune ridge consisting of the Bridgewater Formation before continuing through the Padthaway and Bridgewater Formations beneath the ancient coastal plain.

The unconfined aquifer has a similar wedge shape to the confined aquifer in that it thins appreciably from the east to the west. In the eastern highlands the depth to water can exceed 40 metres, reflecting the elevated topography. Well yields from this aquifer range from 50 to 200 L/sec. The depth to water in the coastal plain is generally less than five metres. Well yields can be up to 300 L/sec. Generally, salinity of the unconfined aquifer ranges from ~1000 mg/L in the east to more than 8000 mg/L in the west (Cobb and Brown 2000).

1.1.4 Confined Aquifer

The confined aquifer in the Tatiara PWA is referred to as the Renmark Group (Figure 3, *Appendix of Figures and Tables)*. Depth to the Renmark Group is over 100 m in the Tatiara PWA and the aquifer thins appreciably from the east to the west.

The confined aquifer consists of non-calcareous quartz sands, interbedded with dark brown carbonaceous clays. Together these units make up the Renmark Group, which was deposited during the early part of the Tertiary Period (approximately 50 million years ago). Much of the underground water in the confined aquifer is over 25,000 years old. For management purposes, the confined aquifer is treated regionally as one aquifer, but it is actually a complex multi-aquifer underground water system (Cobb and Brown 2000).

Recharge to the confined aquifer occurs largely via lateral through-flow, with the main recharge area thought to be the Dundas plateau in Western Victoria (Cobb and Brown, 2000). Due to a lack of data, there is little real understanding of the hydraulic connection between the unconfined and the confined aquifers. A 2001 study by the former Department for Water Resources into vertical underground water recharge to the confined aquifer concluded that at the study sites (near Tarpeena and Nangwarry) recharge occurred via preferential flow (fractures, faults or sinkholes) rather than via diffuse recharge processes through the soil and overlying clay aquitard (Brown *et al.,* 2001). While there is some evidence of hydraulic connection between the unconfined and the confined aquifers, this connection has never been quantified.

Underground water flow for both the unconfined and confined aquifer systems originates from the Dundas Plateau located in western Victoria. From there, underground water flows radially southwest to the coast (and into the marine environment), and northwards to the River Murray. Due to the confining layer, the underground water in the confined aquifer is under pressure and, in some parts of the South East is artesian (i.e. flows to the surface without pumping) (Cobb and Brown 2000).

1.1.5 Management Areas

The unconfined aquifer in the Tatiara PWA is divided into the management areas of Cannawigara, North Pendleton, Tatiara, Shaugh, Stirling, Willalooka, Wirrega and Zone 8A (Figure 2, *Appendix of Figures and Tables)*.

The confined aquifer (Tertiary Confined Sands Aquifer) is divided into management areas on a regional basis. The Tatiara PWA encompasses Zone 8A, Keith, and portions of the Wirrega and Zone 7A confined aquifer management areas (Figure 4, *Appendix of Figures and Tables).*

A number of management areas in the Tatiara PWA are located within the Designated Area, commonly known as the Border Zone. The Designated Area is divided into a series of zones on each side of the South Australian-Victorian border (Figures 1 and 3*, Appendix of Figures and Tables).* The northern part of Zone 7A, all of Zone 8A and the southern part of Zone 9A of the Designated Area are located within the Tatiara PWA. Under the *Groundwater (Border Agreement) Act 1985,* the Border Groundwaters Agreement Review Committee sets a limit to the volume of water permitted to be extracted from licensed wells in each Zone of the Designated Area. When this Plan was originally adopted, it was understood that existing allocations were required to be reduced so as not to exceed that limit. It is now understood this is not the case. However, it is understood that the Border Groundwaters Agreement prevents the Minister from granting new allocations or renewing temporary in excess of that limit.

1.1.6 Climate

The climate in the Tatiara PWA is typical of the South East with hot, dry summers and cool, wet winters. The majority of rainfall occurs during winter. The mean annual rainfall at Keith for the period 1947 to 2008 was 461.4 mm, with a mean annual rainfall of 459 mm for the 1989-1999 period and 402 mm for the 1989-1999 period. Average maximum temperatures range from 29.8°C in summer to 15°C in the winter. The calculated evapotranspiration at Keith was 1627 mm in 2007 and 1547 mm in 2008 (Australian Government Bureau of Meteorology, 2009).

1.1.7 Landscape and Vegetation

The Tatiara PWA landscape comprises sand ridges in the west and a coastal plain in the east. The flats between the ridges are variously sand and clay soils. The clay soils are prone to flooding and waterlogging during wet years.

Prior to European settlement, the natural vegetation was a low heath or mallee heath on undulating, infertile sands overlying clay subsoil. The sand ridges and hills contained scatterings of Brown stringybark (*Eucalyptus baxteri*) with the woodland flats dominated by Pink gum (*E. fasciculosa*). In the late 1940s researchers discovered that the soil in the region had deficiencies in copper and zinc. With the addition of these trace elements and superphosphate, the land became suitable for agricultural production. The Australian Mutual Provident Society (AMP) committed funds and resources to develop the land under the “The AMP Land Development Scheme”. The South Australian Government assisted by introducing special legislation to enable AMP to purchase the land (*Land Settlement (Development*

Leases) Act 1949). By 1997, less than twelve percent of native vegetation cover remained compared with pre-European settlement (F. Smith, DEH 2008, personal communication).

1.1.8 Land and water use

Underground water in the Tatiara District is used extensively to irrigate small seeds, vineyards and other irrigated crops (Figure 5, *Appendix of Figures and Tables*) (Hodge 2009). As the underground water around Keith can be saline, the town's water supply relies on piped water from the River Murray (Tatiara District Council 2007). Tatiara Meat Company, a meat processing works just out of Bordertown, employs around 450 staff, and processes up to 8,000 lambs and sheep a day. Most of the meat is exported to Europe, Asia and America. The viticulture industry has expanded with extensive plantations in the Mundulla region. The olive industry has also expanded, with 185 hectares of olive trees irrigated in the Tatiara PWA in 2008/09 (Hodge 2009). The trees have produced large quantities of olives since 2004. Growers believe the Tatiara District has the environment to become one of the great olive growing regions of the world. A new olive processing plant was recently opened at Keith (Tatiara District Council 2007).

Surface (flood) irrigation is the main irrigation system due to a combination of cost, terrain and underground water salinity. Centre pivot irrigation is used in the eastern part of Tatiara PWA due to lower underground water salinities and undulating topography. In the Hundred of Stirling and Hundred of Wirrega, an intensive area of irrigation occurs with cropping of lucerne. Lucerne seed production makes up nearly half of the region's irrigated crop area, with Tatiara PWA producing approximately 90% of Australia's lucerne seed.

1.1.9 Social and Economic Profile

The Tatiara PWA falls entirely within the Tatiara District Council, one of South Australia's largest Local Government areas (6,525 square kilometres). At 30 June 2004 the estimated resident population in the Tatiara District Council was 7,104 people (3,786 males and 3,318 females), representing an increase of 31 people since 30 June 2000 but a decrease of 120 people since 1994. This represents 0.5% of the State's total population and 1.7% of egional South Australia's total.

A social and economic impact assessment (*Baseline Assessment of the Tatiara District: Social, Economic and Environmental Characteristics*, and the *Impacts of Trends in Groundwater Levels and Groundwater Salinity on the Tatiara District)* was undertaken by the South East Catchment Water Management Board (now superseded by the South East Natural Resources Management Board) in conjunction with the Tatiara District Council and Primary Industries and Resources of South Australia (PIRSA). It investigated the impacts of change in natural resources conditions, specifically underground water salinity, and the social and economic impacts. This assessment developed mitigation strategies and an action plan to limit any potential negative impacts of change on the community.

1.2 Background to the water allocation plan

This Water Allocation Plan for the Tatiara Prescribed Wells Area (the Plan) is made pursuant to Chapter 4, Part 2, Division 2, of the *Natural Resources Management Act 2004* (the Act). The Act requires the South East Natural Resources Management Board (the Board) to prepare a water allocation plan for each of the prescribed water resources in its region.

Following concern that increasing irrigation activity may lower the watertable, the Tatiara Proclaimed Region was gazetted on 12 July 1984 pursuant to the *Water Resources Act 1976.* Upon the introduction of the *Water Resources Act 1997* the Tatiara Proclaimed Region became known as the Tatiara Prescribed Wells Area.

This Plan replaces the Water Allocation Plan for the Tatiara PWA adopted by the Minister for Water Resources on 14 October 2001.

The purpose of the Plan is to provide criteria by which decisions about the regulation and use of water are made, to ensure that water resources are managed sustainably for current and future users and underground water-dependent ecosystems. The Plan sets out the principles for allocation, use and transfer of underground water in the Tatiara PWA. The Plan also provides a framework for the issue of

permits to control relevant water affecting activities. This Plan complies with the objects and requirements of the Act, assisting in the achievement of ecologically sustainable development in the region.

References

Australian Government Bureau of Meteorology website, www.bom.gov.au

Brown, K.G., Love, A.J. and Harrington, G.A. (2001) *Vertical groundwater recharge to the Tertiary confined sand aquifer, South East, South Australia.* SA Department for Water Resources, Report Book 2001/002.

Cobb, M and Brown, K (2000). Water Resource Assessment: *Tatiara Prescribed Wells Area for the South East Catchment Water Management Board*, Deaprtment of Water Resources, South Australia, PIRSA RB 2000/00036.

Department of Environment and Natural Resources (DENR) (1997). *Tatiara Prescribed Wells Area Draft Groundwater Management Plan.*

Hodge B (2009) *Water Allocation and Use in the South East 2008-2009 Summary* (Report, DWLBC, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Mount Gambier).

Stadter, F and Love, A.J (1987) *Tatiara proclaimed region groundwater assessment*. Department of Mines and Energy (Report Book 87/87).

Stadter, F. and Love, A.J. (1989) *The Tatiara proclaimed region, southeastern South Australia: hydrogeological investigations and groundwater management*. BMR Journal of Australian Geology & Geophysics 11(2/3) p253-259

Tatiara District Council (2007) Tatiara District Council Financial Report

2. Assessment of the needs of dependent ecosystems

As required by section 76(4)(a)(i) of the Act, this section provides an assessment of the quantity and quality of water needed by the ecosystems that depend on the water resources, and the times at which (or the periods during which) these ecosystems need that water.

2.1. Ecosystems dependent upon underground water in the Tatiara Prescribed Wells Area

Four types of underground water dependent ecosystems (UWDE) are relevant to the Tatiara PWA:

1. Karst
2. Streams (watercourses)
3. Wetlands
4. Phreatophytic vegetation

Figure 6, *Appendix of Figures and Tables* contains a conceptual diagram of each type of underground water dependent ecosystem.

2.1.1 Karst

Karst aquifer ecosystems occur within the voids (solution features) that have developed within the carbonaceous rocks making up the unconfined aquifer and may contain fauna such as groundwater invertebrates. Karst features are known to occur in the Tatiara PWA, but little is known of these ecosystems, and their ecology or level of dependence on underground water is not known.

2.1.2 Streams (watercourses)

Watercourses are dependent on underground water where its discharge contributes to the watercourse flow or water quality.

Nalang Creek and Tatiara Creek (Figure 7, *Appendix of Figures and Tables*) flow through the Tatiara PWA. However, the watertable lies more than 10m below the surface of these creeks, and therefore they are not in direct connection with the watertable. Remnant native vegetation normally associated with shallow underground water is present along these streams, but is probably dependent on water in the unsaturated zone, rather than the regional unconfined aquifer.

2.1.3 Wetlands

Wetlands can be supported by the discharge of underground water to the surface (or near surface) by creating a damp, saturated or inundated soil environment. Surface runoff and episodic flooding also contributes to the water in wetlands, but underground water influences the timing, duration and extent of wet conditions during dry periods. Wetlands support particular plants, and animals such as frogs, invertebrates and water birds.

There are a number of wetlands in the central area of the Tatiara PWA, including Poocher Swamp and Mundulla Swamp (Figure 7, *Appendix of Figures and Tables*). However, given the substantial depth to the watertable, they can be assumed to be perched wetlands (an assumption strengthened by the fact that both wetlands discharge to the karst system through openings at surface level commonly known as runaway holes).

There are also a number of wetlands in the eastern and north-eastern parts of the Tatiara PWA, which contain gently undulating sand dunes and depressions. However, given the substantial depth to the watertable, these wetlands are also assumed to be perched.

2.1.4 Phreatophytic vegetation

Phreatophytic vegetation is vegetation which exists specifically due to the presence of underground water or episodic flooding that leads to some remnant surface water. Underground water sustains deep-rooted phreatophytic plants in an otherwise dry environment. Phreatophytic vegetation is often closely associated with wetlands.

Throughout the Tatiara PWA there are remnants of native vegetation usually associated with shallow underground water, which may be dependent on the unconfined aquifer and episodic flooding. The associations likely to be dependent on underground water are River Red Gum (*Eucalyptus camaldulensis*) and Swamp Gum (*Eucalyptus ovata)* woodland. In the west Naracoorte Ranges, where the underlying watertable is generally more than 10 m below the surface, it is likely that these communities either exist in damp depressions with a perched watertable, or have only partial dependence on deep underground water.

2.2. Assessment of the quantity and quality of water needs

The Act requires an assessment of the underground water quantity and quality required by the environment. Ecosystem requirements include both the local influence of underground water within an ecosystem and the influence on receiving environments downstream.

2.2.1 Quantity and quality of water needs

Ecosystems dependent upon underground water become adapted to a particular quantity and quality of underground water, and to receiving it in a particular annual and inter-annual pattern. Changes in the quality or availability of underground water will affect ecosystems. Such changes can reduce an ecosystem's size or reduce its biodiversity. Activities affecting these factors, such as vegetation clearance, land use practices, irrigation, underground water extraction and recharge, will be managed with regard to their impact on underground water dependent ecosystems.

Over recent decades, underground water levels have lowered in some areas of the Tatiara PWA. This threatens to reduce underground water access by dependent ecosystems. This may reduce the number of individuals of a dependent species as the spatial extent of an ecosystem declines and ultimately, may cause the loss of the species itself.

The exact level of dependence on underground water by ecosystems in the Tatiara PWA has not been fully studied. As a result, this Plan proceeds on the basis that to conserve ecosystems dependent upon underground water in the Tatiara PWA, the current quality and quantity of that underground water must be conserved.

The Plan accordingly sets out principles for water management in order to achieve:

- no further declines in watertable levels, to ensure underground water dependent ecosystems can continue to access this resource;
- no significant increases in underground water salinity, to ensure no detrimental impact on species sensitive to salinity levels; and
- maintenance of lateral through-flow of underground water in order to prevent recycling of irrigation water (which can lead to increases in salinity), and to ensure that salts are flushed from the region.

The level of underground water allocation that ensures that these conditions are maintained has been determined according to the Department of Water, Land and Biodiversity Conservation (DWLBC) Report *A New Understanding on the Level of Development of the Unconfined Tertiary Limestone Aquifer in the South East of South Australia* (Latcham *et al* 2007). This figure is known as the Total Available Recharge (TAR). This Plan sets out the principles for the reductions so as not to exceed the TAR (see Section 4.3.1 for the calculation of total available recharge).

A total of 10% of available recharge has been set aside to provide for environmental water requirements in general.

The Plan also contains resource condition limits for water table level and underground water salinity. These resource condition triggers are used to assess underground water allocation and transfer applications, and periodically to evaluate trends in the condition of the resource.

In addition, the Plan seeks to protect underground water-dependent ecosystems by using hydrogeological assessment (the Dependent Ecosystem Equation, or DE equation) (see 2.2.3 below for more information on this equation) to determine:

a) whether new wells, or increased underground water extraction, will have a detrimental impact on the quantity or quality of underground water available;

b) minimum setback distances for any new wells or increased extractions in the vicinity of underground water-dependent ecosystems of high conservation value.

2.2.2 Identification of priority ecosystems and ecosystems of high ecological importance

Where wetlands are identified as being dependent on underground water, steps must be taken to prevent their degradation due to the taking and use of underground water.

Each underground water dependent ecosystem has unique water requirements. Further research should clarify the particular requirements of such ecosystems in the PWA. The identification and protection of particularly significant or threatened ecosystems is a priority.

A risk assessment process has been used (by environmental consulting company Resource and Environmental Management, REM) to identify priority underground water dependent ecosystems throughout the South East of the State. The process took into account the likely magnitude of the threat from underground water extraction, the likelihood of adverse impact and the consequences of that impact. It involved a three-tiered assessment approach (REM 2005):

1. REM risk assessment ranking;
2. CSIRO underground water dependence assessment; and
3. Local knowledge rapid assessment.

REM's ranking of wetland sites was based on conservation value, the threat posed to underground water conditions by water-affecting activities such as extraction by pumping and plantation forestry, and the likelihood that the ecological function of individual wetlands (or wetland complexes) would be adversely affected by altered underground water conditions (REM 2005). In the Tatiara PWA, no wetland complexes were identified as requiring immediate protection, although 13 priority wetland complexes requiring immediate protection were identified further south, in the Lower Limestone Coast Prescribed Wells Area.

Although not necessarily identified for immediate protection from water use activities, a significant number of wetlands in the South East of South Australia have been identified as of high or very high ecological importance in the South Australia Wetland Inventory Database (SAWID) for the South East. In the Tatiara PWA, wetlands currently listed as of high or very high ecological importance on this database are Poocher Swamp, Mundulla Swamp (also known as the Moot-Yang-Gunya Swamp and also identified as Nationally Important in the Directory of Important Wetlands in Australia), a wetland complex known as The Gilgais and an un-named swamp in the lower portion of Wirrega (Figure 7, *Appendix of Figures and Tables*). Each underground water dependent ecosystem has unique water requirements and further research should clarify the particular requirements of such ecosystems in the PWA.Poocher and Mundulla (Moot-Yang-Gunya) Swamps are reliant on surface water flows from the Tatiara and Nalang creeks. Unconfined aquifer underground water levels in the vicinity of all of these wetlands (and source tributaries) are between 12 and 37 metres, therefore underground water dependency is of moderate to low likelihood (Table 2.1).

Table 2.1 Ecosystems of high/very high ecological value in the the Tatiara PWA at April 2008*

Management Area	Ecosystem/s	Underground water dependency
Wirrega	Poocher Swamp	Moderate likelihood
Wirrega	Mundulla Swamp (also known as Moot-Yang-Gunya Swamp)	Low likelihood
Wirrega	The Gilgais (Swede Flat)	Low likelihood

*sourced from South Australian Wetland Inventory Database for the South East

As described above, the Plan proposes to protect water dependent ecosystems of high ecological importance, including those listed in Table 2.1, in the Tatiara PWA by means of the Dependent Ecosystem Equation (DE equation) where the following circumstances apply:

a) the wetland is considered by the relevant authority to demonstrate a level of dependence on underground water;

b) at the date of application for the taking or use of water, the wetland is listed as of high or very high ecological value in the SAWID for the South East;

c) any part of the wetland (as mapped in the SAWID) falls within a 2.25km radius from the proposed underground water extraction point; and

d) the wetland is considered by the relevant authority to be under significant or actual threat of degradation identified by, but not limited to, a mean (arithmetic) decrease in underground water levels of greater than 0.05 m/year (measured over the preceding five years) in the nearest observation well or wells.

2.2.3 The Dependent Ecosystems equation (DE equation)

The DE equation protects underground water availability to underground water dependent ecosystems by requiring that any new wells or increases in extraction be located a sufficient distance from the wetland so that no reduction in the relevant watertable will occur. The Plan requires that this distance is calculated using the Dependent Ecosystems (DE) equation in the case of ecosystems identified for protection from water affecting activities by applying the criteria listed above.

The DE equation takes into account the distance between the proposed point of taking and the underground water dependent ecosystem (as mapped in the SAWID), the volume of water proposed to be extracted and the local aquifer characteristics among other parameters, to determine whether the taking or use of water at that point will have a detrimental effect on water levels in the vicinity of the underground water dependent ecosystem. As a result, the minimum setback distance for new wells or a maximum volume that can be extracted from a well can be determined for any point in the vicinity of the wetland.

The DE equation is derived from the Theis well equation shown below (REM, 2006).

$$s = \frac{Q}{4\pi KD} W(u) \qquad \text{where} \qquad u = \frac{r^2 S}{4KDt}$$

The input parameters for the DE equation are described in Table 2.2. A specific equation for each management area has been developed on a line of best fit that has been derived at various pumping rates (REM, 2006).

Table 2.2 Input parameters for calculating the required setback distance for underground water extraction in the vicinity of underground water dependent ecosystems identified for protection (REM, 2006).

Parameter	Data source
r, distance from pumping well (in metres)	Determined from application for allocation transfer
Q, pumping rate (m^3/day)	As above
KD, aquifer transmissivity (m^2/day) determined as hydraulic conductivity (*K*,m/day) x aquifer thickness (*D*,m)	Based on geometric mean of the available data per Management Area or (where available) individual site
S, specific yield	As above
t, time over which pumping takes place (days)	Based on length of irrigation season in the Upper South East (REM, 2006): 66 days
u, dimensionless parameter of the Theis well function	$= \frac{r^2 S}{4KDt}$
W(u), the Theis well function (known as the exponential integral, E1, in non-hydrogeology literature)	$= -0.5772 - \ln(u)$
s, drawdown at distance *r* from pumping well (m)	Maximum drawdown allowed: 0.05m

References

Ecological Associates (2006). *Environmental water requirements of underground water dependent ecosystems in the South East Prescribed Wells Area - field studies to support new and amended policy*. Prepared for REM.

Fass T and Cook, PG. (2005). *Reconnaissance survey of underground water dependence of wetlands, South East, South Australia, using a mass balance of radon and chloride*. In: P Howe, R Evans and P Cook. Eds. (Final Draft) A framework for assessing environmental water requirements for underground water dependent ecosystems; Report 2 Field studies. Prepared for Land & Water Australia. December 2006.

Latcham, B., Carruthers, R. and Harrington, G. (2007). *A new understanding on the level of development of the unconfined tertiary limestone aquifer in the South East of South Australia.* DWLBC Report 2007/11. South Australia Department of Water, Land and Biodiversity Conservation, Mount Gambier.

REM. (2005). *A review of the environmental water requirements of the underground water dependent ecosystems of the South East Prescribed Wells Areas Stage 1 report.* Prepared for the South East Catchment Water Management Board by Resource & Environmental Management Pty Ltd, and Ecological Associates Pty Ltd.

REM. (2005b). *Integrated monitoring review of the South East of South Australia – Phase 1- Final Report.* Prepared for the South East Catchment Water Management Board.

REM. (2006). *A review of the environmental water requirements of the underground water dependent ecosystems of the South East Prescribed Wells Areas Stage 2 report*. Prepared for the South East Catchment Water Management Board by Resource & Environmental Management Pty Ltd, and Ecological Associates Pty Ltd.

REM. (2006b). *Integrated water monitoring review of the South East of South Australia – Phase 2*. Final report prepared for the South East Natural Resources Management Board by Resource & Environmental Management Pty Ltd.

URS Australia. (2000). *Assessment of the environmental requirements of underground water dependent ecosystems in the South East Prescribed Wells Areas.* Prepared for South East Catchment Water Management Board.

3. Assessment of Effects on Other Water Resources

As required by section 76(4)(a)(ii) of the Act, this section provides an assessment as to whether the taking or use of water from the resource will have a detrimental effect on the quantity or quality of water that is available from any other water resource.

This section looks at the potential detrimental impact of taking or using water from the Tatiara PWA upon the quantity or quality of water from other water resources in the Tatiara PWA and adjacent PWAs. Within the PWA, it considers the potential for impacts upon creeks, wetlands, and the possibility of impacts arising from the relationship between the two aquifers. Adjacent to the PWA, this section recognises the possibility of impacts in the Hundred of Laffer.

3.1 Creeks

Nalang Creek and Tatiara Creek flow through the Tatiara PWA (Figure 7, *Appendix of Figures and Tables* and section 2.1.2 of this Plan). However they lie more than 10 metres above the underground watertable and are thought to be losing streams.

Therefore it is unlikely that the taking and use of underground water will have a detrimental effect on the quantity or quality of water available in these creeks.

3.2 Wetlands

There are a number of wetlands in the Tatiara PWA, including Poocher Swamp and Mundulla Swamp (Figure 7, *Appendix of Figures and Tables* and Section 2.1.3 of this Plan), but given the substantial depth to the watertable, they are influent (losing) water bodies, and are point source recharge points to the unconfined aquifer.

3.3 Confined aquifer

There is potential for recharge from the unconfined aquifer to the confined aquifer, since the head in the unconfined aquifer is higher than the head in the confined aquifer. However, the aquitard which separates these aquifers in the Tatiara PWA is generally more than 20 metres thick and has a very low vertical permeability which inhibits downward leakage to the confined aquifer.

It is therefore unlikely that any use of the unconfined aquifer would detrimentally affect the confined aquifer.

3.4 Unconfined aquifer

The low permeability aquitard separating the unconfined and confined aquifers makes it most unlikely that extraction from the confined aquifer would have a detrimental impact on the unconfined aquifer.

There are a low number of wells that have been completed in the confined aquifer and the greatest risk is possibly the failure of the structural integrity of wells completed in both aquifer systems, allowing the potential of some mixing of water from the confined and unconfined aquifers.

Extraction from the confined aquifer might affect the unconfined aquifer if the water from the confined aquifer were discharged to the unconfined aquifer through a discharge well or by deep drainage past the root zone following irrigation application. In this scenario, there may be a volumetric effect due to the increased quantity of water applied to the unconfined aquifer, and possibly a quality effect due to the addition of salts. As the underground water in the confined aquifer in the Tatiara PWA generally has a lower salinity than the unconfined aquifer, the addition of an extra salt load is not considered a significant issue.

Therefore it is unlikely that taking and use from the confined aquifer would detrimentally affect the unconfined aquifer.

3.5 Water resources in adjacent Prescribed Water Resources Areas

While there are only a few examples in the South East region where extraction from the unconfined aquifer has had an impact across management boundaries, one such instance may exist in the Tatiara PWA.

In the Stirling management area, long-term water level decline of more than 5 cm/year has been occurring over a large portion of the management area. However, a similar decline is also being experienced in the northern portion of the Willalooka management area and the north-western part of the Wirrega management area. This is considered to be an expansion of a cone of drawdown emanating from the Hundred of Stirling (Figure 8, *Appendix of Figure and Tables)*.

With the high level of underground water use and associated signs of underground water stress in the Hundred of Stirling, there is a likelihood that some resultant adverse impacts may occur to the underground water resources of the unconfined aquifer in the eastern part of the Hundred of Laffer. The more imminent impacts would be a decline in underground water levels, while in the longer term some underground water quality deterioration may also occur. The magnitude of such underground water changes is difficult to assess and requires further investigation, with particular consideration given to any impacts associated with the existing irrigation underground water use within the Hundred of Laffer.

References

Ecological Associates. (2006). *Environmental water requirements of underground water dependent ecosystems in the South East PWA - field studies to support new and amended policy.* Prepared for REM.

Fass, T. and Cook P.G. (2005). *Reconnaissance survey of underground water dependence of wetlands, South East, South Australia, using a mass balance of radon and chloride.* In: P Howe, R Evans and P Cook. Eds. (Final Draft) A framework for assessing environmental water requirements for underground water dependent ecosystems; Report 2 Field Studies. Prepared for Land & Water Australia. December 2006.

Hatton, T. and Evans, R. (1998*). Dependence of Ecosystems on Underground water and its Significance to Australia.* Land & Water Resource, Research and Development Corporation, Occasional Paper No 12/98.

REM. (2005). *A review of the environmental water requirements of the underground water dependent ecosystems of the South East Prescribed Wells Areas Stage 1 report*. Prepared for the South East Catchment Water Management Board by Resource & Environmental Management Pty Ltd and Ecological Associates Pty Ltd.

REM. (2005b). *Integrated Monitoring Review of the South East of South Australia – Phase 1 - Final Report.* Prepared for the South East Catchment Water Management Board. REM. (2006). *A review of the environmental water requirements of the underground water dependent ecosystems of the South East Prescribed Wells Areas Stage 2 report*. Prepared for the South East Catchment Water Management Board by Resource & Environmental Management Pty Ltd and Ecological Associates Pty Ltd.

REM. (2006b). *Integrated water monitoring review of the South East of South Australia – Phase 2.* Final report prepared for the South East Natural Resources Management Board by Resource & Environmental Management Pty Ltd.

URS Australia. (2000). *Assessment of the environmental requirements of underground water dependent ecosystems in the South East Prescribed Wells Areas.* Prepared for South East Catchment Water Management Board.

4 Assessment of the capacity of the resource to meet demands

As required by section 76(4)(d) of the Act, this section provides an assessment of the capacity of the resource to meet the demands for water on a continuing basis. During the review of the 2001 Water Allocation Plan DWLBC, in collaboration with the Board, conducted several major underground water resource management projects (Brown *et al* 2006, Carruthers 2006, Carruthers *et al* 2006, Latcham *et al* 2006, Latcham *et al* 2007, Pudney 2006, Pudney *et al* 2006, Wohling 2007). These projects evaluated the aquifer response with the use of the latest water level and salinity monitoring data, and adopted the most recent scientific reasoning with the aid of numerical models and assessment tools.

The above studies provided a methodology for incorporating estimates of volumetric allocations and actual extractions into the water balance and an indication of which areas in the Tatiara PWA required greatest attention for future underground water resource management.

The projects required a comprehensive re-evaluation of the capacity of the resource to meet the demand for underground water, and to provide for the allocation and use of water so that:

- an equitable balance is achieved between the social, economic and environmental needs for underground water; and
- the rate of use of underground water is sustainable.

This section evaluates the resource quantity and quality (in terms of water levels and salinity), and the present and future needs of water users. It recognises that the unconfined aquifer cannot sustainably meet the demand placed upon it, and that the Plan must provide for reductions to target management levels. Even then, those levels will have to be regularly monitored and reviewed, particularly to take into account climate change.

4.1 Trends in underground water levels and salinity

In the Tatiara PWA, underground water is extracted from both the unconfined and confined aquifers.

The unconfined aquifer includes the Murray Group Limestone Formation in the highlands and the Bridgewater and Padthaway Formations beneath the ancient coastal plain. Aquifer thickness varies considerably throughout the region and generally thins from east to west (Figure 2, *Appendix of Figures and Tables)*. The unconfined aquifer watertable contours (Figure 9, *Appendix of Figures and Tables*) show that regional underground water flow moves down the potentiometric gradient from east to west through the Tatiara PWA. In the eastern highlands the depth to water can exceed 40 metres (reflecting the elevated topography) and well yield typically ranges between 50 to 200 L/sec. Beneath the ancient coastal plain the depth to water is generally less than five metres, and well yields have been measured at up to 300 L/sec (Brown *et al* 2006).

The confined aquifer in the Tatiara PWA is referred to as the Renmark Group (Figure 2, *Appendix of Figures and Tables)*. It has a similar wedge shape to the unconfined aquifer (in that it thins from east to west). In the Tatiara PWA the depth to the confined aquifer is over 100 metres. Generally, the confined aquifer consists of a series of thin interbedded limestone and sand aquifers separated by thin carbonaceous clay units. The sand units of the aquifer can be fine-grained and difficult to screen. Therefore, well yields are relatively low when compared against the unconfined aquifer. Confined aquifer well yields range between 10 and 20 L/sec (Brown *et al* 2006).

The unconfined aquifer is by far the more developed resource in this region. The primary purposes of underground water use are associated with irrigation. This resource also provides important local supplies for stock and domestic use, recreational and industrial use of water and public water supply.

There are relatively few wells in the confined aquifer in the Tatiara PWA. Three licences have been issued for the use of underground water: two for industrial and one for recreational purposes.

4.1.1 Underground water levels

Unconfined Aquifer

Trends in underground water levels in the unconfined aquifer throughout the Tatiara PWA are variable (Figures 8 and 9, *Appendix of Figures and Tables*).

The five year water level trends in the unconfined aquifer for 2004-2009 (Figure 9, *Appendix of Figures and Tables*) indicate a general decline in water level across most of the region at an average rate of between 0.05 m/year and 0.56m/year. The resource condition trigger for underground water in the unconfined aquifer has been defined as an average water level decline of greater than 0.1 m/year over the preceding five years. Declines in the majority of observation wells in Stirling, Willalooka, North Pendleton and Wirrega exceed the resource condition trigger level, suggesting that in these areas current water extraction exceeds vertical recharge and through flow.

Underground water levels in areas of shallow water tables, such as the Stirling, Willalooka and Wirrega management areas, show a strong correlation with the timing and magnitude of rainfall events. This is evident when comparing hydrographs from observation wells (Figure 9, *Appendix of Figures and Tables*) with a plot of cumulative deviation from mean annual rainfall using historical rainfall data collected at Keith (Figure 10*, Appendix of Figures and Tables*). The cumulative deviation from the annual mean provides an indication of rainfall trends compared to the long-term average. For the years 1999 and 2000 annual rainfall was approximately the same as the long-term average (as shown by the plateau in the cumulative deviation from the annual mean plot). However, since 1996 the region has generally experienced below long-term average rainfall (as illustrated by the falling trend in the cumulative deviation from annual mean plot).

Similarly, the long-term water level trend shown in hydrographs for observation wells STR114, WRG109, STR002 and PET014 showed little overall change until late 1996 (Figure 9, *Appendix of Figures and Tables)*. Since 1996/97, underground water has experienced a fall in levels.

In addition, these decreases can be associated with the compensating increase in extraction resulting from the fact that the mean annual rainfall for the 1999-2008 period at Keith was 402 mm, compared to 459 mm for the 1989-1999 period and the long term average (1947-2008) of 461.4 mm.

In contrast, in the management areas of Zone 8A, Cannawigara and Shaugh, underground water had demonstrated a stable or rising long-term groundwater levels. However, since 2005 current observation wells are showing declining water levels of between 0.05 m/year and 0.01 m/year (Figure 9, *Appendix of Figures and Tables)*. However, in these management areas the water table in is at a depth of over 20 m, and a considerable time lag may exist between recharge or deep drainage at the surface and this water reaching the water table (Wohling 2007). As a result, any modern day recharge to the aquifer cannot be captured within the five year trend interval. The correlation of drawdown to extraction and information on dating of groundwater suggest that the rate of modern diffused recharge in these areas is low.

Confined Aquifer

The confined aquifer is divided into management areas on a regional basis. Tatiara PWA includes part or all of the confined aquifer management areas Zone 7A, Zone 8A, Zone 9A, Wirrega and Keith (Figure 4, *Appendix of Figures and Tables)*.

The resource condition trigger for underground water decline for the confined aquifer is defined as an average water level decrease of greater than 0.1 m/year over the preceding five years.

The five year water level trends in the confined aquifer for 2004-2009 (Figure 11, *Appendix of Figures and Tables*) indicate a decline in water level in the west of the Prescribed Wells Area at an average rate of between 0.2 m/year and 0.3 m/year in the Wirrega and Keith management areas, respectively, all of which exceed the resource condition trigger for the confined aquifer (Brown *et al* 2006). In the Designated Area, which includes the management areas of Zone 7A, Zone 8A and Zone 9A, the five year water level trend has shown some decline, but has not exceeded the limit set by the resource condition trigger.

4.1.2 Salinity

Unconfined aquifer

Salt accumulation in the soil is a natural process, but in areas where irrigation water has an appreciable salt load, continued recycling of this water through the irrigation process may lead to an increase in local underground water salinity, and a corresponding decrease in soil health. A recent study (Powell 2010) has also found salts contained in groundwater are dominated by sodium, producing high sodium adsorption ratio's (SARs) in areas of high salinity within the Tatiara PWA. In particular, irrigating clay based soils with water of a high SAR provides significant risk to soil structure, reducing both the soil's drainage potential as well as uniformity of drainage. Such declines in soil structure exacerbate accumulation of salts within and below the crop root zone. A lack of drainage to flush salt and sodium from soils may also increase uncertainty around the nature of salt movement through soils and the effect salt recycling has on groundwater salinity.

A drainage component is necessary to move accumulated salt beyond the effective root zone to prevent soil salinisation. As a result, an irrigation efficiency level considered low in other irrigation districts of Australia may be necessary to move accumulated salt (and sodium) beyond the effective root zone to prevent soil salinisation and sodicity.

Underground water salinity in the Tatiara PWA varies between 1000 mg/L in the east, to greater than 8000mg/L in the Stirling management area in the west. The 2001 Water Allocation Plan for the Tatiara Prescribed Wells Area defined the resource condition trigger for salinity in the unconfined aquifer as an average increase in salinity of underground water of greater than 10 mg/L/year over the preceding five years in all management areas in the Tatiara PWA, except in the Stirling management area and the Hundred of Pendleton (North Pendleton and part of Wirrega management areas). In these areas, the resource condition trigger was an average increase in salinity of greater than 50 mg/L/year and 25 mg/L/year for the Stirling management area and the Hundred of Pendleton, respectively. For the purposes of this Plan, the resource condition trigger for salinity in the unconfined aquifer has been redefined as an average increase in salinity of underground water of greater than 1% per year over the preceding five years, in all management areas.

The salinity trends in the unconfined aquifer have indicated a general increase in salinity over the Tatiara PWA by an average of 44 mg/L/year over the past ten years. Over the past five years (between 2004 and 2009), the average salinity increased more rapidly by up to 89 mg/L/year and as much as 919 mg/L/year (increases of this magnitude are generally restricted to observation well WLL107 situated in the Willalooka management area) (Figure 12, *Appendix of Figures and Tables*).

The most notable increase in underground water salinity is occurring in the Stirling management area where long-term monitoring of observation wells indicates the groundwater salinity is increasing at a rate of 50 – 100 mg/L/year (Figure 12, *Appendix of Figures and Tables*), with salinity in numerous wells exceeding the resource condition trigger set in the 2001 Water Allocation Plan for the Tatiara PWA of 50 mg/L/year. Over the past five years (2004-2009) a significant number of observation wells in this area have shown an annual increase in salinity greater than 100 mg/L/year, with increases as high as 161 mg/L/year (observation well ST111).

Observation well data shows that the higher the ambient underground water salinity, the greater the annual increase (Brown *et al* 2006). The increase in salinity is attributed to a combination of two key processes: the mobilisation of residual historical salt retained in the landscape prior to the clearance of native vegetation in the area, and the recycling of concentrated irrigation drainage water (Cobb and Brown 2000).

The relatively high water use by lucerne and other irrigated crops in the Stirling management area has resulted in a substantial salt load accumulating in the soil profile around the root zone of these crops. The accumulated salt dissolves during subsequent irrigation or rainfall recharge, and then percolates back down into the aquifer. This continuous recycling of underground water results in an increase in salinity. Recent technical investigation (Wohling 2007) concurs with these long term monitoring observations, with salinity increasing at a rate of approximately 85 mg/L/year, as a result of flood irrigation activity.

Without a significant change in irrigation practices, groundwater salinity has the potential to increase by 500-1000 mg/L in the Stirling Groundwater Management Area (GMA) over the next ten years. As a result, the groundwater resource in Stirling may become unusable for irrigation water use within 10–20 years (Wohling 2007). Research has shown that lucerne seed and dry matter yields decrease when salinity exceeds 7000 mg/L (DENR 1997).

In the management areas of Shaugh, Tatiara and Zone 8A, where the depth to the water table is significantly greater than in the management areas to the west, groundwater salinity is generally less than the Stirling GMA (Figure 12, *Appendix of Figures and Tables*), with long-term salinity increases ranging from zero to 10 mg/L/year, and some areas (eg observation well TAT110) showing decreases of up to 25 mg/L/year.

It is evident that the depth to water and the type of soil profile is a significant influencing factor on groundwater salinity increase brought about by the land use. The lag time between drainage water entering the soil profile and emerging in the saturated zone can be in the order of 10-20 years or more where there is significant depth of clay between ground level and the aquifer. Groundwater age observations in the Tatiara management area indicate a drainage time, under natural rainfall conditions, in the order of 30 to 40 years. As a result, the impacts of excessive drainage (from any cause) may not be evident on groundwater salinity for many years where the water table is deep and/or there is a significant clay layer above the saturated zone.

The Wirrega management area can be considered to be in a transition zone between the shallow water table of Stirling, and the deeper water table of the Tatiara management area. Approximately 40% of the irrigation licences in the Wirrega management area are related to flood irrigation systems. Currently the water quality, with respect to salinity, is sufficiently low to allow successful irrigation of a diverse range of crops. However, there may be a longer-term risk that continued large-scale flood irrigation may have impacts for down gradient users in the direction of groundwater movement, who require low salinity groundwater.

Confined Aquifer

There are no recent salinity records for the confined aquifer in the Tatiara PWA. However historic trends show that the salinity is stable to moderately increasing, with the largest increase being 317 mg/L from 1991 to 2006. Underground water salinity in the confined aquifer varies between 1000 mg/L in the north-west of the Keith management area to 6000 mg/L in the south.

4.2 Present and future needs of water users

As required by section 76(4)(c) of the Act, this water allocation plan must, in providing for the allocation of water, take 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.

4.2.1 Economic needs

Unconfined Aquifer

In the late 1990s the total volume of all water allocations and the estimated annual rate of extraction for irrigation use in some parts of the Tatiara PWA were found to be greater than the volume of underground water available from the resource.

A re-evaluation of the volume of underground water that could be extracted on an annual basis was recently undertaken during the review of the 2001 Water Allocation Plan (Brown *et al* 2006, Latcham *et al* 2007). This aimed to appropriately allocate and protect the long-term viability of underground water resources within the Tatiara PWA.

A total of 13,988 hectare irrigation equivalents (haIEs) have been allocated in the Tatiara PWA. Based on the volumetric conversion model developed by DWLBC (Carruthers 2006, Carruthers *et al* 2006, Latcham *et al* 2006, Latcham *et al* 2007, Pudney 2006, Pudney *et al* 2006), the volume of water required by irrigators to continue to irrigate this area, based on their type of irrigation system, climate, predominant soil types and other factors, is estimated as 189,133 ML/year (Table 4.1).

The volume for flood irrigation pumped over the 2008/09 water use year was 84,228 ML (Hodge 2009b), of which a significant percentage is assumed to return to the unconfined aquifer in the form of deep drainage.

The majority of water allocated and used was for irrigation purposes, with the remainder attributed to industry, recreation and public water supply (Hodge 2009a, Hodge 2009b). Primary industry in the Tatiara PWA is dominated by irrigated agriculture and horticulture, in particular flood-irrigated lucerne for seed production, irrigated pasture, grape vines and oil seed production (Hodge 2009b).

A total of 345 ML has been allocated for industrial use (Table 4.1). Demand for industrial water is expected to remain steady, as no significant future industrial users of underground water are known.

It is unlikely that there will be forestry developments on a large scale in the Tatiara PWA due to the low annual rainfall of this area, and hence lower productivity of tree plantations. However, forestry on a small scale, including farm forestry and Landcare plantings are likely to take place in the future. This small scale expansion is not anticipated to have a significant impact on aquifer sustainability. Forestry plantings for carbon credits may take place in the future, and policy is being developed at the regional level for the purpose of regulating this activity if required.

Confined Aquifer

The licensed allocations for the water use years 2007/2008 and 2008/09 for the Tatiara PWA confined aquifer management areas are shown in Table 4.2.

A total of 365 ML of water was allocated from the confined aquifer, with a usage of 118 Ml and 378 ML/year in the 2007/08 and 2008/09 irrigation season (Hodge 2009b).

All allocations are for industrial and recreational use. The depth to the confined aquifer, cost of drilling and poor yields make it an expensive water resource for irrigation purposes. Consequently, no allocations have been issued for irrigation purposes within the Tatiara PWA. It is unlikely that the confined aquifer will be actively targeted in the immediate future.

4.2.2 Social needs

Unconfined aquifer

SA Water has a water licence of 700 ML for public water supply from a wellfield west of Bordertown in the Wirrega management area. SA Water believes that Bordertown's water use has stabilised and estimates that a maximum usage of 700 ML/year will meet future demand.

However, this is a vulnerable resource. This town water supply is accessed from an area of the unconfined aquifer that is recharged from Poocher Swamp during high-intensity rainfall and flooding events. This area of the aquifer has underground water with salinity levels suitable for drinking (potable) water purposes, but is surrounded by more saline water. Increasing use of underground water in this area for irrigation increases the risk of drawing higher salinity water into the town water supply wellfield.

Careful management of this source of potable water will need to be maintained during drought conditions to ensure that the water quality of this resource does not deteriorate beyond limits for future public water supply.

The township of Keith receives its water supply from the River Murray via the Tailem Bend-Keith pipeline and does not use local underground water supplies.

A total of 580 ML of underground water has been allocated for recreational use (Hodge 2009). These licences are largely held by sporting clubs for watering sports fields, greens and gardens, and by local government for the watering of parks and gardens. Demand for underground water for recreational use is expected to remain steady.

As stock and domestic water use is not required to be licensed, the level of actual use is unknown. Domestic water use for household and garden purposes is considered to be relatively small, as rainwater tanks are prominent in the area. Stock water use, based on stock numbers for 1996/97 has been estimated at a total of 2,300 ML, and is not expected to vary significantly in the future.

Table 4.1 Summary of Tatiara Prescribed Wells Area unconfined aquifer Underground water allocations and usage for the water use years 2007-2008 and 2008-2009

Management Area	Tatiara	Zone 8A	Shaugh	Wirrega	Willalooka	Cannawigara	North Pendleton	Stirling	Totals
No of Licences	98	42	8	169	46	25	16	74	**478**
Total area-based allocations (halEs)	1,039	691	837	4,880	1,669	574	1,028	3,270	**13,988**
Conversion of area-based allocation to ML *	10,750	6,249	8,509	55,803	28,928	5,307	10,798	62,789	**189,133**
Holding Allocations (ML)	0	412	0	0	0	0	0	0	**412**
Public Water Supply (ML)	0	0	0	700	0	0	0	0	**700**
Aquaculture (ML)	31	60	0	44	0	0	0	0	**135**
Industrial (ML)	188	0	0	128	0	29	0	0	**345**
Recreational (ML)	311	0	0	58	6	0	0	205	**580**
Existing volumetric irrigation licences	173	0	1,088	82	0	0	0	0	**1343**
Total Indicative Allocations (ML)	11,453	6,721	9,597	57,039	28,934	5,336	10,798	62,994	**192,648**
Use (extraction) 2007/08	5,134	1,171	5,454	33,851	11,768	2,155	7,502	44,662	**111697**
Use (extraction) 2008/09 (ML)	6,474	909	7,986	32,626	10,492	2,006	5,264	42,020	**107,777**

these values have been obtained using the conversion rates specified in Table 1 (Appendix of Figures and Tables) and are indicative only.

Table 4.2 Allocations and usage for water use years 2007-2008 and 2008/2009 in the confined aquifer management areas of Zone 7A, Zone 8A, Wirrega and Keith

Management Area	Zone 7A	Zone 8A	Wirrega	Keith	Totals
No. of Licences	0	0	1	2	**3**
Total area-based Allocations (halEs)	0	0	0	0	**0**
Conversion of area-based allocation to ML	0	0	0	0	**0**
Holding Allocations ((ML)	0	0	0	0	**0**
Public Water Supply (ML)	0	0	0	0	**0**
Aquaculture (ML)	0	0	0	0	**0**
Industrial (ML)	0	0	225	130	**355**
Recreational (ML)	0	0	0	10	**10**
Total Allocations (ML)	0	0	225	140	**365**
Use (extraction) 2007/08 (ML)	0	0	71	47	**118**
Use(extraction) 2008/2009 (ML)	0	0	242	136	**378**

Confined aquifer

The confined aquifer is not presently used for any town water supply. A small number of wells are operational in the Hundred of Stirling for stock and domestic purposes. Recreational use of the confined aquifer is minimal and is not likely to increase in the future.

4.2.3 Environmental needs

Environmental water requirements is a relatively new area of scientific research and, for the purposes of this plan, are described in terms of watertable elevation and underground water quality rather than volumes. The future needs of the environment are expected to remain the same as present requirements.

4.2.4 Indigenous and cultural needs

Access to, and use of, water from prescribed water resources by Aboriginal people for the purpose of social, cultural or spiritual use is exempt from licensing, provided that the taking does not involve stopping, impeding or diverting the flow of water for the purpose of collecting the water, or diverting the flow of water from water resources.

The current and future Aboriginal needs for water have not been identified or quantified at this time. The traditional owners of the land that is now the Tatiara PWA are the Ngarkat and Portaruwutj people. Representatives of all traditional owners in the South East region are working closely with the South East Natural Resources Management Board through the South East Aboriginal Focus Group to identify and quantify these needs.

4.2.5 Border Groundwaters Agreement

The Border Groundwaters Agreement is an agreement between the South Australian and Victoria Governments to manage the groundwater resources along the border in a sustainable manner. South Australia's *Natural Resources Management Act 2004* and its equivalent legislation in Victoria, are subject to this Agreement.

When this Plan was originally adopted, it was understood that the effect of this Agreement was that existing allocations were required to be reduced so as not to exceed the Allowable Annual Volume (AAV) or the Permissible Annual Volume (PAV) determined by the Border Groundwaters Agreement Review Committee (BGARC). This is now understood not to be the case. However, it is understood that the Border Groundwaters Agreement prevents the Minister from granting new allocations in excess of those limits.

The BGARC has advised that recent scientific investigations have led to changes in the understanding of the nature of the resource in an area which includes the management areas of Tatiara, Zone 8A and Shaugh. The BGARC adopted a precautionary approach in setting sustainable limits for allocation within the Designated Area (the PAV) resulting in a PAV that is lower than the corresponding TML set by the Board for each of the management zones within the Designated Area.

In Zone 8A, the estimated total level of allocation prior to the date of adoption of this Plan was less than the Permissible Annual Volume (PAV), the limit to water that is permitted to be extracted from licensed wells. As a precaution the Committee determined that the PAV should be reduced from 7,700 ML to the level of commitment at that time based on crop water use only (ie as calculated according to the area-based allocation system), to reduce the risk of further development. As a result, the Committee determined that the PAV for Zone 8A was to be reduced from 7,700 ML to 4,854 ML by 1 July 2012. This PAV was later amended to be 5,121 ML by 1 July 2012. This has the effect of preventing the Minister from granting any new allocations in respect of Zone 8A.

4.3 Capacity of the resource to meet demand

Under the 2001 Water Allocation Plan for the Tatiara Prescribed Wells Area, underground water extracted in the Tatiara PWA was allocated on an area basis rather than by volume of water applied.

This allocation system managed irrigation extraction by controlling the area of crops grown. The irrigation area could not exceed the equivalent value of the Irrigation Equivalents (IE) endorsed on the water licence. However, under this system it was difficult to accurately determine levels of extraction from the resource to identify and manage areas with resource condition issues.

Several major water resource projects were conducted during the review of the 2001 water allocation plan in order to to develop a volumetric conversion model that allows a more accurate representation of the level of development of underground water resources in the region (Carruthers 2006, Carruthers *et al* 2006, Carruthers *et al* 2006).

This Plan follows a precautionary approach in the aquifer response management of the underground water resource. Policy determinations have been in a manner that strives to minimise the risk of long-term adverse effects on the underground resource, rather than delaying decisions until all necessary data is available.

4.3.1 Unconfined aquifer

As a result of several underground water resource science and management projects undertaken to December 2007 (Brown *et al* 2006, Latcham *et al* 2007), new methodologies were developed for estimating the volume of underground water that could be sustainably extracted by licensed underground water users from the unconfined aquifer at a management area scale. The term Total Available Recharge (TAR) has been developed to describe the volume of mean annual vertical recharge available for extraction on an annual basis from each management area.

TAR is calculated as the mean annual vertical recharge in each management area, less a nominal 10% (assuming dryland agriculture) groundwater flow maintenance provision, as follows:

TAR = [Total Area – (Area of Native Vegetation + Lakes)] x Recharge Rate x 0.9

The studies found that in most management areas in the Tatiara PWA, the potential demand on the unconfined aquifer exceeded the TAR, even when taking into account that the delivery supplement is assumed to return to the aquifer and is therefore not considered a net loss from the resource. Results showed that

- all management areas with the exception of Zone 8A are over-allocated with respect to the TAR (Table 4.3);
- Stirling and Wirrega management areas are over-extracted with respect to the TAR; and
- resource condition triggers for both groundwater salinity and changes in depth to water table (as defined in the 2001 Tatiara PWA Water Allocation Plan) are being exceeded in the Stirling, Willalooka and Wirrega management areas.

Table 4.3 Comparison of allocation and Total Available Recharge (TAR) for the unconfined aquifer in the Tatiara PWA

Management Area	Tradeable component (ML)	Delivery supplement (ML)	Specialised production requirements (ML)	Existing volumetric allocations (ML)	Water (holding) allocations (ML)	Total allocation (ML/year)	Stock and domestic demands (ML)	Total Available Recharge (TAR) (ML/year)
Cannawigara	5,195	112	0	29	0	5,336	285	3,399
North Pendleton	9,300	1,498	0	0	0	10,798	170	6,699
Shaugh	8,416	0	93	1,088	0	9,597	170	3,597
Stirling	29,570	33,219	0	205	0	62,994	285	17,027
Tatiara	8,931	1,817	2	703	0	11,453	250	6,185
Willalooka	14,313	14,615	0	6	0	28,934	340	13,072
Wirrega	42,533	12,766	504	1,236	0	57,039	590	24,442
Zone 8A	6,515	0	0	60	412	6,987	280	7,211
TOTALS	124,507	64,027	599	3327	412	192,872	2,370	81,632

Target Management Level (TML)

This Plan has been developed on the principle that a sustainable level of allocation is that at which resource condition triggers are not exceeded. As a result, it proposes reductions to allocations in those management areas in which trends in groundwater salinity and depth to water exceed these triggers. Reductions are proposed to occur over a number of years, with allocations to reduce to a target level by 1 July 2012.

In management areas located outside the Designated Area (Figure 1, *Appendix of Figures and Tables*), it is proposed that the potential level of net extraction of groundwater on an annual basis should not exceed the Target Management Level shown in Table 4.4. Thus, it is proposed that where the sum of all losses from allocations (but not volumes assumed to return through deep drainage) and stock and domestic requirements exceeds the TML for a particular management area, that allocations be reduced proportionately. The TML was set at:

a) TAR where resource condition triggers had been exceeded at December 2006 (referred to as TML(a)); or

b) the average between the indicative level of allocation (with the exception of water assumed to return to the resource) following volumetric conversion and TAR, where resource condition triggers had not been exceeded at December 2006, referred to as TML(b).

In addition, in order to provide for aquifer response management, regular reviews of the conditions of the resource are proposed, with the first review to determine the trends in depth to water and in groundwater salinity in the 5 years preceding December 2010. The Plan provides for a response in any changes in resource condition trends in the form of adjustments to TML. Where conditions have improved, reductions to TML(a) may be discontinued and the TML set at the level of allocation at that date TML(c) (Table 4, *Appendix of Figures and Tables*) or where conditions have deteriorated, reductions to TML(b) might be further increased to a value equivalent to the TAR and referred to as TML(d) (Table 4, *Appendix of Figures and Tables)*.

Table 4.4 Comparison of Indicative volumetric allocations, Target Management Levels and Permissible Annual Volumes for the unconfined aquifer in the Tatiara PWA

Management Area	Indicative Total allocation following volumetric conversion* (ML/year)	Net losses component of allocations* (ML/year)	Stock and domestic demands	Total Available Recharge (TAR) (ML/year)	TML(a) (ML/year)	TML (b) (ML/year)
Cannawigara	5,336	5,195	285	3,399	-	4,154
North Pendleton	10,798	9,300	170	6,699	-	8,008
Stirling	62,994	29,570	285	17,027	17,027	-
Willalooka	28,934	14,313	340	13,072	13,072	-
Wirrega	57,039	43,387	590	24,442	24,442	-

*These values have been calculated by applying the volumetric conversion policy to existing volumetric allocations and are indicative only as a number of allocation components are subject to application and to eligibility criteria.

In management areas located within the Designated Area (Figure 2, *Appendix of Figures and Tables*) the Plan sets out principles to ensure total allocation following volumetric conversion is reduced to a TML shown in Table 4.5. In the event that resource condition triggers are exceeded, further reductions may be considered having regard to the relevant AAV and PAV. Where the sum of all losses from allocations (excluding delivery supplements) and stock and domestic requirements exceeds the TML for a particular management area, allocations will be reduced proportionately so as not to exceed the TML. The TML has been set at:

a) in the Tatiara management area (where resource condition triggers had not been exceeded as at December 2006) the average between the indicative level of allocation (with the exception of water assumed to return to the resource) following volumetric conversion and TAR.

b) in the Zone 8A management area (where the indicative level of allocation did not exceed TAR, and no resource condition triggers had been exceeded, at December 2006) – the indicative level of allocation at the date of adoption of this water allocation plan plus stock and domestic water requirements;

c) in the Shaugh management area (where no resource condition triggers had been exceeded at December 2006) – a level that is considered to be appropriate having regard to the TAR and to the

unique nature of the resource (ie. the availability of water not accounted for in the TAR by virtue of water transitioning from the confined aquifer to the unconfined aquifer) plus stock and domestic water requirements.

4.3.2 Confined aquifer

Current allocation from the confined aquifer is understood to be within the capacity of the resource. However, triggers have been exceeded in the Keith management area and must be monitored to avoid the potential impact of localised drawdown.

As a precautionary approach, the Target Management Levels for the confined aquifer management areas has been set at the current level of allocation (as shown in Table 4.2). Notwithstanding the TML, the Plan provides for some additional allocation for the purposes of recalculation of existing licenses according to this Plan and for public water supply.

Table 4.5 Comparison of Indicative volumetric allocations, Permissible Annual Volumes in Zones 7A, 8A and 9A and TMLin the Designated Area of the unconfined aquifer in the Tatiara PWA

Designated Area Zone	Permissible Annual Volume at 1 July 2012	Management Area	Prescribed Wells Area	Total allocation (ML/year) *	Stock and domestic demands	TML (ML/year)
Zone 7A	7,500	Western Flat	Lower Limestone Coast	@	@	@
		Tatiara	Tatiara	11,453	250	8,036
Zone 8A	5,121	Zone 8A	Tatiara	6,987	280	7,267
Zone 9A	11,595	Shaugh	Tatiara	9,597	170	7,930
		Zone 9A North	Mallee	@@	@@	@@

*allocation volumes determined using the volumetric conversion principles set out in this Plan (indicative only).
@ to be determined by the Water Allocation Plan for the Lower Limestone Coast WAP (currently in preparation).
@@ to be determined by the Water Allocation Plan for the Mallee Prescribed Wells Area (currently under preparation).

4.4 Climate change

Climate change presents a significant challenge to South Australia.

While the water policy decisions included in this Plan were based on the most recent meteorological, hydrological and hydrogeological information and trends, the effects of climate change are not yet clearly understood and therefore it is difficult to know the consequences for future water allocation demand.

Since 1960 the mean temperature in Australia has increased by about 0.7^{o}C, with some areas experiencing warming of 1.5 - 2^{o}C in the last 50 years, with 2000 to 2009 the hottest decade on record. Australian average temperatures are projected to rise by 0.6 to 1.5^{o}C by 2030, and, if greenhouse

emissions continue at current levels, by 2.2 to 5.0ºC by 2070. Warming is projected to resultin an increase in the number of hot days.

While total rainfall on the Australian continent has been relatively stable, the geographic distribution of rainfall has changed significantly over the past 50 years, with rainfall decreasing in southwest and southeast Australia (Bureau of Meteorology, 2010).

In the South East region climate modelling has indicated a significant variation from the current weather pattern. Predicted changes include a continuation of the increasing trend in annual average temperatures and an overall decreasing annual rainfall (but with higher intensity rainfall events), most significantly in spring. Annual decreases in rainfall of up to 5% are predicted by 2030 and up to 40% by 2070 (CSIRO, 2007).

Increasing temperatures and a lower frequency, but higher intensity rainfall predictions are expected to lead to an increased demand for water and an associated increased length of irrigation seasons, potentially placing additional stresses on underground water resources. Increasing temperatures, low frequency and high intensity rainfall predictions will lead to an increased demand for water and an associated increased length of irrigation seasons, potentially placing additional stresses on underground water resources. Therefore ongoing monitoring and technical investigations during the life of this Plan will be critical to reviewing the future sustainability of the underground water resource.

It is critical that water policy decision-makers apply precaution with effective risk and adaptive management and planning. Underground water resource condition triggers for both water level and salinity will enable adaptive management in the event that climate change is having an unforeseen adverse impact on the resource. This can be achieved in the future once a numerical underground water flow model has been developed for this area.

Management may lead to a change in planting seasons for annual crops to adjust and utilise the change in rainfall pattern. There may also be a demand for alternative crops to better suit the changed climatic conditions. Desirable characteristics of alternative crops are disease resistance, heat tolerance and lower water use.

References

Border Groundwaters Agreement Review Committee (2007) *Management Review of the Tertiary Limestone Aquifer in Province 2 of the Designated Area, December 2007.*

Brown, K., Harrington. G., and Lawson, J. (2006). *Review of underground water resource condition and management principles for the Tertiary Limestone Aquifer in the South East of South Australia.* DWLBC Report 2006/2.South Australia. Department of Water, Land and Biodiversity Conservation.

Bureau of Meteorology (2010) *State of the Climate* www.bom.gov.au

Carruthers, R. (2006). *Volumetric Conversion in the South East of South Australia: Community Consultation Processes*. DWLBC Report 2006/33. South Australia Department of Water, Land and Biodiversity Conservation, Mount Gambier.

Carruthers, R., Latcham, B. and Pudney, S. (2006). *Volumetric Conversion in the South East of South Australia: Summary of the Conversion Model and Associated Conversion Rates*. DWLBC Report 2006/29. South Australia Department of Water, Land and Biodiversity Conservation, Mount Gambier.

Carruthers, R., Skewes, M., Latcham, B. and Pudney, S. (2006). *Volumetric Conversion in the South East of South Australia: Calculation of the Crop Adjustment Factor*. DWLBC Report 2006/32. South Australia Department of Water, Land and Biodiversity Conservation, Mount Gambier.

Cobb, M and Brown, K (2000). Water Resource Assessment: *Tatiara Prescribed Wells Area for the South East Catchment Water Management Board*, Deaprtment of Water Resources, South Australia, PIRSA RB 2000/00036.

CSIRO (2007) *Climate Change in Australia – technical report.*

Department of Environment and Natural Resources (DENR) (1997). *Tatiara Prescribed Wells Area Draft Groundwater Management Plan.*

Hodge B (2009a) *Water Allocation and Use in the South East 2007-2008 Summary Report* (Report, DWLBC, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Mount Gambier).

Hodge B (2009b) *Water Allocation and Use in the South East 2008-2009 Summary Report* (Report, DWLBC, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Mount Gambier).

Latcham, B., Carruthers, R. and Harrington, G. (2007). *A new understanding on the level of development of the unconfined tertiary limestone aquifer in the South East of South Australia.* DWLBC Report 2007/11. South Australia Department of Water, Land and Biodiversity Conservation, Mount Gambier.

Latcham, B., Pudney, S. and Carruthers, R. (2006) *Volumetric Conversion in the South East of South Australia: Calculation of the Delivery Component and Bridging Volume*. DWLBC Report 2006/34. South Australia Department of Water, Land and Biodiversity Conservation, Mount Gambier.

Powell, T (2010). *Low Impact, High Performance Irrigation in the South East of South Australia.* (in progress) DWLBC report 2010/XX, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Adelaide.

Pudney, S. (2006). *Volumetric Conversion in the South East of South Australia: Validating the allocation model*. DWLBC Report 2006/30. South Australia Department of Water, Land and Biodiversity Conservation, Mount Gambier.

Pudney, S., Latcham, B. and Carruthers, R. (2006). *Volumetric Conversion in the South East of South Australia: Calculation of Specialised Production Requirements*. DWLBC Report 2006/31. South Australia Department of Water, Land and Biodiversity Conservation, Mount Gambier.

Smith M and McIntyre N (2008) *Water Allocation and Use in the South East 2006-2007 Summary Report*. Resource Allocation Division – South East Region, Department of Water, Land and Biodiversity).

Wohling D (2007) *Minimising Salt Accession to the South East of South Australia. The Border Designated Area and Hundred of Stirling Salt Accession projects. Volume 2 – Analytical techniques, Results and Management Implications,* DWLBC Report 2008/03, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Adelaide.

5. Definitions and Abbreviations

Any terms used in this Plan that are defined in the Act have the definitions in that Act. In addition, for the purposes of this Plan, the following terms have the definitions set out below:

"the Act" means the *Natural Resources Management Act (2004)*

"Adjacent Management Area" includes all management areas that adjoin the management area in which the allocation or licence was initially granted, including those that may lie within an adjoining Prescribed Wells Area.

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

"Allotment" means:

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

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

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

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

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

(f) a separately defined piece of land identified as an allotment for the purposes of the *Real Property Act 1886* in a plan prepared by the Registrar-General and accepted for filing in the Lands Titles Registration Office;

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

"Allowable Annual Volume (AAV)" means the volume of water permitted to be extracted from licensed wells in a subzone of the Designated Area, according to the Groundwater (Border Agreement) Act 1985.

"Ambient underground water" means the underground water (as that term is defined in the Act) that exists in the relevant aquifer, without any impact from 'recharged water' (see definition of recharged water)'.

"Amphipod" means a member of a group of small (approximately 5 mm long) aquatic crustaceans found in fresh, saline and marine environments, including underground cave environments.

"Annual allocation" means the sum of the tradeable component, any delivery supplement and any specialised production requirements (with the exception of water for grapevine frost control), but does *not* include bridging volumes, carry-overs or additional water transferred in temporarily for the purposes of managing seasonal variability.

"Annual water use report" means a report produced by a licensee and submitted to the DWLBC, Mount Gambier office, by 5pm 31 July each year, in accordance with section 11 (*Monitoring, Evaluation and Reporting*) of this Plan.

"Aquaculture" means the farming of aquatic organisms of any species, including their reproductive products and body parts, for trade, business or research purposes, but does not include an activity declared by regulation not to be aquaculture for the purposes of the *Aquaculture Act 2001*.

"Aquifer" means a rock or sedimentary layer that is sufficiently permeable to conduct groundwater to a well or spring.

"Aquifer storage and recovery" means a form of managed aquifer recharge (see definition) in which water is stored in aquifers for subsequent recovery.

"Aquitard" means a saturated but poorly permeable bed, formation, or group of formations that does not yield water freely to a well or a spring. An aquitard retards, but does not prevent, the flow of water to or from an adjacent aquifer.

"the Board" means the South East Natural Resources Management Board.

"Confined Aquifer" means the saturated sands and gravels of either the Dilwyn Formation or the Mepunga Formation in the Otway Basin, or the Renmark Group in the Murray Basin or any other aquifer located beneath these aquifers.

"**Crop Adjustment Factor"** or **"(CAF)**" is part of the tradeable component, constituted by a particular volume granted where the existing Crop Area Ratio (CAR) does not provide adequate allocation to meet net irrigation requirements of the eligible crop.

Crop Adjustment Volume - see principle 14.

"Dam" means an excavation, wall or other structure designed to hold water diverted or pumped from a watercourse, a drainage path, aquifer or other source, and includes clay pits.

"Date of Adoption" or "**Adoption Date"** means the date that the Minister adopts this Plan.

"**Delivery Supplement**" means the volume of water in addition to the tradeable component that eligible flood irrigators are allowed to extract, subject to application, from the aquifer and which is assumed to return to the aquifer.

"Designated Area" means the area designated by the *Groundwater (Border Agreement) Act 1985.* This is a 40km wide strip bisected by, and extending the full length of, the border of South Australia and Victoria. It is divided into 22 management zones (11 in each state). In the Tatiara PWA, the Designated Area encompasses the management areas of Tatiara, Zone 8A and Shaugh.

"Domestic Water Use" means the taking of water for ordinary household purposes, and includes the watering of land in conjunction with a dwelling not exceeding 0.4 hectares.

"Draw down" means the occasional, seasonal or permanent lowering of the water table or reduction in potentiometric level of an aquifer resulting from the extraction of underground water.

"Ecosystem" means a community of organisms, which may include humans, interacting with one another and including the physical, chemical and biological processes inherent in their interaction and the environment in which they live.

"Ecosystem dependent on underground water" means an ecosystem that relies either wholly or partially on underground water to sustain it for some portion of the year.

"**Environmental water provision**" means that part of environmental water requirements that can be met; what can be provided at a particular time after consideration of existing users' rights, and social and economic impacts.

"**Environmental water requirement"** means the water regime needed to sustain the ecological values of aquatic ecosystems, including their processes and biological diversity, at a low level of risk.

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

"Farm" means a place being used solely or predominantly for the business of agriculture, pasturage, horticulture, viticulture, animal farming or any other business consisting of the cultivation of soils, the production of crops or the rearing of livestock.

"Flood irrigation" (also known as 'lasered flood', 'surface irrigation' or 'border-check'), means any irrigation in which underground water is pumped or directed onto an irrigation bay or levelled land and flows uniformly across the bay or the land without the aid of sprinklers, drippers or other infrastructure.

"Groundwater" see "underground water"

"Groundwater Flow Maintenance Provision" is a 10 per cent assignment of the total available recharge to assist in maintaining groundwater flow and direction. This is a nominal and precautionary assignment to assist in the transport of salt through the groundwater system to help maintain system sustainability, for both environmental and consumptive purposes.

"Hectare irrigation equivalent (haIE)" is the evapotranspiration minus contribution by effective rainfall from one hectare of reference crop (8-15 cm tall, uniform height, actively growing, green grass cover completely shading the ground and not short of water) under the average climatic conditions for the region. Conversion factors have been calculated to allow the growth of different crops based on the same quantity of water. The area-based water licensing system expresses allocations as a number of haIE.

"Imported water" means water which has been brought into a management area from another management area by means of a pipe or other channel, and the water (including surface water) has been extracted and piped, or directed into a channel, under licence or permit under the Act, or the *Groundwater (Border Agreement) Act 1985* from the originating management area or zones within the Border Designated Area. Imported water excludes water that would have, prior to diversion formed part of the water balance of the prescribed resource.

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

- the making of any article (or part thereof); or
- the altering, repairing, ornamenting, finishing, assembling, cleaning, washing, packing, bottling, canning or adapting for sale, or the breaking up or demolition of any article; or
- the obtaining, dressing or treatment of materials.

"Irrigation system type" means the specific type of irrigation system used to irrigate, for example flood irrigation, drip irrigation (sub-surface drip; micro-sprinklers; trickle; micro-jet) or spray irrigation (pivots – mobile, fixed, lateral move; sprinklers – overhead, under-tree, pop-up, fixed, portable; travellers – wheel line, mobile gun/spray).

"Karst feature" means a cavity or cave formed by the dissolution of limestone by naturally occurring acids.

"Licensee" means a person or entity who holds a water licence pursuant to Section 146 of the Act.

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

"Management area" means the areas indicated as management areas:

- for the unconfined aquifer, in that part of the PWA shown in Figure 3 (Appendix of Figures and Tables); and
- for the confined aquifer, in that part of the PWA shown in Figure 4 (*Appendix of Figures and Tables*).

"Maximum production pasture" refers to pasture maintained in optimal growing conditions.

"the Minister" means the Minister to whom administration of the *Natural Resources Management Act 2004* is committed.

"**Over-allocation"** or "**over-allocated**" means:

(a) in a management area located outside the Designated Area, that the total loss (ie sum of tradeable components, specialised productions requirements and stock and domestic requirements, but not delivery supplements or carry-overs), exceeds the Target Management Level (TML) for that management area;

(b) in a management area located inside the Border Designated Area, that the total loss (ie sum of tradeable components, specialised production requirements and stock and domestic requirements, but not delivery supplements or carry-overs) exceeds the TML set out in Column G of Table 4 (*Appendix of Figures and Tables*).

"the/this Plan" means this Water Allocation Plan for the Tatiara Prescribed Wells Area

"the 2001 Plan" means the 2001 Water Allocation Plan for the Tatiara Prescribed Wells Area

"Permissible Annual Volume (PAV)" means the volume of water permitted to be extracted from licensed wells in a Zone of the Designated Area, according to the *Groundwater (Border Agreement) Act 1985*.

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

"Potentiometric level", "potentiometric surface" or **"potentiometric head"** means the level to which water rises in a well due to water pressure in the aquifer.

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

"Recharge Rate" means the volume of water that replenishes underground water via infiltration or percolation of water to an aquifer, generally expressed in terms of mm (of rainfall) per year.

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

"Recreational use" means the use of water for the irrigation of parks, gardens and sports grounds of greater than 0.4 hectares, whether publicly or privately owned.

"Reserved water" means water reserved by notice published in the *South Australian Government Gazette* under section 166 of the Act.

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

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

"**Specialised Production Requirements (SPRs)**" means the water required for crop production in addition to crop water use and delivery volumes. This may include activities such as frost protection for grapevines, drift control for potatoes and high production pasture.

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

"Stock water use" means the taking of water to provide drinking water for stock other than stock subject to intensive farming (as defined by the Act).

"Target Management Level (TML)" means:

a) for the unconfined aquifer, the maximum annual volume of underground water that can be potentially extracted from the aquifer on an annual basis by 1 July 2012, including allocations for irrigation, industry, public water supply, aquaculture, recreational use and specialised production requirements, as well as provisions for unlicensed stock and domestic requirements, but not including allocations for seasonal carryover or delivery supplement. The TML for each unconfined management area is listed in Table 4 (*Appendix of Figures and Tables*);

b) for the confined aquifer, the maximum annual volume of underground water that can be potentially extracted from the aquifer at the date of adoption of the Plan. TML includes allocations for irrigation (including delivery supplements), industry, public water supply, aquaculture, recreational use and specialised production requirements, as well as provisions for unlicensed stock and domestic requirements, but not including allocations for seasonal carryover.

"Three year rolling average" when used to describe grapevine frost control specialised production requirements, means that within any water use year the allocation available for extraction for that purpose will be no greater than the sum of the special production allocation for that year, plus the allocation for that purpose for the next two consecutive years and in any three year period, the maximum volume that can be extracted cannot exceed three times the specialised production allocation.

"Total Available Recharge (TAR) for the unconfined aquifer" means the volume of mean annual vertical recharge in a particular management area, less a nominal 10% set aside for groundwater flow maintenance provisions , and is calculated as follows:

TAR = [Total Area – (Area of Native Vegetation + Lakes)] x Recharge Rate x 0.9

"Tradeable component" means the component of a water allocation that can permissibly be traded.

"Unconfined Aquifer" means the saturated geological formation where groundwater has a free water table occurring above the aquitard on top of the Dilwyn Formation or the Mepunga Formation in the Otway Basin, or the Renmark Group in the Murray Basin, whether occurring within the Gambier Limestone of the Otway Basin, the Murray Group Limestone of the Murray Basin, or some other younger geological unit.

"Underground water" means –

(a) water occurring naturally below ground level as distinct from surface water;

(b) water pumped, diverted or released into a well for storage underground.

"Underground Water Access Trench (UWAT)" means a well or shallow trench of up to 2.5 m in depth, excavated into the aquifer with the purpose of providing direct access to underground water, for stock watering or other purposes.

"Underground Water Dependent Ecosystem (UWDE)" bears the same meaning as "ecosystem dependent on underground water"

"Water Development Management Plan (WDMP)" means the plan that must accompany an application to DWLBC for a new water allocation from the Minister or the conversion of a water (holding) allocation to a water (taking) allocation. The WDMP must outline the timeframe for the development of the allocation within 3 years.

"Water (holding) allocation" means a type of allocation previously available under the *Natural Resources Management Act 2004,* until that Act was amended by the *Natural Resources Management (Water Resources and Other Matters) Amendment Act 2007*. This type of allocation no longer exists under the NRM Act as amended. However, the transitional provisions (regulation 47 of the *Natural Resources Management (General) Regulations 2005,* and Clause 5 of Schedule 1 to the *Natural Resources Management* (*Water Resources and Other Matters Amendment Act 2007*) still temporarily permit this Plan to determine a quantity of water to be included on a licence to achieve the same effect. The relevant transitional provisions that permit this to happen only operate until a day designated by the Minister when the Minister is satisfied that the Plan has been amended to take into account the 2007 amendments.

Thus a reference to a water (holding) allocation in this Plan is an allocation which does not authorise the taking of water but enables the holder of the licence to make a request to the Minister to convert the allocation to a water allocation which may be taken.

"Water table" means the upper surface of saturation in the unconfined aquifer.

"Water (taking) allocation" means a water allocation that may be taken.

"Water use year" means a period of 12 months commencing on the 1 July in any year and ending 30 June of the following year.

"Well" means:

a) an opening in the ground excavated for the purpose of obtaining access to underground water;

b) an opening in the ground excavated for some other purpose but that gives access to underground water;

c) a natural opening in the ground that gives access to underground water.

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

Abbreviations

The following abbreviations shall have the meanings set out below.

"DWLBC" Department of Water, Land and Biodiversity Conservation

"DEH" Department for Environment and Heritage

"PWA" Prescribed Wells Area

"**NRM"** Natural Resources Management

"TAR" Total Available Recharge

"**TML"** Target Management Level

Measurements

haIE	hectare irrigation equivalents
km^2	square kilometre(s)
m	metre(s)
mg/L	milligram(s) per litre
ML	megalitre(s)
TDS	Total dissolved solids – usually expressed as mg/L

6. Allocation Criteria – Unconfined Aquifer

6.1 Objectives

The objectives of the unconfined aquifer allocation criteria are:

a. To manage the underground water resource of the unconfined aquifer so that it may continue to be available for the social, economic and environmental needs of current and future generations.

b. To protect the resource locally, throughout each management area, and the entire PWA.

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

d. To maintain and/or improve the availability of underground water to ecosystems dependent on underground water.

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

f. To provide principles for water management so that water allocations are available to sustain economic development.

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

h. To bring at risk and/or over-allocated management areas to environmentally sustainable levels of allocation.

i. To provide for the implementation of the volumetric conversion of unconfined aquifer allocations.

6.2 Principles

Limit to total allocation

1. No new water shall be allocated from the unconfined aquifer for the life of this Plan.

2. Notwithstanding principle 1, water from the unconfined aquifer may be allocated during the life of this Plan for the following purposes:

    a) to give effect to the volumetric conversion of existing area-based allocations;

    b) to convert a water (taking) allocation to a water (holding) allocation;

    c) to convert a water (holding) allocation to a water (taking) allocation;

    d) to temporarily or permanently transfer an allocation according to Section 7 of this Plan;

    e) to give effect to a whole of licence transfer where the allocation will continue to be taken and used on the same allotment/s and for the same purposes as was the case prior to the transfer;

    f) to give effect to the recalculation of volumetric allocations in existence at date of adoption according to principles 33-38 (*Recalculation of volumetric allocations granted prior to date of adoption*);

    g) to give effect to the allocation of water drained or discharged according to principles 100-104 (*Basis of allocation of water drained or discharged into a well*);

    h) to give effect to delivery supplements issued in accordance with principles 119 and 120 (*Temporary transfers to manage seasonal variability*) and principle 33(c) (*Recalculation of volumetric allocations granted prior to date of adoption*);

    i) to allow a water (taking) allocation to be taken from another management area in accordance with principles 84-87 (*Rotational crops*);

j) to give effect to the transfer (including the surrender and reissue of a water (taking) allocation) from the confined aquifer to the unconfined aquifer according to principle 171;

k) to give effect to the transfer (including the surrender and reissue of a water (taking) allocation) from an over-allocated management area to a management area that is not fully allocated, according to principle 108(c);

l) to give effect to the allocation of carry-over volumes according to principle 39;

m) to give effect to the allocation of water according to principles 94 and 95 (Addressing management areas outside the Designated Area, where a resource condition trigger is being exceeded and/or which are overallocated).

n) to give effect to the allocation of water according to principle 98 (Addressing management areas inside the Designated Area, where a resource condition trigger is being exceeded and/or which are overallocated).

Protection of ecosystems dependent on underground water

3. Water shall not be allocated pursuant to principles 2(c),(d),(g),(i) (j) or (k) if to do so may create or contribute to a significant adverse effect on ecosystems dependent on underground water.

4. For the purposes of principle 3, in assessing the likelihood of a significant adverse effect upon an ecosystem dependent on underground water, consideration shall be given to:

   a) if, at the date of application, the wetland is listed on the Department of Environment and Heritage's South Australian Wetland Inventory Database (SAWID) for the South East of South Australia, as a wetland of high or very high conservation value - whether any part of the wetland as mapped in the SAWID falls within a 16 km^2 circle centred on the proposed point of taking of the allocation; and

   b) whether the wetland identified in principle 4(a) is considered by the Minister to:

      i. demonstrate a level of dependence on underground water; and

      ii. be under significant or actual threat of degradation (identified by, but not limited to, a mean (arithmetic) decrease in underground water levels of greater than 0.05 m/year (measured over the preceding 5 years) in a representative observation well within the 16 km^2 circle specified in 4(a) above or, in the absence of a representative well within that radius, in the nearest representative observation well or wells as determined by the Minister); and

   c) the current demand for underground water (determined by the level of allocation within the management area); and

   d) the volume of water proposed to be taken; and

   e) any other relevant environmental matter.

5. For any underground water dependent ecosystem identified for protection under principle 4 above, the set-back distance for any new wells shall be calculated using the DE equation described in Section 2 (*Assessment of the needs of dependent ecosystems)*.

Basis of allocation

6. Water shall be allocated by volume.

Conversion of allocations expressed in haIE to volumetric allocation

7. Allocations presently expressed in hectare irrigation equivalents shall be converted to a volume in accordance with principles 8-32.

8. The allocation of water for irrigation purposes shall not exceed a volume determined as indicated in principles 9-32.

9. For the purposes of converting haIE allocations to a volume, each licence shall be assigned to the corresponding volumetric conversion zone shown in Figure 13 (*Appendix of Figures and Tables)* based upon the management area stated on the licence at the date of adoption. In the case of management areas that incorporate more than one volumetric conversion zone, the corresponding volumetric zone shall be based on the location of the point of extraction.

10. For the purposes of principle 9, where an allotment is, or two or more adjoining allotments held by the same licensee are divided by a volumetric conversion zone boundary:

    a) the volumetric allocation shall be calculated, subject to principle 12(b), based on the location of the point of extraction;

    b) the licensee may request in writing to the Minister that a proportion of the area-based allocation be assigned to each volumetric conversion zone, calculated according to the average area in hectares irrigated in each area in the 2002/03, 2003/04 and 2004/05 water use years;

    c) the Minister will not consider any request under principle 10(b) received after 5 pm on the nearest business day following six months after date of adoption.

Tradeable component

11. A tradeable component is the component of a water allocation which may be permissibly traded.

12. The tradeable component is:

    a) in the case of a water (holding) allocation - the entire volume expressed as a water (holding) allocation;

    b) in the case of a water (taking) allocation - the volume allocated on the licence, minus

        i. any delivery supplement (see principles 16-27);

        ii. any specialised production requirements (see principles 28-32); and

        iii. any carry-overs (see principles 39-40).

13. The tradeable component of a water (taking) allocation for irrigation shall be calculated according to the values contained in Columns B and C of Table 1 (*Appendix of Figures and Tables*) for the corresponding volumetric conversion zone and irrigation system type.

14. Licensees that have grown an eligible crop in an eligible volumetric conversion zone, as listed in Table 2 (*Appendix of Figures and Tables*) will be granted an additional volume to be included as a crop adjustment volume in the calculation of the tradeable component.

15. For the purposes of principle 14, the crop adjustment volume shall be calculated by multiplying the average area in hectares of the eligible crop grown in the 2002/03, 2003/04 and 2004/05 water use years by the crop adjustment factor for the corresponding volumetric conversion zone in accordance with Table 2 (*Appendix of Figures and Tables*), and this volume shall be added to and become part of the tradeable component specified in principle 13.

Delivery Supplement in management areas outside the Designated Area

16. In management areas outside the Designated Area, a licensee may make a written request to the Minister for an additional volume known as a delivery supplement. The Minister, in their absolute discretion, may grant such a request if satisfied that:

    a) the licensed allocation has been used for flood irrigation prior to the date of adoption, and

    b) the allocation has been converted to a volume in accordance with principles 7-10 (*Conversion of allocations expressed in haIE to volumetric allocation).*

17. The delivery supplement shall be calculated according to the values contained in Column D of Table 1 (*Appendix of Figures and Tables*) for the corresponding volumetric conversion zone.

18. Notwithstanding principle 17 if the licensee has had a crop adjustment volume added to their tradeable component pursuant to principle 14, an additional delivery volume shall be calculated and added to the delivery supplement.

19. For the purposes of principle 18, the additional delivery volume will be calculated by multiplying the delivery supplement by a factor calculated by dividing the crop adjustment volume by the tradeable component.

20. A delivery supplement shall be:

    a) allocated on a temporary basis until 30 June of the third water use year after the date of adoption; and

    b) subject to review by the Minister, reissued for the life of the Plan at a volume less than or equal to the volume endorsed on the licence as at 30 June of the third year after the date of adoption.

21. Where a licence is endorsed with a delivery supplement for flood irrigation, the delivery supplement may not be used for any irrigation system type other than flood irrigation.

22. A licensee must notify the Minister in writing of any conversion of any part of an existing irrigation system to a different irrigation system type, prior to applying any water through the different irrigation system type.

23. Where a licensee is using more than one irrigation system type per licence, any corresponding delivery supplement shall be:

    a) calculated based on the proportional split of irrigation systems in place reported in the licensee's Annual Water Use Report for the 2007/08 water use year; or

    b) in the absence of an Annual Water Report for the 2007/08 water use year, on the proportional split of irrigation systems in place reported in the licensee's Annual Water Use Report for the 2006/07 water use year; and

    c) issued for the proportion of tradeable component associated with each eligible system type identified in any Annual Water Use reports for the 2006/07 and/or 2007/08 received by DWLBC by 31 July 2008, as the maximum proportional split via irrigation system type at 30 June 2007 or 30 June 2008, whichever is the greater.

24. For the purposes of principle 23, the proportional split of irrigation system types, shall be calculated by:

    a) multiplying the net irrigation requirement for each crop in the relevant volumetric conversion zone by the area (ha) of each crop grown in the water use year identified in principle 25 as the year with the maximum area under flood irrigation, for each irrigation system type; and

    b) summing the net irrigation requirement for each system type to determine the licensee's total net irrigation requirement for the licence; then

    c) determining the proportional split of each irrigation system type by dividing the net irrigation requirement for system type by the total net irrigation requirement for the licence.

25. The Minister will not consider:

    a) any request under principle 16 received after 5 pm on the nearest business day following six months after date of adoption; and

    b) for the purposes of principles 23 and 24:

        i. any request received after 5 pm on the nearest business day following six months after date of adoption; and

        ii. where no Annual Water Use Report for any of the 2006/07 or 2007/08 water use years was received by DWLBC by 31 July 2008;

    instead the licensee will be considered to have carried out no flood irrigation during the 2006/07 and 2007/08 water use years.

Delivery Supplement in management areas within the Designated Area

26. For management areas located within the Designated Area (Tatiara, Zone 8A and Shaugh), a licensee may make a written request to the Minister for a delivery supplement subject to principles 17-27 and the following:

a) the maximum delivery supplement shall correspond to:

i. if Annual Water Use Reports have been received by DWLBC for any of the 2005/06, 2006/07 or 2007/2008 years by 31 July 2008 - the greatest area (haIE) actually flood irrigated according to those reports;

ii. if no Annual Water Use Report for 2007/2008 was received by DWLBC by 31 July 2008 - the greatest area (haIE) actually irrigated according to Annual Water Use Report received by DWLBC for any of the 2004/2005, 2005/2006 or 2006/2007 water use years; and

27. The Minister will not consider any request under principle 26:

a) if the application is received after 5pm on the nearest business day following six months after date of adoption; or

b) if no Annual Water Use Report for any of the 2004/05, 2005/06, 2006/07 or 2007/08 water use years was received by DWLBC by 31 July 2008.

Specialised Production Requirements

28. A licensee may make a written request to the Minister for an additional volume known as specialised production requirements.

29. The Minister, in their absolute discretion, may grant such a request if satisfied that:

a) the original allocation to which the request relates has been converted to a volume in accordance with principles 7-10 (Conversion of allocations expressed in haIE to volumetric allocation);

b) the application is for an eligible crop(s) listed in Table 3 (Appendix of Figures and Tables) and for the maximum area(s) of the crop(s) referenced in Annual Water Use Reports for the 2002/03, 2003/04 or 2004/05 water use years, whichever is the greater;

c) the additional volume of water sought does not exceed the amount specified in Table 3 for the relevant crop (Appendix of Figures and Tables);

d) the licensee grew the eligible crop during at least one of the 2002/03, 2003/04 or 2004/05 water use years (according to the Annual Water Use Reports received by DWLBC prior to 1 July 2006); and

i. for grapevines: that prior to 1 July 2005, the licensee had installed (or made a significant financial commitment for the installation of) an overhead spray system for frost control, and that by the date of the application under principle 29, a separate meter had been installed to measure the amount of water used for frost control;

ii. for fruit trees: that prior to 1 July 2005, the licensee had installed (or made a significant financial commitment for the installation of) a spray system for fruit tree crop cooling;

iii. for maximum production pasture: that the pasture management system, irrigation system, irrigation management system, pasture species and stock and pasture productivity meet the eligibility criteria as determined by the Minister for maximum production pasture;

iv. for potatoes, onions and subterranean clover seed: that the crop was grown under irrigation; or

v. for olives: that the irrigation water has an electrical conductivity ≥ 2500 micro-Siemens per cm.

30. A specialised production requirements allocation shall be:

a) allocated on a temporary basis until 30 June 5 years after the date of adoption; and

b) subject to review by the Minister, reissued for the life of the Plan at a volume less than or equal to the volume endorsed on the licence as at 30 June 5 years after the date of adoption.

31. Where a licence is endorsed with a specialised production requirements allocation, the specialised production requirements allocation may not be used for any other purpose than the purpose for which it was issued.

32. The Minister will not consider any request under principle 28 received after 5pm on the nearest business day following six months after date of adoption.

Recalculation of volumetric allocations granted prior to date of adoption

33. Existing licences at the date of adoption endorsed with a volumetric allocation will not be recalculated except in the following circumstances:

    a) licences granted for irrigation purposes that were originally granted as a volume based on the net irrigation requirement for the reference crop, and/or delivery losses, at rates different from those used in Table 1 (Appendix of Figures and Tables);

    b) licences granted for recreational purposes that were originally granted as a volume based on the net irrigation requirement for the reference crop and/or delivery losses at rates different from those used in Table 1 (Appendix of Figures and Tables);

    c) licences granted for recreational purposes and specifically for the Bordertown Recreational Lake;

    d) licences granted for plant nurseries where the allocation is deemed by the Minister to be insufficient.

34. Allocations described in principle 33(a) and (b) shall be recalculated according to principle 7, except that:

    a) licensees with allocations made in accordance with principle 33(a) will not be eligible to apply for specialised production requirements according to principles 28-32;

    b) licensees with allocations described in principle 33(b) will not be eligible to apply for delivery supplements or specialised production requirements according to principles 16-27 and 28-32, respectively.

35. Notwithstanding principle 34, allocations that were granted for irrigated recreational purposes under principles 6.2.2-6.2.3 (*Unlicensed pre-existing water use*) in the 2001 Water Allocation Plan for the Tatiara Prescribed Wells Area, shall not exceed 10 ML.

36. Licensees with allocations described in principle 33(c) will be eligible to apply for a non-tradeable delivery supplement equivalent to 71% of the existing licence, subject to the installation of a meter for the sole purpose of measuring the volume of water extracted for the licence.

37. Any delivery supplement issued according to principle 36 shall be:

    a) non-tradeable;

    b) temporary for the life of the Plan; and

    c) used only for the specific purposes of filling the Bordertown Recreational Lake.

38. Licensees with allocations described in principle 33(d):
    a) will not be eligible to apply for delivery supplements, specialised production requirements according to principles 17-28 and 29-32, respectively; and

    b) shall be recalculated based on best industry practice standards as determined by the Minister.

Seasonal variability – carry-over and temporary trade volumes

39. Where:

a) a licence is endorsed with a volumetric water (taking) allocation for the purposes of irrigation, recreation, industry or public water supply; and

b) DWLBC has received an Annual Water Use Report for the preceding water use year by the required date; and

c) at the end of the preceding water use year the water allocation has not been fully used;

the licensee will be entitled to take (in addition to their annual allocation), a volume of water known as a carry-over, equivalent to the unused volume of allocation at the end of the preceding water use year, or 20% of the licensee's annual allocation for the preceding year, whichever is the lesser.

40. Notwithstanding principle 39, in management areas located within the Designated Area:

a) any water extracted for the purposes of carry-overs shall be referenced to the previous water use year;

b) should metered extraction in any zone or subzone exceed the relevant PAV or AAV set by the Border Groundwaters Agreement Review Committee in any of the first 3 water use years of the Plan, licensees in the corresponding management area(s) will not be eligible for a carry-over in that water use year.

41. Where a licence is endorsed with a volumetric water (taking) allocation for the purposes of irrigation, the licensee will be entitled to take a volume of water in addition to their annual allocation known as a temporary trade volume, subject to principles 118 and 119 (*Temporary transfers to manage seasonal variability)*.

42. No allocation granted according to principles 39-41 shall result in the total volume available for use in any one water year exceeding 140% of the licensee's annual allocation.

43. For the purpose of principle 39(c), a licensee is deemed to use the components of their water allocation in the following order:

a) carry-over;

b) temporary trade volume (including any associated delivery supplement);

c) annual allocation.

44. For the purposes of principles 39-43, annual allocation comprises the sum of

a) the tradeable component;

b) any delivery supplement; and

c) any specialised production requirements (except of frost control for grapevines);

but does not comprise carry-overs or additional water transferred in temporarily under principles 119 and 120 (Temporary transfers to manage seasonal variability).

45. In assessing the volume of any specialised production requirements used for grapevine frost control, the specialised production requirements allocation shall be managed according to a three year rolling average such that, in any three year period, the maximum volume extracted for this purpose cannot exceed three times the specialised production requirements allocation.

46. Where a licensee does not have a separate meter to account for the volume of water extracted as specialised production requirements for grapevine frost control,

a) any water extracted through the meter between 1 July and 30 November in any year shall be considered to be water extracted for the purpose of frost control; and

b) any water extracted from 1 December to 30 June in the water use year shall be considered to be use of the licensee's annual allocation.

Water (holding) allocations

47. Water licences may be endorsed with water (holding) allocations.

48. A licence endorsed with a water (holding) allocation shall specify the management area from which the water (holding) allocation is sourced.

49. The purpose of a water (holding) allocation is to preserve the right (subject to the NRM Act) of the licensee to obtain a water (taking) allocation in respect of the quantity of water allocated by the water (holding) allocation.

50. The quantity of water allocated from the unconfined aquifer by a water (holding) allocation is reserved for the time when the water (holding) allocation is converted under principles 52 and 53 (*Conversion of a water (holding) allocation to a water (taking) allocation).*

51. After the date of adoption, water (holding) allocations shall be endorsed on a licence only where:

    a) a water (holding) allocation was already endorsed on the licence prior to the date of adoption;

    b) a water (taking) allocation is converted to a water (holding) allocation at the licensee's request; or

    c) a water (holding) allocation was converted to a water (taking) allocation and any conditions of active and expeditious use remained unfulfilled at the end of the timeframe specified in the Water Development Management Plan or Irrigation Development Management Plan, in which case all or part of the water (taking) allocation will be converted back to a water (holding) allocation based upon the level of fulfilment of the conditions.

Conversion of a water (holding) allocation to a water (taking) allocation

52. A water (holding) allocation may be converted to a tradeable component of a water (taking) allocation of the same volume, subject to the following:

    a) where the conversion is from a water (holding) allocation to a tradeable component of a water (taking) allocation and where the proposed point of taking is located in the same management area, the conversion will be subject to:

        i. principles 58-64 (*Hydrogeological effects and assessment*); and

        ii. principles 3-5 (*Protection of ecosystems dependent on underground water);*

    b) where the conversion is from a water (holding) allocation from one management area to a tradeable component of a water (taking) allocation in another management area, the conversion will be subject to:

        i. principles 58-64 (*Hydrogeological effects and assessment*);

        ii. principles 3-5 (*Protection of ecosystems dependent on underground water);* and

        iii. the transfer principles set out in Section 7.

53. Where a water (holding) allocation has been converted to a water (taking) allocation, the licensee is not eligible to apply for a delivery supplement, or specialised production requirements.

Conversion of a water (taking) allocation to a water (holding) allocation

54. Where a water (taking) allocation is converted to a water (holding) allocation:

    a) only the tradeable component of the water (taking) allocation shall be considered to have become the volume of the water (holding) allocation; and

    b) any specialised production requirements, carry-over or delivery supplement that formed part of the water (taking) allocation shall be forfeited to the Minister; and

    c) any subsequent conversion of the water (holding) allocation back to a water (taking) allocation will be subject to:principles 52 and 53 (Conversion of a water (holding) allocation to a water (taking) allocation).

Returned water

55. Where all or part of a water allocation endorsed on a licence is surrendered or otherwise forfeited to the Minister, that water will not be available for allocation except where the area is or becomes under-allocated with respect to the limits to allocation set out in Table 4 (*Appendix of Figures and Tables*) and principle 108(c) (*Transfers of allocations*) applies.

56. For the purposes of principle 55, with respect to the Target Management Levels set out in Columns C, D, E and F of Table 4 (*Appendix of Figures and Tables*):

    a) where a tradeable component or specialised production requirements is forfeited, this will be considered to constitute a reduction in the level of allocation in that management area;

    b) where a delivery supplement is forfeited, the returned volume shall not be regarded as a reduction in the level of allocation for that management area.

57. For the purposes of principle 55, with respect to the TML in Column G of Table 4 (*Appendix of Figures and Tables*):

    a) where a tradeable component or specialised production requirement is forfeited, this will be considered to constitute a reduction in the level of allocation in that management area;

    b) where a delivery supplement is forfeited, the returned volume shall not be regarded as a reduction in the level of allocation for that management area.

Hydrogeological effects and assessment

58. The allocation of water for all purposes other than industry, energy generation and public water supply, shall comply with the 16 km^2 circle test as defined in principles 61 and 62.

59. No allocation shall be made which appears, in the opinion of the Minister, to have potential to cause:

    a) one or more of the following underground water resource condition triggers to be exceeded:

        i. a mean (arithmetic) increase in salinity of the underground water resource of greater than 1% per annum (measured over the preceding 5 years) in a representative observation well within a 16 km^2 circle centred over the point of taking or, in the absence of any representative wells within the 16 km^2 circle, in the nearest representative well or wells as determined by the Minister; or

        ii. a mean (arithmetic) decrease in underground water levels of greater than 0.1 m per annum (measured over the preceding 5 years) in a representative observation well within a 16 km^2 circle centred over the point of use or, in the absence of any representative wells within the 16 km^2 circle, in a representative observation well or wells as determined by the Minister;

    b) a significant adverse effect on the structural integrity of the aquifer;

    c) a significant adverse effect on any other water resource, both within and beyond the PWA;

    d) a significant adverse effect on ecosystems dependent on underground water, by contravening principles 3-5 (*Protection of ecosystems dependent on underground water*).

Hydrogeological assessment for allocations resulting from temporary transfers to manage seasonal variability

60. The granting of a water allocation resulting from principles 119 and 120 (*Temporary transfers to manage seasonal variability)* is exempt from principles 58 and 59 (*Hydrogeological effects and assessment)*.

The 16km^2 circle test

61. For the purposes of principle 58, the granting of a water (taking) allocation shall not cause the total volume of water which may be used within a circle of 16 km^2 area to exceed 1.25 times the amount of annual average vertical recharge for the management area.

62. For the purposes of principle 61:

    a) the 16 km2 circle shall be centred on:

        i. the specified point of taking or,

        ii. where the point of taking is not specified, on the centremost point of the nominated allotment (and the well must be constructed within 100 m radius of the centremost point of the nominated allotment);

    b) the total volume of water which may be taken includes the sum of the tradeable component, and any specialised production requirements, but does not include delivery supplements, carry-overs or additional water transferred in temporarily under principles 119 and 120 (Temporary transfers to manage seasonal variability);

    c) the annual average vertical recharge rate for a management area shall be calculated using the annual average vertical recharge rate set out in Column B of Table 4 (Appendix of Figures and Tables) for the relevant management area, multiplied by the area within the 16 km2 circle (less the area occupied by bodies of water and/or native vegetation).

16 km^2 test for the irrigation of rotational crops for a period equal to or less than 12 months

63. Notwithstanding principles 57-58, for the purpose of irrigating a rotational crop for a period equal to or less than one water use year, the granting of a water (taking) allocation shall not cause the total volume of underground water (minus any delivery supplements) extracted within the 16 km^2 circle during the water use year prior to the application, to exceed 1.25 times the amount of annual average vertical recharge indicated in Column B of Table 4 (*Appendix of Figures and Tables*) for that management area.

Hydrogeological assessment for the allocation of water for the purposes of industry, energy generation or public water supply

64. The taking of water for industry, energy generation or public water supply shall not, in the opinion of the Minister:

    a) adversely affect the quality of water in the unconfined aquifer by (including but not limited to) having the potential to cause or contribute to an increase in salinity in excess of the rate specified in principle 59(a)(i);

    b) adversely affect the water level of the unconfined aquifer by having the potential to cause or contribute to a long term decline in underground water levels at the point of taking and the nearest representative observation well(s) as determined by the Minister, exceeding 0.1 m/year after 3 years from the start of taking; or

    c) adversely affect or have the potential to adversely affect the structural integrity of the aquifer.

Quantity of allocation

65. Where an allocation is granted for purposes other than irrigation, the allocation shall not exceed the amount reasonably required for the purpose proposed in accordance with current industry best practice standards, as determined by the Minister.

Efficient use of water

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

Restrictions on use

67. Water taken pursuant to this plan shall not be used for the purposes of wild flooding.

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

    a) the volume of tail water produced for disposal will not exceed an amount reasonably produced according to industry best practice at the time of assessment of the application, as determined by the Minister; and

    b) the disposal of tail water will not cause an increase (above seasonal fluctuations) in:

        i. underground water levels in the unconfined aquifer; or

        ii. the potentiometric pressure in the confined aquifer;

    at the boundary of the allotment where the tail water is disposed of, or at the boundary of any adjoining allotment held by the same owner, whichever is the greater distance from the point of disposal; and

    c) the disposal of tail water will not cause:

        i. an acceleration in salinity increase in either aquifer; or

        ii. pollution of either aquifer by the tail water; or

        iii. pollution of either aquifer by any other substance; and

    d) the ponds, tanks, vessels or other places for the keeping of any water for the aquaculture process have no significant hydraulic connection with either aquifer.

69. For the purpose of principle 68, tail water is the volume of water that flows out of the aquaculture system once it has flowed through any ponds, tanks, vessels or other places for the keeping of the aquatic species being farmed by means of aquaculture.

Active and expeditious use of water

70. Water (taking) allocations granted after 29 June 2001, excluding those obtained through transfers, must be developed in accordance with the associated Water Development Management Plan or Irrigation Development Management Plan.

71. Water (taking) allocations resulting from the conversion of a water (holding) allocation must be developed within 3 years of the granting of the allocation.

72. Further to principle 71, any proportion of the allocation that is not developed within 3 years of the granting of the allocation shall be converted back to a water (holding) allocation.

73. For the purposes of principles 70-72, development of an allocation means the development of sufficient facilities, land or equipment to a capacity that enables the water (taking) allocation to be utilised at its maximum lawful annual rate.

74. Where the licensee can demonstrate to the Minister that extenuating circumstances apply, the maximum period for the application of principles 70-73 may be increased to 4 years.

75. Where:

    a) an allocation is not the result of the conversion of a water (holding) allocation to a water (taking) allocation; and

    b) active and expeditious use principles have not been fulfilled for the allocation;

    the undeveloped portion shall be forfeited to the Minister as returned water and the returned volume shall be managed according to principles 55-57 (Returned water).

Piping of water for a distance greater than 2.25 km

76. Where water from the unconfined aquifer is to be taken from one point to be used at another point at least 2.25 km from the point of taking:

    a) the water must be transported by pipe or other enclosed vessel; and

    b) with the exception of public water supply:

        i. the taking and use of water shall comply with principles 58-64 (*Hydrogeological assessment*);

        ii. notwithstanding principle72(b)(i), the 16 km^2 circle test shall apply only at the point of taking.

Use of imported water

77. Unconfined aquifer water may only be brought into a management area from another management area or PWA:

    a) by means of a pipe or other enclosed vessel; and

    b) if at a rate greater than 1 ML/year, use of the water must comply with section 10.6 of the Plan.

Divided allotments and allotments held in adjacent management areas

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

    a) the allocation remains referenced to, and accounted for, in the originating management area and PWA;

    b) the taking and use of water complies with principles 58-64 (Hydrogeological effects and assessment) and principles 3-5 (Ecosystems dependent on underground water);

    c) the point of extraction and/or use is not moved more than 2 kilometres into an adjacent management area or PWA (unless it can be demonstrated that the allocation (or part thereof) was being extracted or used at that location prior to date of adoption);

    d) an allocation from another management area is not taken in a zone within the area designated under the Groundwater (Border Agreement) Act 1985 (unless it can be demonstrated that the allocation (or part thereof) was being extracted in that zone within the Designated Area prior to date of adoption);

    e) an allocation from another management area is not taken or used in the Stirling management area, the Hundred of Pendleton (including the portion within the Wirrega management area), or the Padthaway PWA.

79. An allocation that has been taken and used in an adjoining management area or PWA pursuant to principle 78 will not be available for further transfer within the receiving management area or PWA.

Endorsement of Certificates of Title on licences

80. An additional allotment may only be endorsed on a licence where the licensee can demonstrate to the Minister's satisfaction that the licensee is able to physically extract and use the allocation endorsed on the water licence on the relevant allotment and is not prevented from doing so by the presence of, for example, but not limited to, native vegetation, plantations, roadways or structures.

81. Where a licensee is not the registered proprietor of, or does not have legal access to, an allotment endorsed on a water licence prior to the date of adoption, the endorsement of that allotment on the license will be removed unless by 5 pm on the nearest business day following 6 months from date of adoption of the Plan, the licensee provides to the Minister a statutory declaration made by the registered proprietor of the allotment confirming their consent to the endorsement.

82. On or after the date of adoption, a licence endorsed with a water (taking) allocation may not be varied to enable the water to be used on additional allotments, unless:

    a) the subject land is owned by the applicant, or

    b) the licensee has made an application to the Minister for such a variation, accompanied by a statutory declaration made by the registered proprietor of the land consenting to the variation.

83. For the purposes of principles 80-82, where the licensee is not the registered proprietor of the land, the relevant Certificate(s) of Title will only be endorsed for a maximum of 5 years unless otherwise specified in the statutory declaration.

Rotational crops

84. A licensee may apply in writing to the Minister to vary a water licence for the purposes of irrigating a rotational crop, subject to principles 58-63 (*Hydrogeological effects and assessment)* and principles 3-5 (*Ecosystems dependent on underground water)*.

85. An allocation of water may be taken from another management area to irrigate a rotational crop for a maximum period of 5 years.

86. Notwithstanding principle 84, water may not be taken from another management area to irrigate a rotational crop, where the proposed point of taking lies within the Padthaway PWA or the Designated Area.

87. Where:

    a) the proposed point of taking lies within a management area that is located outside the Designated Area; and

    b) that management area is fully allocated on date of adoption; or

    c) the taking of water to irrigate a rotational crop causes the sum total of water (holding) allocations, tradeable components and specialised production requirements of water (taking) allocations in the management area to exceed the relevant Target Management Level as set out in Table 4 (Appendix of Figures and Tables);

    the Minister may grant a variation for a maximum of 12 months, if the level of water extracted in the form of tradeable components and specialised production requirements (but not delivery supplements) from the unconfined aquifer in the management area of the proposed point of taking in the preceding water use year did not exceed 90% of the Target Management Level as set out in Table 4 (*Appendix of Figures and Tables*).

Addressing management areas outside the Designated Area, where a resource condition trigger is being exceeded and/or which are over-allocated

88. In management areas located outside the Designated Area, water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations shall be reduced to TML(a), TML(b), TML (c) or TML (d) as set out in Columns C, D, E and F in Table 4 (*Appendix of Figures and Tables*) by 1 July 2012 in accordance with principles 89-95.

89. Where a management area is over-allocated at date of adoption and a resource condition trigger (as described in principle 55(a)(i) and (ii) (*Hydrogeological effects and assessment*)) was exceeded at December 2006 (those management areas being Stirling, Willalooka and Wirrega):

    a) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations shall be reduced proportionately to TML(a) as set out in Column C, Table 4 (Appendix of Figures and Tables) by reducing each licensed allocation by the same percentage so that the aggregate of all allocations in each management area does not exceed TML(a) (Column C, Table 4 Appendix of Figures and Tables) by 1 July 2012;

    b) 60% of the required reduction will take place at:

    i. date of adoption; or

    ii. 1 July 2010;

    whichever is the later date,

    c) the remaining reduction will take place in two equal volumetric steps at the commencement of each subsequent water use year.

90. Notwithstanding principle 89, if a review of the conditions of the resource undertaken prior to 1 July 2012 determines that no resource condition triggers (as described in principle 59(a)(i) and (ii) (*Hydrogeological effects and assessment*)) are being exceeded at December 2010, the schedule of reductions may be altered so that the aggregate of water *(holding) allocations and the tradeab*le components and specialised production requirements of water (taking) allocations does not exceed TML(c) Column *E, Table 4 (Appendix of Figures and Tables*) at 1 July 2012.

91. Where a management area is over-allocated at date of adoption, and a resource condition trigger/s (as d*escribed in principle 55(a)(i)* and (ii) (*Hydrogeological effects and assessment*)) was not exceeded at December 2006 (those management areas being Cannawigara and North Pendleton): allocations shall be reduced proportionately to TML(b) as set out in Column D, Table 4 *(Appendix of Figures and Tables*) by reducing:

    a) each licensed allocation by the same percentage so that the aggregate of water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations in each management area does not exceed TML(b) (Column D, Table 4 (*Appendix of Figures and Tables*) at 1 July 2012

    b) 60% of the required reduction will take place at:

    i. date of adoption; or

    ii. 1 July 2010;

    whichever is the later date;

    c) the remaining reduction occurring in two equal volumetric steps at the commencement of each subsequent water use year.

92. Notwithstanding principle 91, if a review of the conditions of the resource undertaken prior to 1 July 2012 determines that no resource condition triggers (as described in principle 59(a)(i) and (ii) (*Hydrogeological effects and assessment*)) are being exceeded at December 2010, the schedule of reductions may be altered so that the aggregate of water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations does not exceed TML(d) Column F, Table 4 (*Appendix of Figures and Tables*) at 1 July 2012.

93. If a resource condition trigger is still exceeded at December 2013 in a management area located outside the Designated Area, water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations shall be reduced in 3 equal annual steps by 1 July 2015 so that the level of allocation equals the sustainable level identified by the Minister.

94. Notwithstanding principles 88-93, until such time as separation of entitlements occurs in management areas outside the Designated Area, where the Minister identifies that the sustainable level of allocation is greater than the specified allocation limit, water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations shall be increased proportionately so that the level of allocation equals the sustainable level identified by the Minister.

95. For the purposes of principles 88-94, any associated delivery supplement shall be proportionately reduced or increased consistently with the tradeable component by the Minister.

Addressing management areas within the Designated Area, where a resource condition trigger is being exceeded and/or which are over-allocated

96. In the Tatiara, Zone 8A and Shaugh management areas, water (holding) allocations and all components of water (taking) allocations (ie tradeable components, delivery supplements and/or specialised production requirements) will be reduced proportionately in equal annual steps from date of adoption, such that the sum of total water allocations (with the exception of delivery supplements) and stock and domestic water use in each management area does not exceed the TML set out in Column G of Table 4 by 1 July 2012.

97. DELETED - by s89(2) amendment dated 3 July 2012.

98. Notwithstanding principle 96, until such time as separation of entitlements is implemented, where the TML set out in Column G of Table 4 is increased after 3 July 2012, water (holding) allocations and all components of water (taking) allocations (ie tradeable components, and/or specialised production requirements) may be increased proportionately so that the sum of total water allocations (with the exception of delivery supplements) and stock and domestic water use equals the amended TML.

Exemption from reductions

99. Notwithstanding principles 88-98, allocations for the purposes of public water supply, industry and recreation in existence at date of adoption, are exempt from reductions.

Basis of allocation of water drained or discharged into a well - aquifer storage and recovery

100. Water that is drained or discharged into a well under principles 101-104 will not be available for allocation where it is considered that it would have contributed to the natural vertical recharge of the unconfined or confined aquifer systems.

101. Water that is drained or discharged into a well consistent with a permit granted pursuant to section 127(3)(c) of the Act will only be available for allocation where the drainage or discharge has been metered and a meter reading has been taken by the Minister; and either

    a) the water has been taken under a licence issued under the provisions of the Act and treated by a desalination plant; or

    b) water that has been imported for the purposes of drainage and discharging into a well and has been taken and used under a licence issued under the provisions of the Act.

102. An allocation of water drained or discharged into a well must be taken and used within a period of three years calculated from 1 July in the year in which the water was drained or discharged.

103. An allocation of water drained or discharged into a well shall only be taken from the original well of drainage or discharge of the imported water to the aquifer, or from a well within a radius of 500 metres of the original well.

104. Subject to principles 100-103:

    a) if the water drained and discharged is a product of a desalination process, a maximum of 100% of the volume drained or discharged may be allocated to the permit holder;

b) if the water drained and discharged is not the product of a desalination process, a maximum of 80% of the volume drained or discharged may be allocated to the permit holder.

7. Transfer Criteria – Unconfined Aquifer

7.1 Objectives

The objectives of the unconfined aquifer transfer criteria are:

a. To manage the underground water resource of the unconfined aquifer so that it may continue to be available for the social, economic and environmental needs of current and future generations.

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

c. To maintain and/or improve the availability of underground water for ecosystems dependent on underground water.

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

e. To minimise constraints on transfers of water allocations so that these are available to sustain economic development.

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

g. To ensure that allocations resulting from transfers remain within the sustainable limits of the unconfined aquifer in the relevant management area.

h. To provide for the transfer of volumetric allocations from the unconfined aquifer.

7.2 Principles

Transfers of allocations

105. All transfers of unconfined aquifer water (holding) allocations and unconfined aquifer water (taking) allocations are subject to the allocation principles set out in section 6 of the Plan.

106. Allocations from the unconfined aquifer may not be transferred to the confined aquifer.

107. Where a licensee has an allocation in the confined aquifer, the licensee may forfeit the allocation and be reissued an allocation of the same value in the unconfined aquifer, subject to principle 2, and providing that the reissue of the allocation does not cause the receiving management area to become over-allocated.

108. The whole or part of an allocation from the unconfined aquifer endorsed on a licence may be:

    a) transferred within the same management area temporarily or permanently;

    b) transferred for a maximum of 5 years into an adjacent management area within or outside the Tatiara PWA, provided the transfer does not cause the receiving management area to become over-allocated;

    c) transferred permanently from an over-allocated management area into an under-allocated management area within the Tatiara PWA providing the transfer does not cause the receiving management area to become over-allocated.

109. Notwithstanding principle 108, no allocations may be transferred into the Padthaway PWA or the Designated Area.

110. For the purposes of principle 108(b), an “adjacent management area” includes all management areas that adjoin the management area from which the allocation or licence was initially granted.

111. Where water is temporarily transferred into another management area pursuant to principle 108(b)

    a) that water will not be available for subsequent transfer into other adjacent areas;

    b) the allocation must be accounted for in both the originating and receiving management areas;

    c) the corresponding endorsement of land parcel or allotment must be removed from the licence upon the expiry of the transfer period.

112. Where a water allocation from the unconfined aquifer is transferred:

    a) any delivery supplement associated with a tradeable component shall be forfeited to the Minister, and only re-issued as a temporary allocation to the transferee if the Minister is satisfied that the tradeable component will continue to be used for the purposes of flood irrigation ;

    b) in the case of a temporary transfer, any delivery supplement associated with a tradeable component forfeited to the Minister, and re-issued as a temporary allocation to the transferee according to principle 112(a), shall be forfeited by the transferee at the end of the temporary transfer and re-issued to the transferor;

    c) no specialised production requirements or seasonal carry-over will be transferred, unless:

        i. the licence or allocation is transferred in its entirety; and

        ii. the Minister is satisfied that the water is to be taken and used on the same allotment(s) for the same purpose.

113. If part only of an allocation is transferred, any delivery supplement and/or specialised production requirements that relate to the allocation not transferred will be reduced proportionately.

114. Taking and use of allocations transferred from the unconfined aquifer shall be consistent with the relevant water allocation plan for the receiving management area or PWA.

Transfers in management areas subject to allocation reductions

115. In management areas subject to reductions in allocations, a licensee may apply in writing to the Minister to transfer in an allocation from the same management area exempt from principles 58-64 (Hydrogeological effects and assessment).

116. Notwithstanding principle 115, only transfers of a volume less than or equal to 75% of the extent of the reduction to the licensee's allocation are exempt from principle 58-64 (Hydrogeological effects and assessment).

117. For the purposes of principles 115-116, the maximum total allocation that can be transferred by a licensee under these principles from date of adoption shall not exceed 75% of the reduction implemented by 30 June 2012.

118. DELETED – by s89(2) amendment dated 1 December 2015.

Temporary transfers to manage seasonal variability

119. A licensee who holds an unconfined aquifer water (taking) allocation for irrigation purposes may apply in writing to the Minister for the transfer in of additional water for the purpose of managing seasonal variability, subject to the following:

    a) a licensee may only apply for such transfers in three of every five consecutive years;

    b) the application must be for a transfer in of a tradeable component unused in the current water use year within the same management area;

    c) the quantity of water transferred in cannot exceed 20% of the transferee's annual allocation (which for this purpose will be taken to be the sum of the tradeable component, and any

specialised production requirements with the exception of water for frost control for vines, but does not include delivery supplement, carry-overs or additional water transferred in temporarily);

d) the transfer shall expire at the end of the water use year in which the application was made; and

e) the transfer is exempt from principles 58-64 (*Hydrogeological effects and assessment*) and principles 3-5 (*Ecosystems dependent on underground water*).

120. Where a transfer occurs pursuant to principle 119:

a) any delivery supplement associated with tradeable component unused in the current water use year and which is proposed to be transferred will be forfeited to the Minister, and only re-issued to the transferee if the Minister is satisfied that it will continue to be used for the purposes of flood irrigation;

b) any delivery supplement issued as a result of the transfer shall expire at the end of the water use year in which the transfer was made.

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

121. Where a licence granted by the Minister includes a condition(s) requiring the expeditious use of water (including a requirement that the equipment by which, or land on which, the water is used must be developed within a certain time period), the following applies:

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

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

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

Applications to transfer water (taking) allocations – piping of water more than 2.25 km

122. Where a transfer application requires water from the unconfined aquifer to be taken from one point to be used at another point at least 2.25 kilometres from the point of taking:

a) the water must be transported by pipe or other enclosed vessel; and

b) with the exception of public water supply:

i. both the taking and use of water shall comply with principles 58-64 (Hydrogeological assessment);

ii. notwithstanding principle 122(b)(i), the 16 km^2 circle test shall apply only at the point of taking.

123. Notwithstanding principle 122, where the proposed point of taking and point of use are the same as those utilised prior to transfer, the proposed transfer of water shall be deemed to have complied with principles 57-64 at both the extraction and discharge sites without further assessment.

Endorsement of Certificates of Title on licences

124. If an unconfined aquifer water (taking) allocation is transferred, any allotment(s) corresponding to the proposed point of application and/or proposed point of taking shall only be endorsed on a water licence, if the Minister is satisfied that the applicant is able to physically extract and use the allocation endorsed on the water licence on the allotment, and is not prevented from doing so by the presence of (for example, but not limited to) native vegetation, plantations, roadways or structures.

125. In the case of a temporary transfer, upon expiry of the agreed transfer period, both the allocation temporarily transferred and any Certificate(s) of Title endorsed as a consequence of the transfer, shall be removed from the transferee's licence.

Applications to transfer water allocated on the basis of water drained or discharged

126. Water drained and discharged into the unconfined aquifer according to principles 100-104 (Basis of allocation of water drained or discharged into a well) may only be transferred if the Minister is satisfied that the transferred water will be taken from:

    a) the same point of extraction; or

    b) a proposed extraction well within a 500 metre radius of the point where the imported water was drained or discharged.

Hydrogeological effects and assessment

127. An unconfined aquifer transfer application shall be deemed to have complied with the 16 km2 circle test (as defined in principles 61 and 62 (The 16km2 circle test)) without further assessment if:

    a) the application is to transfer a licence endorsed with a water (taking) allocation, or the whole or part of a water (taking) allocation, where the transferred water is to be used on the same allotment(s) and:

        i. the transferred water will continue to be taken from the same well; or

        ii. the transferred water will be taken from a replacement well within 1 kilometre of the original well; or

    b) the application is to renew a temporary transfer (of the same quantity), where:

        i. the transferred water is to be taken from the same well (or a well that replaces the original well but lies with 100 m of the original well);

        ii. the transferred water is to be used on the same allotment(s); and

        iii. the application to renew is received and processed prior to the date and time of expiry of the original temporary transfer.

128. Notwithstanding principle 127, the renewal of a temporary transfer of an allocation which has been in place for 5 years or greater, is subject to principles 58-64 (*Hydrogeological effects and assessment*).

129. Notwithstanding principle 127 and 128, if one or more of the resource condition triggers for the unconfined aquifer specified in principle 59(a)(i) and (ii) have been exceeded, the transfer application may still be approved if:

    a) the resource condition triggers for both underground water salinity and water table levels at the destination are exceeded at a lesser rate than at the point of origin; and

    b) approval would not cause the triggers at the destination to exceed those existing at the origin prior to transfer.

8. Allocation Criteria – Confined Aquifer

8.1 Objectives

The objectives of the confined aquifer allocation criteria are:

a. To cautiously manage the confined aquifer, an ancient resource with limited recharge.

b. To manage the underground water resource of the confined aquifer so that it may continue to be available for the social, economic and environmental needs of current and future generations.

c. To protect the resource locally, throughout each management area, and throughout the entire PWA.

d. To protect the environment generally by ensuring that the taking and use of underground water from the confined aquifer does not cause significant degradation of any other resource, including soils and other water resources.

e. To promote the active and efficient use of water allocations to drive best practice water use.

f. To bring at-risk and/or overallocated management areas to environmentally sustainable levels of allocation.

g. To provide for the implementation of the volumetric conversion of confined aquifer allocations.

8.2 Principles

Limit to total allocation

130. No new water shall be allocated from the confined aquifer for the life of this Plan.

131. Notwithstanding principle 130, water from the confined aquifer may be allocated during the life of this Plan for the following purposes:

    a) to give effect to the allocation of water for the purpose of public water supply in accordance with principle 136 (Allocations for purpose of public water supply);

    b) to convert a water (taking) allocation to a water (holding) allocation;

    c) to convert a water (holding) allocation to a water (taking) allocation;

    d) to temporarily or permanently transfer an allocation pursuant to Section 9 of this Plan;

    e) to give effect to a whole of licence transfer where the allocation will continue to be taken and used on the same allotment/s and for the same purpose/s as was the case prior to the transfer;

    f) to give effect to the recalculation of volumetric allocations in existence at date of adoption according to principles 132-133 (Recalculation of volumetric allocations from the confined aquifer granted prior to date of adoption).

Recalculation of volumetric allocations from the confined aquifer granted prior to date of adoption

132. Existing licences at the date of adoption endorsed with a volumetric allocation will only be recalculated if the allocation was for recreational purposes and granted as a volume based only on the net irrigation requirement for the reference crop, with no allowance for delivery losses.

133. A licence endorsed as described in principle 132 shall be allocated an additional 11% of the allocation volume for drip irrigation, and 18% of the allocation volume for flood or spray irrigation.

Seasonal variability – carryover and temporary trade volumes

134. Where:

a) a licence is endorsed with a volumetric water (taking) allocation for the purposes of irrigation, recreation, industry or public water supply; and

b) DWLBC has received an Annual Water Use Report for the preceding water use year by the required date; and

c) at the end of the preceding water use year the water allocation has not been fully used;

the licensee will be entitled to take a volume of water equivalent to the unused volume of allocation at the end of the preceding water use year in addition to the annual allocation, known as a carry-over.

135. Notwithstanding principle 134

a) a carry-over may not exceed 20% of the licensee's annual allocation for the preceding year; and

b) in management areas located within the Designated Area, any water extracted for the purposes of carry-overs shall be referenced to the previous water use year.

136. Where a licence is endorsed with a volumetric water (taking) allocation for the purposes of irrigation, the licensee will be entitled to take a volume of water in addition to their annual allocation known as a temporary trade volume, subject to principle 176 (Temporary transfers to manage seasonal variability),

137. No allocation granted according to principles 134-136 shall result in the total volume available for use in any one water year exceeding 140% of the licensee's annual allocation.

138. For the purpose of principle 134(c), a licensee is deemed to use the components of their water allocation in the following order:

a) carry-over;

b) temporary trade volume (including any associated delivery supplement);

c) annual allocation.

139. For the purposes of principles 134-138, annual allocation comprises the sum of the tradeable component, any delivery supplement and any specialised production requirements with the exception of frost control for grapevines, but does not comprise carry-overs or additional water transferred in temporarily under principle 162 (Temporary transfers to manage seasonal variability).

140. Notwithstanding principle 139, in assessing the volume of any specialised production requirements used for grapevine frost control, the specialised production requirements allocation shall be managed according to a three year rolling average such that, in any three year period, the maximum volume extracted for this purpose cannot exceed three times the specialised productions requirement allocation.

141. Notwithstanding principle 140, where a licensee does not have a separate meter to account for the volume of water extracted as specialised production requirements for grapevine frost control, any water extracted through the meter between 1 July and 30 November in any year shall be considered to be water extracted for the purpose of frost control, and any water extracted from 1 December to 30 June in the water use year shall be considered to be use of the licensee's annual allocation.

Water (holding) allocations

142. Water licences may be endorsed with water (holding) allocations.

143. A licence endorsed with a water (holding) allocation shall specify the management area from which the water (holding) allocation is sourced.

144. The purpose of a water (holding) allocation is to preserve the right (subject to the Act) of the licensee to obtain a water (taking) allocation in respect of the quantity of water allocated by the water (holding) allocation.

145. The quantity of water allocated from the confined aquifer by a water (holding) allocation is reserved for the time when the water (holding) allocation is converted under principles 147-148 (Conversion of a water (holding) allocation to a water (taking) allocation).

146. After the date of adoption, water (holding) allocations from the confined aquifer shall be endorsed on a licence only where:

a) a water (holding) allocation was already endorsed on the licence at the date of adoption;

b) a water (taking) allocation is converted to a water (holding) allocation at the licensee's request; or

c) a water (holding) allocation was converted to a water (taking) allocation and any condition(s) of active and expeditious use remained unfulfilled at the end of the timeframe specified in the Water Development Management Plan or Irrigation Development Management Plan, in which case all or part of the water (taking) allocation will be converted back to a water (holding) allocation based upon the level of fulfilment of the condition(s).

Conversion of a water (holding) allocation to a water (taking) allocation

147. A water (holding) allocation from the confined aquifer may be converted to a tradeable component of a water (taking) allocation in the same management area and of the same volume, subject to:

a) principles 152-154 (Hydrogeological effects and assessment);

b) principles 158-163 (Active and expeditious use of water); and

c) if the water (holding) allocation was initially the result of the conversion of a water (taking) allocation for the purposes of public water supply or industry, then the resulting water (taking) allocation will be for the purposes of public water supply or industry.

148. Where a water (holding) allocation has been converted to a water (taking) allocation, the licensee is not eligible to apply for a delivery supplement or specialised production requirements.

Conversion of a water (taking) allocation to a water (holding) allocation

149. Where a water (taking) allocation is converted to a water (holding) allocation:

a) only the tradeable component of the water (taking) allocation shall be considered to have become the volume of the water (holding) allocation; and

b) any specialised production requirements, carry-over or delivery supplement that formed part of the water (taking) allocation shall be forfeited to the Minister; and

c) any subsequent conversion of the water (holding) allocation back to a water (taking) allocation will be subject to principles 147-148 (Conversion of a water (holding) allocation to a water (taking) allocation).

Allocations for the purpose of public water supply

150. Water from the confined aquifer may be allocated upon application in writing to the Minister for the purpose of public water supply, subject to the following:

a) allocations, if granted, will be granted in order of receipt of applications;

b) allocations shall be issued as a temporary allocation for 3 years;

c) after expiry of the 3 year temporary allocation, the allocation will be reissued as a permanent allocation only in respect of the portion of the allocation that has met principles 158-163 (Active and expeditious use of water).

Returned water

151. Where all or part of a water allocation from the confined aquifer is surrendered or otherwise forfeited to the Minister, that water will not be available for allocation, except where principle 150 applies (Allocations for the purpose of public water supply).

Hydrogeological effects and assessment

152. No allocation of water from the confined aquifer shall be made which appears, in the opinion of the Minister, to have potential to:

a) adversely affect the quality of water in the confined aquifer to a signficant extent, and in particular shall not cause or contribute to an increase in salinity;

b) cause or contribute to a long term decline in the potentiometric level of the confined aquifer by causing or being likely to cause a mean (arithmetic) decrease in the potentiometric level of the confined aquifer:

c) within the vicinity of the point of taking (including neighbouring properties and the nearest potentiometric level monitoring wells);

d) within the relevant confined aquifer management area;

e) of greater than 0.1 metres per year (measured over the preceding 5 years);

f) adversely affect to a significant extent, or have the potential to adversely affect to a significant extent, the structural integrity of the aquifer;

g) adversely affect to a significant extent any other water resource inside or outside the PWA;

h) cause a rise in the water level of the unconfined aquifer which results in waterlogging of the soil or localised underground water mounding; or

i) adversely affect to a significant extent ecosystems dependent on underground water.

153. In areas where the existing confined aquifer potentiometric level is greater than the unconfined aquifer potentiometric level, the taking of water from the confined aquifer shall not occur if it has, in the opinion of the Minister, the potential to cause the confined aquifer potentiometric level to permanently fall below the unconfined aquifer potentiometric level.

154. The taking of any water from the confined aquifer shall not, in the opinion of the Minister, have the potential to cause a seasonal drawdown at any point beyond the 2 km radius from the point(s) of taking of greater than 2 metres, unless:

a) the water is taken and used for the purpose of public water supply by SA Water Corporation, a statutory water supply authority or a local government authority; and

b) that Corporation or authority had supplied the public with water from the point(s) of taking on or before 29 June 2001.

Quantity of allocation

155. Where an allocation is granted for purposes other than irrigation, the allocation shall not exceed the amount reasonably required for the purpose proposed in accordance with current industry best practice standards, as determined by the Minister.

Efficient use of water

156. Water from the confined aquifer shall be used and applied using water efficient technologies and techniques appropriate for the particular purpose and circumstances for which the water is to be used in accordance with industry best practice standards, as determined by the Minister.

Restrictions on use

157. Water taken from the confined aquifer pursuant to this Plan shall not be used for the purpose of:

a) wild flooding;

b) aquaculture.

Active and expeditious use of water

158. Water (taking) allocations from the confined aquifer granted after 29 June 2001, excluding those obtained through transfers, must be developed in accordance with the associated Water Development Management Plan or Irrigation Development Management Plan.

159. Water (taking) allocations from the confined aquifer resulting from the conversion of a water (holding) allocation shall be developed within 3 years of the granting of the allocation.

160. Further to priniciples 158 and 159, any proportion of the allocation that is not developed in accordance with principle 159 within 3 years, shall be converted back to a water (holding) allocation.

161. For the purposes of principles 158-160, development of an allocation means the development of sufficient facilities, land or equipment to a capacity that enables the water (taking) allocation to be utilised at its maximum lawful annual rate.

162. Where the licensee can demonstrate to the Minister that extenuating circumstances apply, the maximum period for the application of principles 158-161 may be increased to 4 years.

163. Where:

a) an allocation is not the result of the conversion of a water (holding) allocation to a water (taking) allocation; and

b) active and expeditious use principles have not been fulfilled in accordance with principles 158-162;

the undeveloped portion shall be forfeited to the Minister as returned water and the returned volume shall be managed according to principle 151 (*Returned water*).

Endorsement of Certificates of Title on licences

164. An additional allotment may only be endorsed on a licence where the licensee can demonstrate to the Minister's satisfaction that the licensee is able to physically extract and use the allocation endorsed on the water licence on the relevant allotment and is not prevented from doing so by the presence of, for example, but not limited to, native vegetation, plantations, roadways or structures.

165. Where a licensee is not the registered proprietor of, or does not have legal access to, an allotment endorsed on a water licence prior to the date of adoption, the endorsement of that allotment on

the license will be removed unless by 5 pm on the nearest business day following 6 months from date of adoption of the Plan, the licensee provides to the Minister a statutory declaration made by the registered proprietor of the allotment confirming their consent to the endorsement.

166. On or after the date of adoption, a licence endorsed with a water (taking) allocation may not be varied to enable the water to be used on additional allotments, unless:

    a) the subject land is owned by the applicant; or

    b) the licensee has made an application to the Minister for such a variation, accompanied by a statutory declaration made by the registered proprietor of the land consenting to the variation.

167. For the purposes of principles 164-166, where the licensee is not the registered proprietor of the land, the relevant Certificate(s) of Title will only be endorsed for a maximum of 5 years unless otherwise specified in the statutory declaration.

Piping of water for a distance greater than 2.25 km

168. Where water from the confined aquifer is to be taken from one point to be used at another point at least 2.25 kilometres from the point of taking:

    a) the water must be transported by pipe or other enclosed vessel; and

    b) the taking of water shall comply with principles 152-154 (*Hydrogeological effects and assessment)*; and

    c) the use of water shall comply with principle 152 (a)(c)(d)(e) and (f).

Use of imported water

169. Confined aquifer water may only be brought into a management area from another management area or PWA:

    a) by means of a pipe or other enclosed vessel; and

    b) if at a rate greater than 1 ML/year, it's use must comply with section 10.6 of the Plan.

9. Transfer Criteria – Confined Aquifer

9.1 Objectives

The objectives of the confined aquifer transfer criteria are:

a. To cautiously manage the confined aquifer, an ancient resource with limited recharge.

b. To protect the environment generally, by ensuring that the taking and use of underground water from the confined aquifer does not cause significant degradation of any other resources, such as soils and other water resources.

c. To maintain and/or improve the availability of underground water for ecosystems dependent on underground water.

d. To provide flexibility and equity in access to the underground water resource of the confined aquifer.

e. To provide for the transfer of confined aquifer volumetric allocations.

9.2 Principles

Transfer of water allocations

170. All transfers of confined aquifer water (holding) allocations and confined aquifer water (taking) allocations are subject to the allocation principles set out in Section 8 of the Plan.

171. An allocation from the confined aquifer may be transferred to the unconfined aquifer subject to the principles set out in Section 6 of the Plan.

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

173. A licence endorsed with a water (taking) allocation or the whole or a part of a water (taking) allocation may only be transferred (whether permanently or temporarily) within the same management area.

174. Where a water allocation from the confined aquifer is transferred, no seasonal carry-overs will be transferred unless:

    a) the licence or allocation is transferred in its entirety; and

    b) the licence or allocation is to be taken and used on the same allotment(s) for the same purpose(s).

Purpose of use

175. A water (taking) allocation from the confined aquifer for purposes of public water supply or industry may only be transferred and used for the purposes of industry or public water supply.

Temporary transfers to manage seasonal variability

176. A licensee who holds a confined aquifer water (taking) allocation for irrigation purposes may apply in writing to the Minister for the transfer in of additional water for the purpose of managing seasonal variability, subject to the following:

    a) a licensee may only apply for such transfers in three of every five consecutive years;

    b) the application must be for a transfer in of a tradeable component unused in the current water use year within the same management area;

    c) the quantity of water transferred in cannot exceed 20% of the transferee's annual allocation (which for this purpose will be taken to be the sum of the tradeable component, and any

specialised production requirements with the exception of water for frost control on grapevines, but does not include delivery supplement, carry-overs or additional water transferred in temporarily);

d) the transfer shall expire at the end of the water use year in which the application was made;

e) the transfer is exempt from principles 152-154 (Hydrogeological effects and assessment).

Endorsement of Certificates of Title on licences

177. If a confined aquifer water (taking) allocation is transferred, any allotment(s) corresponding to the proposed point of application and/or proposed point of taking shall only be endorsed on a water licence, if the Minister is satisfied that the applicant is able to physically extract and use the allocation endorsed on the water licence on the allotment, and is not prevented from doing so by the presence of (for example, but not limited to) native vegetation, plantations, roadways or structures.

178. In the case of a temporary transfer, upon expiry of the agreed transfer period, both the allocation temporarily transferred and any Certificate(s) of Title endorsed as a consequence of the transfer, shall be removed from the transferee's licence.

Hydrogeological effects and assessment

179. A confined aquifer transfer application shall be deemed to have complied with the principles 152-154 (Hydrogeological effects and assessment) without further assessment if:

a) the application is to transfer a licence endorsed with water (taking) allocation or the whole or a part of a water (taking) allocation, where the transferred water is to be used on the same allotment(s) and:

i. the transferred water will continue to be taken from the same well; or

ii. the transferred water will be taken from a replacement well within 100 metres of the original well;`

b) the application is to renew a temporary transfer (of the same quantity), where:

i. the transferred water is to be taken from the same well (or a well that replaces the original well but lies within 100m of the original well);

ii. the transferred water is to be used on the same allotment(s); and

iii. the application to renew is received prior to the date and time of expiry of the original temporary transfer.

180. Notwithstanding principle 179, the renewal of a temporary transfer of an allocation which has been in place for 5 years or greater, is subject to principles 152-154 (Hydrogeological effects and assessment).

Applications to transfer water (taking) allocations – piping of water more than 2.25 km

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

182. Where a transfer application requires water to be taken from one point and transported to be used at another point at least 2.25 kilometres from the point of taking:

a) the taking of water shall comply with principles 152-154 (*Hydrogeological effects and assessment)*;

b) the use of the water shall comply with principle 131(a)(c)(d)(e) and (f); and

c) if the transported water crosses a management area boundary of a PWA boundary, the transfer must comply with Section 10.6 (*Importation of Water)*.

183. Notwithstanding principle 182, where the proposed point of taking and point of use are the same as those utilised prior to transfer, the proposed transfer of water shall be deemed to have complied with principles 152-154 (Hydrogeological effects and assessment) at both the extraction and discharge sites without further assessment.

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

184. Where a licence granted by the Minister includes a condition(s) requiring the expeditious use of water (including a requirement that equipment by which, or land on which, the water is used must be developed within a certain time period), the following applies:

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

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

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

10. Permits

An activity of the kind listed in this section can only be undertaken if authorised by a water licence or permit granted by the relevant authority.

Permits will only be granted if the activity complies with the relevant objectives and principles of this section.

In some cases a permit may not be required because:

- section 129 of the Act removes the requirement; or
- the activity is the construction of drainage works licensed under the *South Eastern Water Conservation and Drainage Act 1992* or the *Upper South East Dryland Salinity and Flood Management Act 2002*.

Relevant authority

The **relevant authority** in relation to a permit means the authority that is for the time being the relevant authority under section 126 of the Act for the purpose of granting or refusing the application for a permit of that kind.

10.1 Permit Objectives

The following objectives apply to all water affecting activities within the boundaries of the Tatiara PWA. They apply in addition to the objectives set out in the relevant NRM plan.

a. To protect the quantity and quality of the water resources.

b. To maintain natural hydrological systems and environmental flows.

c. To prevent deterioration in the quality of surface water, underground water or water in watercourses or lakes.

d. To protect the ecological functions of water resources and dependent biological diversity;

e. To ensure that any water discharged to the environment is of suitable quality to:

f. i) sustain the existing uses of the water, and

g. ii) protect ecosystems dependent on these resources.

10.2 Well siting, construction, and maintenance

A permit is required for the drilling, plugging, backfilling or sealing of a well and for the repairing, replacing or altering of the casing, lining or screen of a well, pursuant to section 127(3)(a) and (b) of the Act, respectively.

The objectives and principles that follow apply specifically to an activity under section 127(3)(a) and (b) of the Act. They are additional to those expressed for all water affecting activities, and are intended to apply to wells of a depth equal or greater than 2.5 metres.

10.2.1 Objectives

a. To ensure the drilling, plugging, backfilling or sealing of a well occurs in a manner that will protect the quality of the surface water and underground water resources and water dependent ecosystems.

b. To minimise the impact of repair, replacement or alteration of the casing, lining or screen of wells on the surface water and underground water resources and water dependent ecosystems.

c. To protect the surface water and underground water resources and water dependent ecosystems from pollution, deterioration and undue depletion.

d. To ensure the integrity of the headworks of wells is maintained.

e. To ensure that wells are constructed in the correct aquifer system.

10.2.2 Principles

185. The relevant authority shall not grant a permit for the construction of a new or replacement well that may create or may contribute to a significant adverse effect on ecosystems that depend on underground water.

186. For the purposes of principle 185 in assessing the likelihood of significant adverse effects, consideration shall be given to:

a) if at the date of application, the wetland is listed on the Department of Environment and Heritage's South Australian Wetland Inventory Database (SAWID) for the South East of South Australia, as a wetland of high or very high conservation value – whether any part of the wetland as mapped in the SAWID falls within a 16 km^2 circle centred on the proposed point of taking of the allocation; and

b) whether the wetland identified in principle 186(a) is considered by the Minister to both:

   i. demonstrate a level of dependence on underground water; and

   ii. be under significant or actual threat of degradation (identified by, but not limited to, a mean (arithmetic) decrease in underground water levels of greater than 0.05 m/year (measured over the preceding 5 years) in a representative observation well within the 16 km^2 circle specified in principle 186(a) above or, in the absence of any representative wells within that radius, in the nearest representative observation well or wells as determined by the Minister); and

c) the current demand for underground water (determined by the level of allocation within the management area);

d) the volume of water proposed to be taken; and

e) any other relevant matter.

187. For any underground water dependent ecosystem identified for protection under principle 186 above, the set-back distance for any new wells shall be calculated using the DE equation described in Section 2 (Assessment of the needs of dependent ecosystems).

188. Notwithstanding principles 185-186, a permit for the construction of a replacement well shall be granted if the location of the replacement well is no closer to the wetland than the original well.

189. The equipment, materials and method used in the drilling, plugging, backfilling or sealing of a well, or the replacement or alteration of the casing, lining or screen of a well, shall not have the potential to adversely impact on the quality of the surface water and underground water resources and water dependent ecosystems.

190. 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 impact aquifers, surface water flows and water dependent ecosystems.

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

192. The head-works of a well from which water is authorised to be taken shall be constructed so that the extraction of water from the well can be metered without interference.

193. The head-works of a well for the drainage or discharge of water (artificial recharge) for the purpose of taking and use according to Section 6 of this Plan shall be constructed so that the draining or discharge operations and extraction can be metered without interference.

10.3 Underground water access trenches (wedgeholes)

The principles under 10.3 have no force or effect unless a regulation provides that wells of this class require a permit.

194. Any underground water access trench exceeding a depth of 2.5 m shall be governed by the principles under 10.2.

195. The maximum surface area of an underground water access trench shall not exceed the area recommended by the relevant authority, for the area where the underground water access trench is to be constructed.

196. An underground water access trench must be, and must remain:

    a) fenced sufficiently to prevent stock access;

    b) bunded or surrounded by an earthen levee at least 500mm high.

    c) All new underground water access trenches shall be maintained so as to prevent contamination of the water resources.

197. Completion of an underground water access trench must be reported within 90 days to the relevant authority, for inspection to ensure compliance with principles 194-196.

10.4 Draining or discharging of water into a well

The following objectives and principles apply to permits required for the draining or discharging of water directly or indirectly into a well ("artificial recharge") (section127(3)(c) of the Act). These objectives are additional to those expressed for all water affecting activities.

10.4.1 Objectives

a. To protect the underground water resource from waste or pollutants (as defined in the *Environment Protection (Water Quality) Policy 2003* under the *Environment Protection Act 1993*) or its replacement document to the receiving underground water resource during the draining or discharging of water into a well.

b. To provide for the draining or discharging (artificial recharge) of water directly or indirectly into a well in a manner that does not have the potential to adversely affect:

    i. the quality of surface water and underground water resources;

    ii. the integrity of the relevant aquifer (including, but not limited to, the ability of the aquifer to transmit water);

    iii. water tables (particularly where the adverse effect might include water logging, land salinisation or damage to infrastructure (roads, buildings, foundations etc.);

    iv. any water-dependent ecosystem or ecologically sensitive area that depends on the underground water resource;

    v. the ability of other persons to lawfully take from that underground water;

    vi. the longevity of the drainage or discharge operations; and

    vii. the sustainable operation and management of aquifer storage and recovery schemes.

10.4.2 Principles

198. In addition to any permit required to drain or discharge water directly or indirectly into a well, additional authorisations may be required under the *Environment Protection Act 1993.*

199. Water drained or discharged into a well must comply with the *Environment Protection Act 1993* and any associated policy.

200. The salinity of drained or discharged water must not exceed:

a) 1500 mg/L TDS; or

b) where the ambient background underground water salinity levels are less than 1500 mg/L TDS - the ambient background underground water salinity level.

201. A permit to drain or discharge water into a well will not be issued unless a risk assessment is undertaken to the satisfaction of the Minister.

202. The 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 must include:

a) an investigation into the suitability of the draining or discharging site, including but not limited to tests for transmissivity, effective porosity and storage coefficient, 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 are in place to protect the integrity of the aquifer on an ongoing basis;

c) a water quality assessment which identifies hazards in the water being drained or discharged; and

d) a report on the consequences and impacts to the ambient underground water resource where the water quality characteristics (salinity and chemistry composition) of the water to be discharged differ from that of the native underground water.

203. Water drained or discharged into a well by means of gravity is exempt from principle 202(a).

204. Roof runoff (surface water) drained or discharged into a well via a closed system of capture and transport is exempt from principles 202 (a), (c) and (d), provided that the system is equipped with a mechanism to divert first flush water.

205. Paddock runoff (surface water) that would have contributed to the natural vertical recharge of the unconfined or confined aquifer systems within the management area, and that is drained or discharged into a well, is exempt from principles 202 (a), (c) and (d) provided reasonable and practicable measures have been applied to protect water quality.

206. Further to principle 202(b), the granting of a permit for draining and discharge requires the submission to the relevant authority of an annual report that addresses the impacts to the ambient underground water at the draining and discharge site.

207. Roof runoff captured in a closed system and then drained or discharged into a well is exempt from principle 206.

208. For the purposes of principles 201 and 202, the relevant concentrations, levels or amounts shall be measured in sufficient representative samples of:

a. the water to be drained or discharged; and

b. ambient underground water collected from the proposed point of injection, or as near as possible to the proposed point of injection.

209. For the purposes of principle 208, “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.

210. For the purposes of principles 206 and 208, the term “ambient underground water” means the underground water (as that term is defined in the Act) that exists in the relevant aquifer absent of any such water drained or discharged to that aquifer by artificial means.

211. 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.

212. 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.

213. The headworks for the draining and discharge of water shall be constructed so that water cannot leak if the well becomes clogged.

214. For the purposes of principles 212 and 213, the term “headworks” means any assembly on top of a well located between the well casing and the water delivery system.

215. Wells constructed for the draining or discharge of water at pressures greater than gravity, must (in addition to all other requirements for well construction) be pressure cemented along the full length of the casing.

10.5 Managed Aquifer Recharge: aquifer storage and recovery

216. Managed aquifer recharge, including activities comprising aquifer storage and recovery developments,are subject to principles 198-215 (*Draining and discharging into a well*).

217. Any water licence granted for the recovery component of an aquifer storage and recovery development, must be consistent with principles 100-104 (*Basis of allocation of water drained or discharged into a well*).

218. The recovery of discharged water from a well other than the discharge well must be consistent with principle 126 (*Applications to transfer water allocated on the basis of water drained or discharged*).

219. Any aquifer storage and recovery development must (subject to any authorisation to the contrary) be operated in a manner consistent with the *Environment Protection (Water Quality) Policy 2003* under the *Environment Protection Act 1993* or its replacement document.

10.6 Importation of Water

The following objectives and principles apply to permits required for using water in the course of carrying on a business (other than public water supply) at a rate that exceeds 1 ML/year where the water has been brought into the NRM region by any means (“use of imported water”), or from a water resource in some other part of the NRM region (prescribed by regulation pursuant to sections 127(5)(i) and 127(5)(k) of the Act).

The principles in this section are additional to those expressed for all water affecting activities.

10.6.1 Objective

a. To ensure that the application of imported water does not adversely impact on the quality and quantity of water resources in the PWA or surface water resources, or downstream areas, water dependent ecosystems or the productive capacity of the land.

10.6.2 Principles

220. Use of imported water:

a) shall not cause a rise in the underground water level sufficient to detrimentally affect ecosystems or structures (including, but not limited to, any building, fence or wall);

b) shall not have the potential to adversely affect the quality of the prescribed underground water resource;

c) shall not adversely affect the productive capacity of the land by causing salinity, water-logging, perched water-tables or other impacts.

221. For the purposes of principle 220, the total dissolved solids (TDS) in the imported water must not exceed:

a) 1500 mg/L TDS; or

b) where the ambient background underground water salinity levels are less than 1500 mg/L TDS - the ambient background underground water salinity level.

11. Monitoring, Evaluation and Reporting

Section 76(4)(d) of the Act requires the Plan to assess the capacity of the resource to meet the demands for water on a continuing basis and provide for regular monitoring of the capacity of the resource to meet those demands.

Monitoring, evaluation and reporting is part of the systematic process of optimising performance, through measurements against an agreed reference point. For this Plan, the reference points relate to effectiveness of policies, and the health of the underground water resource.

There is therefore a need to monitor and evaluate the effectiveness of the Plan's policies and the health and sustainability of the underground water resource.

A comprehensive monitoring program that considers the ecological and hydrogeological performance of the PWA is recommended to compare desired management objectives with actual performance, and to evaluate the effectiveness and efficiency of water provisions.

A detailed program to monitor the parameters listed below will be formulated and implemented through an investigations program detailed in the NRM Plan for the South East Natural Resources Management Region.

11.1 Objectives

The monitoring strategy set out in this Plan aims to ensure:

a. that sufficient data is available to assess the capacity and health of the underground water resource and dependent ecosystems;

b. the timely evaluation and reporting of monitoring data;

c. the sustainable use of underground water resources; and

d. the adequate protection of underground water dependent ecosystems.

11.2 Monitoring the capacity of the underground water resource

DWLBC and its predecessors have undertaken regular water-level and confined aquifer pressure monitoring in the Tatiara PWA since 1975 when a water level monitoring network was established. Salinity monitoring began slightly later in 1978 (information obtained from this monitoring can be accessed from http://info.pir.sa.gov.au/obswell/new/obsWell/MainMenu/menu).

11.2.1 Unconfined Aquifer

A water level monitoring network in the Tatiara PWA has been in operation for the unconfined aquifer for over 30 years, and is monitored by DWLBC. Over this period, the network has been constantly upgraded and enlarged to provide adequate monitoring of the underground water resource to meet agricultural expansion in the PWA.

In addition, there are two monitoring networks for underground water salinity operating in the Tatiara PWA: the Tatiara Monitoring Network and the Tatiara Irrigation Network.

The principal underground water salinity network is the Tatiara Monitoring Network, which is sampled by DWLBC on a regular basis, while the Tatiara Irrigation Network is sampled by irrigators themselves or by DWLBC, on an irregular basis during the irrigation season. This second network augments the main network, while ensuring public involvement and increasing the data points, especially in the main irrigation area.

Data collected will be used to:

- determine trends in the conditions of the unconfined aquifer;
- determine whether any resource condition triggers established for this Plan have been exceeded; and
- inform the implementation of the policy set out in this Plan.

The number of monitoring wells and the frequency of water level monitoring is described in Table 11.1.

Table 11.1 Summary of existing unconfined aquifer underground water monitoring wells network and monitoring requirements at a regional level

Unconfined Aquifer				
Property measured	**Number of Observation Wells in the Tatiara PWA**	**Frequency**	**Comment**	**Responsible**
Underground water levels in the unconfined aquifer	54	Quarterly		Minister through DWLBC
	41	6 monthly		Minister through DWLBC
Total number of wells for monitoring depth to water table	95			
Underground water salinity in the unconfined aquifer	11	Quarterly	Tatiara Monitoring Network	Minister through DWLBC
	32	6 Monthly	Tatiara Monitoring Network	Minister through DWLBC
	101	Irregular	Tatiara Irrigation Network	Minister through DWLBC and licensees
Total number of wells for monitoring underground water salinity	144			

11.2.2 Confined Aquifer

In addition to the monitoring network set out for the unconfined aquifer, there are a number of monitoring wells for water level and salinity in the confined aquifer in the Tatiara PWA (Table 11.2). These wells are monitored by DWLBC on a regular basis.

Table 11.2 Summary of existing confined aquifer underground water monitoring wells network and monitoring requirements at a regional level

Property measured	**Number of Observation Wells in the Tatiara PWA**	**Frequency**	**Responsible**
Underground water levels in the confined aquifer	5	6 monthly	Minister through DWLBC
Underground water salinity in the confined aquifer	4	6 monthly	Minister through DWLBC

11.3 Monitoring the taking and use of underground water at property level

11.3.1 Annual Water Use Report

222. An Annual Water Use Report must be prepared by each licensee and submitted to the DWLBC, Mount Gambier office, by 5 pm on 31 July each year.

223. Each licensee must provide the following information in the Annual Water Use Report:

a) the volume of water allocated on the licence;

b) the volume of water actually used by the licensee and recorded on each meter during the water use year (ie opening and closing meter readings);

c) the period of water use (ie start date and end date of irrigation for the season);

d) the purpose for which water has been taken;

e) the salinity reading, date and well number of any underground water salinity measurements taken during the water use year;

f) the total amount of imported water recharged for each meter for the purpose of managed aquifer recharge in the water use year (where applicable); and

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

i. the irrigation method;

ii. a sketch plan showing the location of each area irrigated, a description of the equipment type used, and the area and location of each irrigation method or equipment type;

iii. the area of each crop irrigated;

iv. the number of irrigations; and

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

11.3.2 Evaluation of the demands on the resource and the capacity of the resource to meet demands

224. Once each year DWLBC will prepare a summary of the patterns in use of underground water.

225. By the end of the third operational year of the Plan, the Board will commence a review of the Plan and the condition of the underground water resource in the Tatiara PWA including:

a) trends in underground water level salinity;

b) trends in underground water table levels; and

c) levels of underground water extraction;

The data collected will be used to determine whether any changes are required to the allocations of underground water extraction.

11.4 Monitoring the Water Needs of Ecosystems Dependent on Underground Water

All monitoring programs for the water needs of ecosystems dependent on underground water for the Tatiara PWA will be consistent with the National Natural Resource Management Monitoring and Evaluation Framework, Resource Condition Indicators (Inland Aquatic Ecosystem Integrity).

11.4.1 Current Management and Monitoring

There are a large number of wetlands in the South East of South Australia. A number of these are managed by DEH through site specific management plans. Specific management plans have also been developed for high value features such as Bool Lagoon. One common example of a management action is the implementation of ongoing monitoring programs to establish resource condition and trends. Management actions also often relate to the integration of Government and Non-Government Organisations or community groups.

Most of the current water dependent ecosystem monitoring programs are focused on baseline monitoring for ecological values. Water quantity and quality are often measured in conjunction with the monitoring programs with the primary aim of assessing upper and lower limits required to maintain ecological function.

DEH manages and maintains a significant number of spatial Geographical Information System (GIS) data sets relevant to wetlands and national parks. Historical aerial photography and satellite imagery of varying resolutions are also available. DEH has established 16 separate programs across the NRM region for the monitoring of specific species including bats, swamp antechinus, southern bandicoots, frogs, and threatened orchids. A community-based water watch program is coordinated by DEH and the Board and supported by funding applications from the Board.

DWLBC is also involved in the collection of baseline and ongoing wetland monitoring data as part of the Upper South East Dryland Salinity and Flood Management Program.

For the purpose of a monitoring program, underground water dependent ecosystems identified as priority, or high or very high ecological value systems found within the PWA should be included in the monitoring to assess the success with which the environmental protection policy (principles 3 and 4 of this Plan) protects these underground water dependent ecosystems, both at each site and more generally at a regional scale. The following parameters should be measured, recorded, evaluated and made publicly available/reported on, ideally on an annual basis:

a) seasonal underground water level fluctuations;

b) volume of underground water extracted;

c) seasonal underground water salinity fluctuations;

d) water-dependent species composition and abundance (flora and fauna);

e) water-dependent species recruitment (both flora and fauna);

f) specific terrestrial and aquatic vegetation health; and

g) ecosystem water use.

In the absence of information on the quality and quantity of underground water required by each ecosystem, the Plan establishes a limit to trends in underground water salinity and depth to water, and provides for reductions to allocations in management areas where the resource conditions exceed these limits. This approach essentially maintains access to underground water at current levels.

In addition, the Plan provides for the underground water requirements of water–dependent ecosystems identified as high or very high priority in the Tatiara PWA (see Table 2.1) through the management of the taking of underground water around these ecosystems where certain conditions are met. Essentially, applications to extract underground water in the vicinity of an ecosystem are subject to an assessment to establish a minimum setback distance for the point of extraction that ensures no changes to underground water levels in the vicinity of the ecosystem if water tables have recently dropped in the vicinity of the ecosystem.

11.4.2 Identification of knowledge gaps and further research required

Current knowledge gaps with respect to the needs of water dependent ecosystems include:

1. Intrinsic knowledge of underground water dependent ecosystems' underground water/surface water interaction and dependency including:
   a) water level and quality thresholds; and
   b) long term implications of climate change.

2. A regional integrated approach for the collection and interpretation of monitoring data; including:
   a) defining roles and responsibilities; and
   b) establishing reporting mechanisms.

3. Definition of the threatening processes, the risks they pose and the consequences of not addressing them, including:
   a) development of shallow and deep drains; and
   b) land use change (including cross-border issues).

4. Intrinsic knowledge of cause-and-effect relationships, and the development of effective management tools to address the following issues:
   a) declining underground water discharge due to interception of recharge in inland areas by high water use crops and industrial plantation forestry;
   b) declining underground water discharge due to lowering of the water table as a result of climatic trends;
   c) increasing salinity due to landward migration of the boundary between fresh underground water (associated with declining water table elevations in the unconfined regional aquifer); and
   d) contamination of the aquifer, particularly with nitrates.

5. The development of environmental response functions (ERFs) for individual ecosystems dependent on underground water is required to better inform the determination of environmental protection policy. ERFs describe the relationship between ecosystem function and water regimes in which the ecosystems exist (eg. depth to water table fluctuations, soil water content, soil water and underground water salinity). The types of investigations undertaken should be consistent with those conducted during 2006 (Ecological Associates, 2006). In addition to the parameters listed above, at the more local (underground water dependent ecosystems of high ecological importance) scale, monitoring programs should focus on the following:

   a) intra-annual underground water level and salinity trends (say at two monthly intervals), to assist in assessing whether the unconfined aquifer is responding to management (this will require appropriately constructed monitoring wells within the protected UDE to provide representative data);

   b) proximity of the pumping wells or to underground water dependent ecosystems, to assist in assessing whether the set back distances are adequate; and

   c) the amount of existing underground water pumping occurring.

11.4.3 Evaluation

The evaluation of monitoring data will need to focus on assessing the effectiveness of the policies of this Plan in maintaining the ecological function of ecosystems dependent on underground water as entered on the South Australian Wetlands Inventory Database for the South East region.

Evaluation of monitoring data should be undertaken in a manner that considers underground water and ecosystem condition trends, primarily in relation to the proximity of water affecting activities in the vicinity

of underground water dependent ecosystems, but also recognising that other factors such as climate variability and land management may be contributing to observed ecosystem condition.

In the case of all high ecological value underground water dependent ecosystems identified for protection through the Plan, evaluation and reporting of monitoring data should be undertaken annually. The Board in association with State Government agencies will need to determine who is best placed to undertake the evaluation of monitoring data.

References

Ecological Associates. 2006. *Environmental water requirements of underground water dependent ecosystems in the South East PWA - field studies to support new and amended policy*. Prepared for REM.

REM. 2005. *A review of the environmental water requirements of the underground water dependent ecosystems of the South East Prescribed Wells Areas Stage 1 report*. Prepared for the South East Catchment Water Management Board by Resource & Environmental Management Pty Ltd, and Ecological Associates Pty Ltd.

REM 2005b, *Integrated Monitoring Review of the South East of South Australia – Phase 1- Final Report. Prepared for the South East Catchment Water Management Board.* This report is the prelude to the Final report and provides information on the stakeholders, their statutory commitments and monitoring requirements.

REM. 2006. *A review of the environmental water requirements of the underground water dependent ecosystems of the South East Prescribed Wells Areas Stage 2 report.* Prepared for the South East Catchment Water Management Board by Resource & Environmental Management Pty Ltd, and Ecological Associates Pty Ltd.

REM. 2006b. Integrated *water monitoring review of the South East of South Australia – Phase 2.* Final report prepared for the South East Natural Resources Management Board by Resource & Environmental Management Pty Ltd.

12. Consistency with other Plans and Legislation

In preparing this water allocation plan, the Board has had regard to the issues set out in section 7 of the *Natural Resources Management Act 2004, the Groundwater (Border Agreement) Act 1985,* the *South Eastern Water Conservation and Drainage Act 1992*, the *Upper South East Dryland Salinity and Flood Management Act 2002* and the *Native Vegetation Act 1991.*

The Plan shows consistency with the following plans and policies:

a. Relevant management plans under the *Coast Protection Act 1972*;

b. Relevant Development Plans under the *Development Act 1993*;

c. The *Environment Protection Act 1993* and any associated policies;

d. Relevant management plans under the *National Parks and Wildlife Act 1972*;

e. The Initial South East Natural Resources Management Plan 2006;

f. The State Natural Resources Management Plan 2006;

g. An Intergovernmental Agreement on a National Water Initiative 2004;

h. South Australia's Strategic Plan 2007.

Appendix of Figures and Tables

Table 1 - Volumetric conversion of hectare irrigation equivalents (halE)

Column A	Column B	Column C	Column D
VOLUMETRIC CONVERSION ZONE*	**Tradeable component (spray, flood) (ML/halE)****	**Tradeable component (drip) (ML/halE)**	**Delivery supplement (flood) (ML/halE)*****
CANNAWIGARA	9.04	8.50	2.76
NORTH PENDLETON	9.04	8.50	2.76
SHAUGH	9.65	9.10	2.94
STIRLING	9.04	8.50	10.26
TATIARA	8.57	8.10	6.10
WILLALOOKA (east)	8.57	8.10	6.10
WILLALOOKA (west)	8.57	8.10	13.14
WIRREGA (south)	8.57	8.10	6.10
WIRREGA (north)	9.04	8.50	6.43
ZONE 8A	9.04	8.40	2.76

*As shown in Figure 12 (Appendix of Figures and Tables).
**Tradeable component calculated as (hectare irrigation equivalents x net irrigation requirement) + 18% (Column B) or (hectare irrigation equivalents x net irrigation requirement) + 11% (Column C)
***Calculated as [(hectare irrigation equivalents x net irrigation requirement) + volume required to deliver net irrigation requirement] - tradeable component

Table 2 - Crop adjustment factor (ML per ha of crop) for the volumetric conversion of hectare irrigation equivalents

*As shown in Figure 12 (Appendix of Figures and Tables).

VOLUMETRIC CONVERSION ZONE*	BEANS BROAD/FABA		CHINESE CABBAGE SEED	CLOVER SEED PERRENNIAL	CORIANDER	FRUIT TREES		LUPINS	MAIZE	MUSTARD	NATIVE FLOWERS	NATIVE FOLIAGE	ONION	PEAS FIELD	POTATOES
CANNAWIGARA	0.47		1.06	0.73	2.16	2.00		0.47	3.20	0.96	2.22	0.63	2.64	0.15	1.22
NORTH PENDLETON	0.47		1.06	0.73	2.16	2.00		0.47	3.20	0.96	2.22	0.63	2.64	0.15	1.22
SHAUGH	0.59		1.23	0.85	2.44	2.06		0.60	3.25	1.12	2.39	0.71	2.70	0.26	1.27
STIRLING	0.47		1.06	0.73	2.16	2.00		0.47	3.20	0.96	2.22	0.63	2.64	0.15	1.22
TATIARA	0.42		1.01	0.64	2.04	2.00		0.43	3.23	0.92	2.16	0.58	2.67	0.14	1.31
WILLALOOKA (east)	0.42		1.01	0.64	2.04	2.00		0.43	3.23	0.92	2.16	0.58	2.67	0.14	1.31
WILLALOOKA (west)	0.42		1.01	0.64	2.04	2.00		0.43	3.23	0.92	2.16	0.58	2.67	0.14	1.31
WIRREGA (south)	0.42		1.01	0.64	2.04	2.00		0.43	3.23	0.92	2.16	0.58	2.67	0.14	1.31
WIRREGA (north)	0.47		1.06	0.73	2.16	2.00		0.47	3.20	0.96	2.22	0.63	2.64	0.15	1.22
ZONE 8A	0.47		1.06	0.73	2.16	2.00		0.47	3.20	0.96	2.22	0.63	2.64	0.15	1.22

Table 3 - Specialised Production Requirements (ML per ha of crop/infrastructure) for the volumetric conversion of hectare irrigation equivalents

VOLUMETRIC CONVERSION ZONE*	Vines - Frost Protection	Fruit Trees	Potatoes	Olives	Onions	Sub Clover Seed	Maximum Production Pasture		
							SPRAY	FLOOD	DRIP
CANNAWIGARA	1.55	0.38	1.70	0.28	1.47	0.38	0.72	0.94	0.68
NORTH PENDLETON	1.55	0.38	1.70	0.28	1.47	0.38	0.72	0.94	0.68
SHAUGH	1.55	0.38	1.70	0.28	1.47	0.38	0.60	0.79	0.57
STIRLING	1.55	0.38	1.70	0.28	1.47	0.38	0.72	1.54	0.68
TATIARA	1.55	0.38	1.70	0.28	1.47	0.38	0.87	1.49	0.82
WILLALOOKA (east)	1.55	0.38	1.70	0.28	1.47	0.38	0.87	1.49	0.82
WILLALOOKA (west)	1.55	0.38	1.70	0.28	1.47	0.38	0.87	2.21	0.82
WIRREGA (south)	1.55	0.38	1.70	0.28	1.47	0.38	0.87	1.49	0.82
WIRREGA (north)	1.55	0.38	1.70	0.28	1.47	0.38	0.72	1.23	0.68
ZONE 8A	1.55	0.38	1.70	0.28	1.47	0.38	0.72	0.94	0.68

*As shown in Figure 12 (Appendix of Figures and Tables). .

Table 4 – Unconfined aquifer annual average vertical recharge, TML (a)-(d) and limits to licensed allocation in the Designated Area for the Tatiara PWA

COLUMN A	COLUMN B	COLUMN C	COLUMN D	COLUMN E	COLUMN F	COLUMN G
Management Area	**Annual Average Vertical Recharge (mm/year)**	**TML(a)[1] (ML/year)**	**TML(b)[2] (ML/year)**	**TML(c)[3](ML/year)**	**TML(d)[4](ML/year)**	**TML(e)[5] (ML/year) in the Designated Area**
Cannawigara	15	-	4,154	-	4,439	-
North Pendleton	30	-	8,008	-	8,579	-
Shaugh	15	-	-	-	-	7,930
Stirling	50	17,027	-	19,308	-	-
Tatiara	15	-	-	-	-	8,036
Willalooka	40	13,072	-	13,431	-	-
Wirrega	30	24,442	-	27,759	-	-
Zone 8A	15	-	-	-	-	7,267

[1] TML(a) the level of allocation (excluding delivery supplements) plus stock and domestic requirements which is equivalent to TAR (total available recharge) (see Table 4.4 Section 4 for TAR values)

[2] TML(b) calculated as the level of allocation (excluding delivery supplements) plus stock and domestic requirements following 50% of the reduction required to reach TML(a) calculated as 50% of the reduction required to reach TML(a)

[3] TML(c) calculated as the level of allocation (excluding delivery supplements) plus stock and domestic requirements following 80% of the reduction required to reach TML(a)

[4] TML(d) calculated as the level of allocation (excluding delivery supplements) plus stock and domestic requirements following 80% of the reduction required to reach TML(b)

[5] The TML in the Shaugh management area is a level that is considered to be appropriate having regard to the TAR and to the nature of the resource in the Shaugh management area plus stock and domestic water requirements. The TML in the Tatiara management area is set at the average between the indicative level of allocation (with the exception of water assumed to return to the resource) following volumetric conversion and TAR (total available recharge). The TML in the Zone 8A management area is the indicative level of allocation immediately following volumetric conversion of allocations plus stock and domestic requirements, which is considered to be within sustainable limits.

Figure 1 – Prescribed Water Resources Areas within the South East Natural Resources Management Region

Figure 2 – East-west geological cross section through the Tatiara Prescribed Wells Area

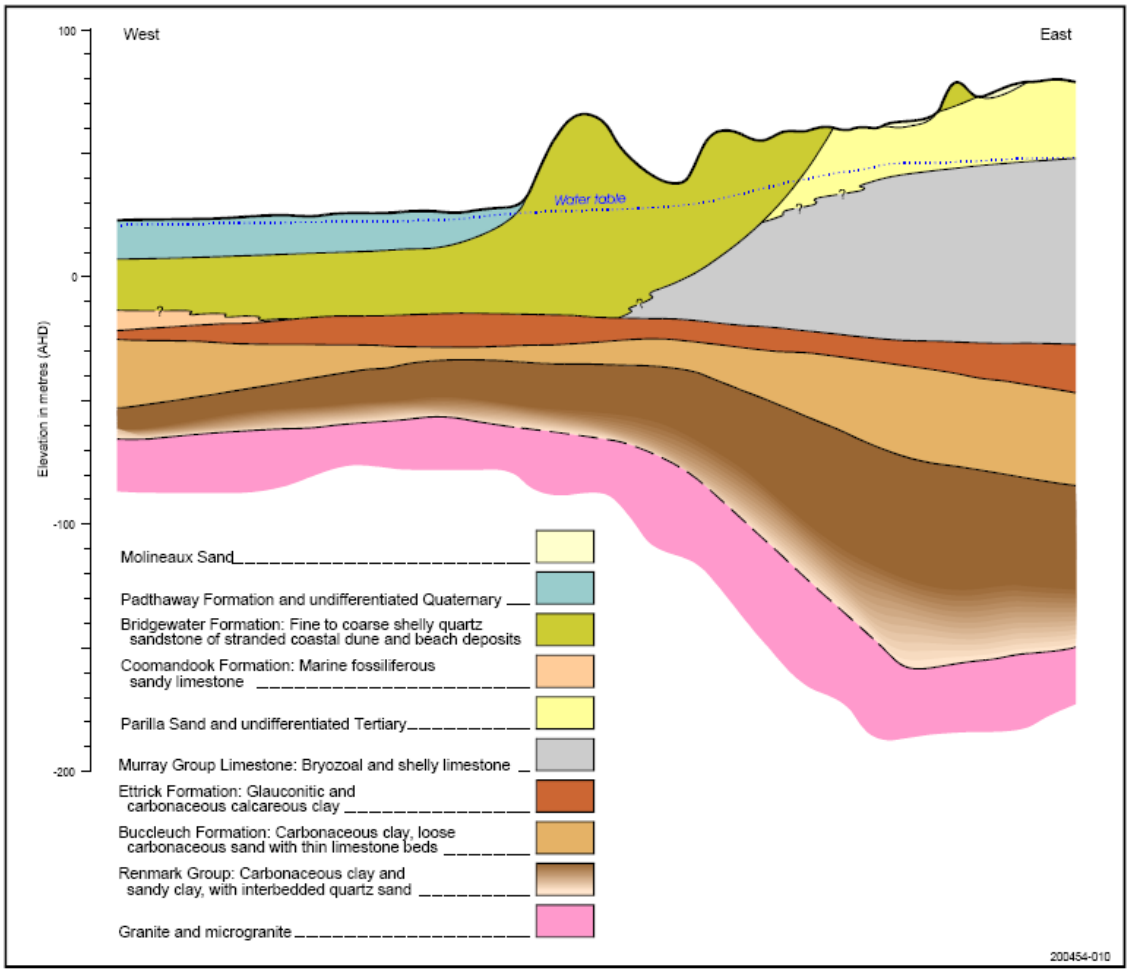

Figure 3. Unconfined aquifer management areas and Designated Area zones in the Tatiara Prescribed Wells Area

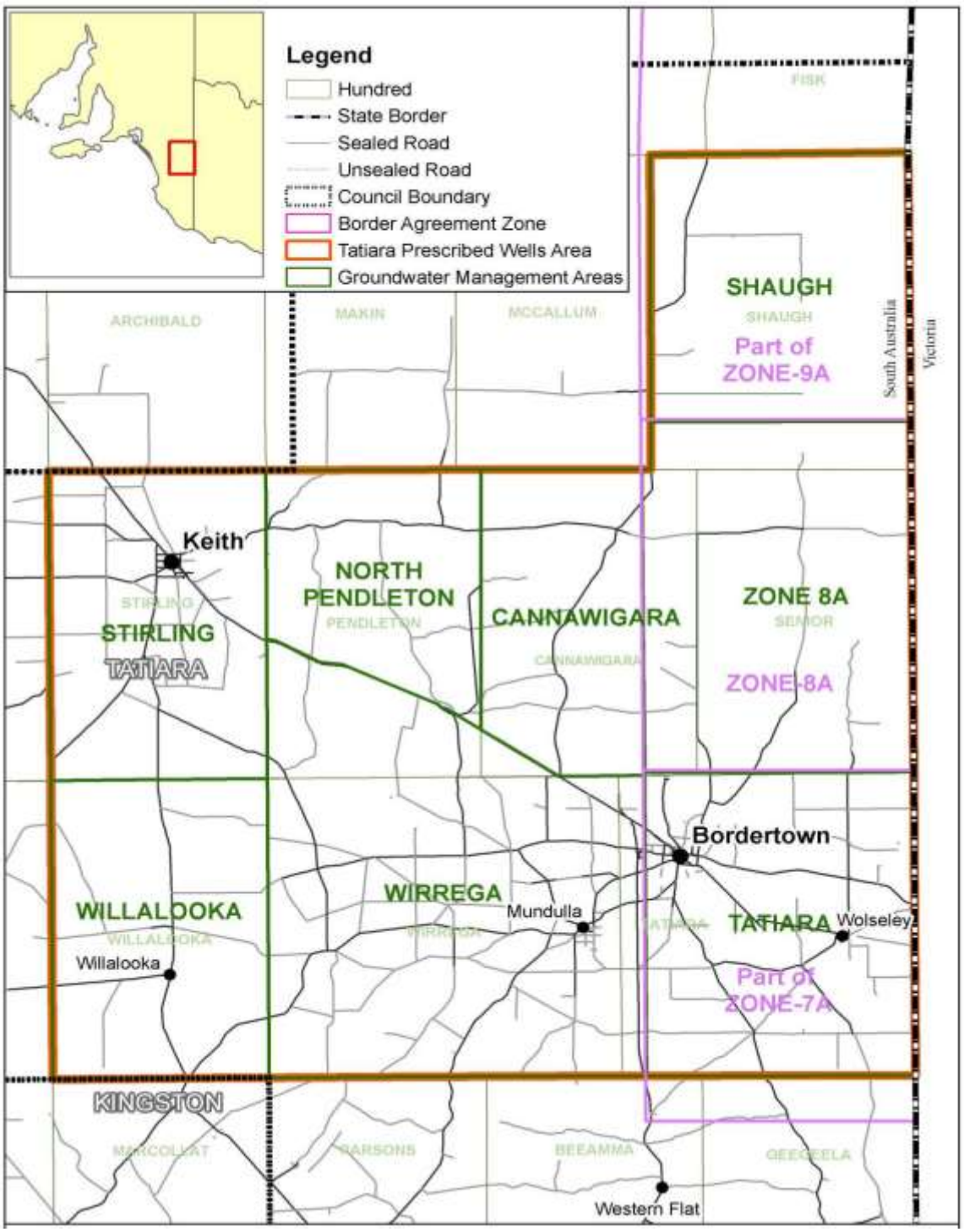

Figure 4. Management areas for the confined aquifer in South East Natural Resources Management Region

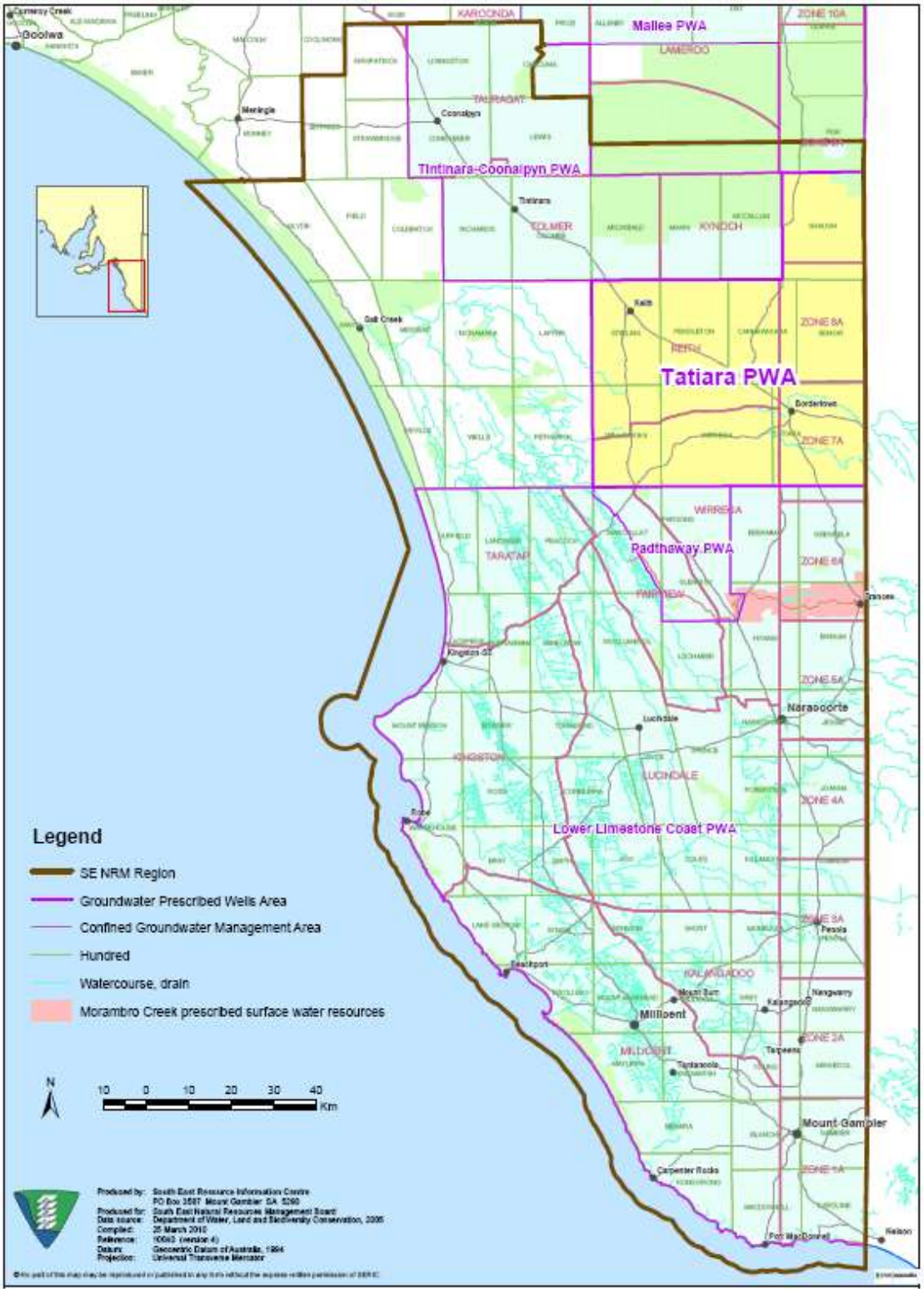

Figure 5. Area of irrigated crops (hectares) in the Tatiara PWA for the 2008/09 water use year (adapted from: Hodge, 2009)

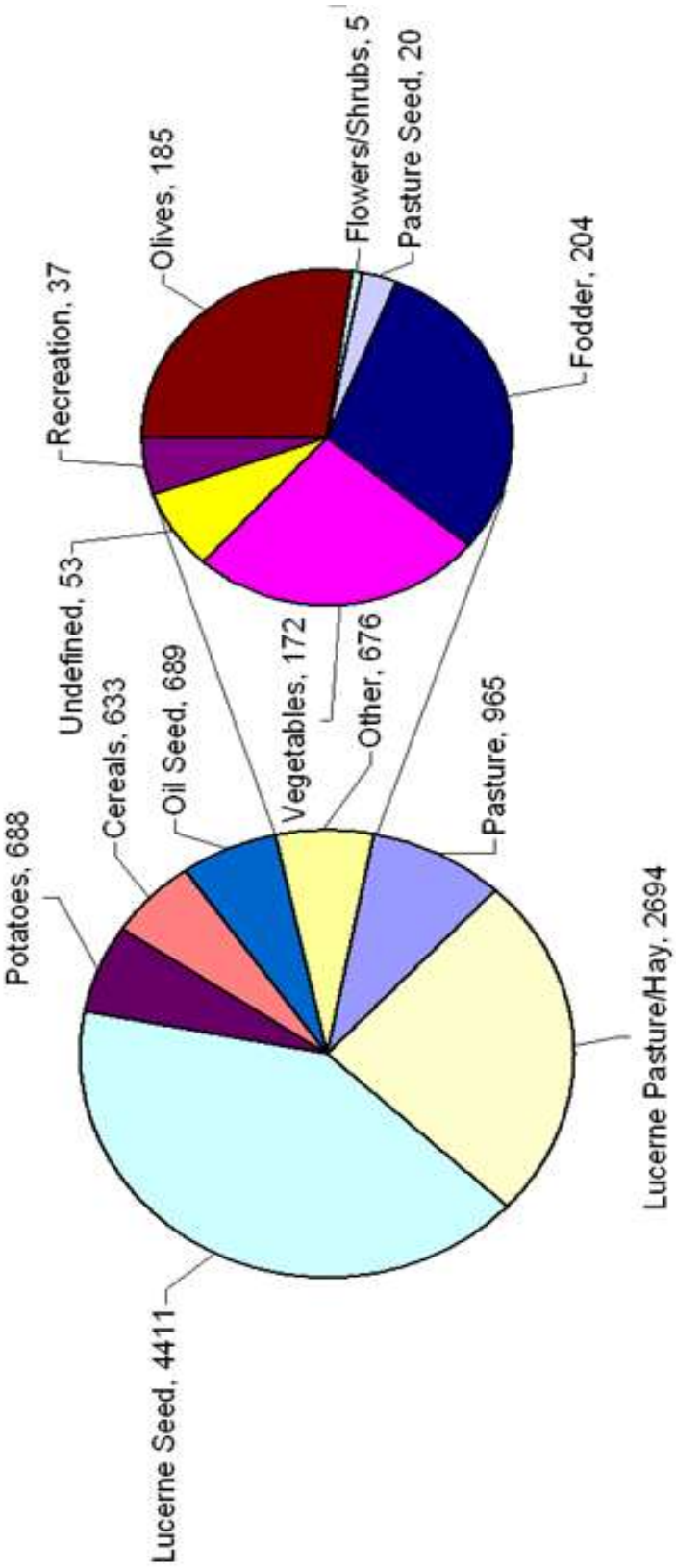

Figure 6 - Types and categories of underground water dependent ecosystems (URS, 2000)

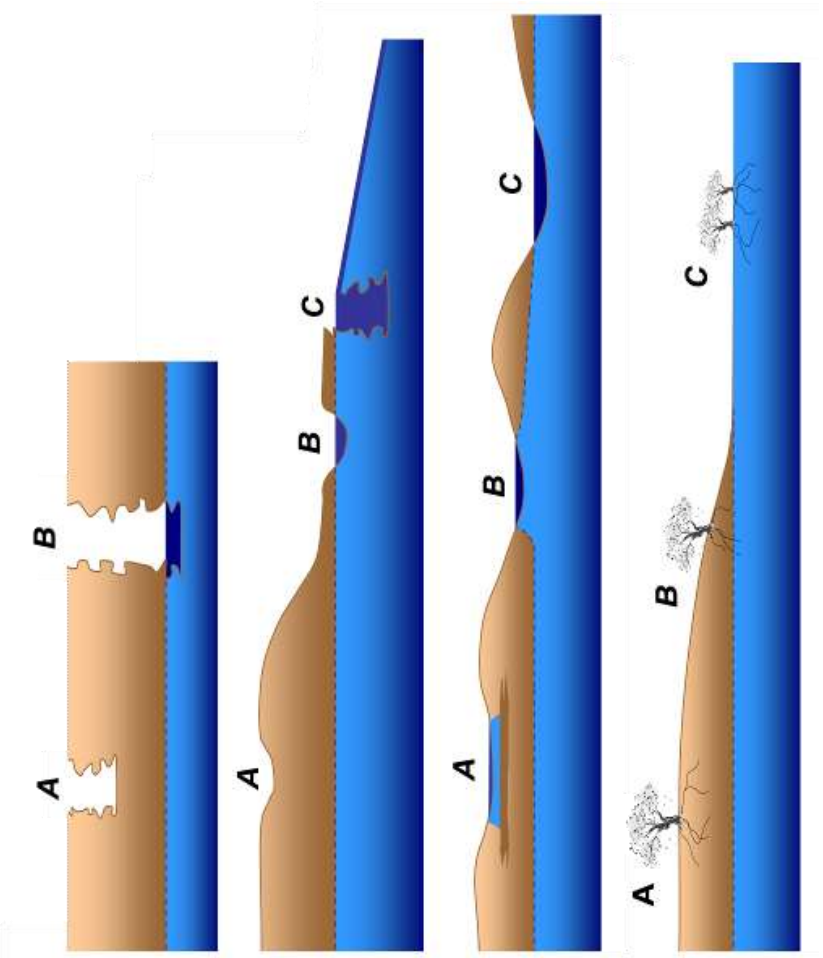

Figure 7- Ecosystems of high ecological importance in the Tatiara PWA

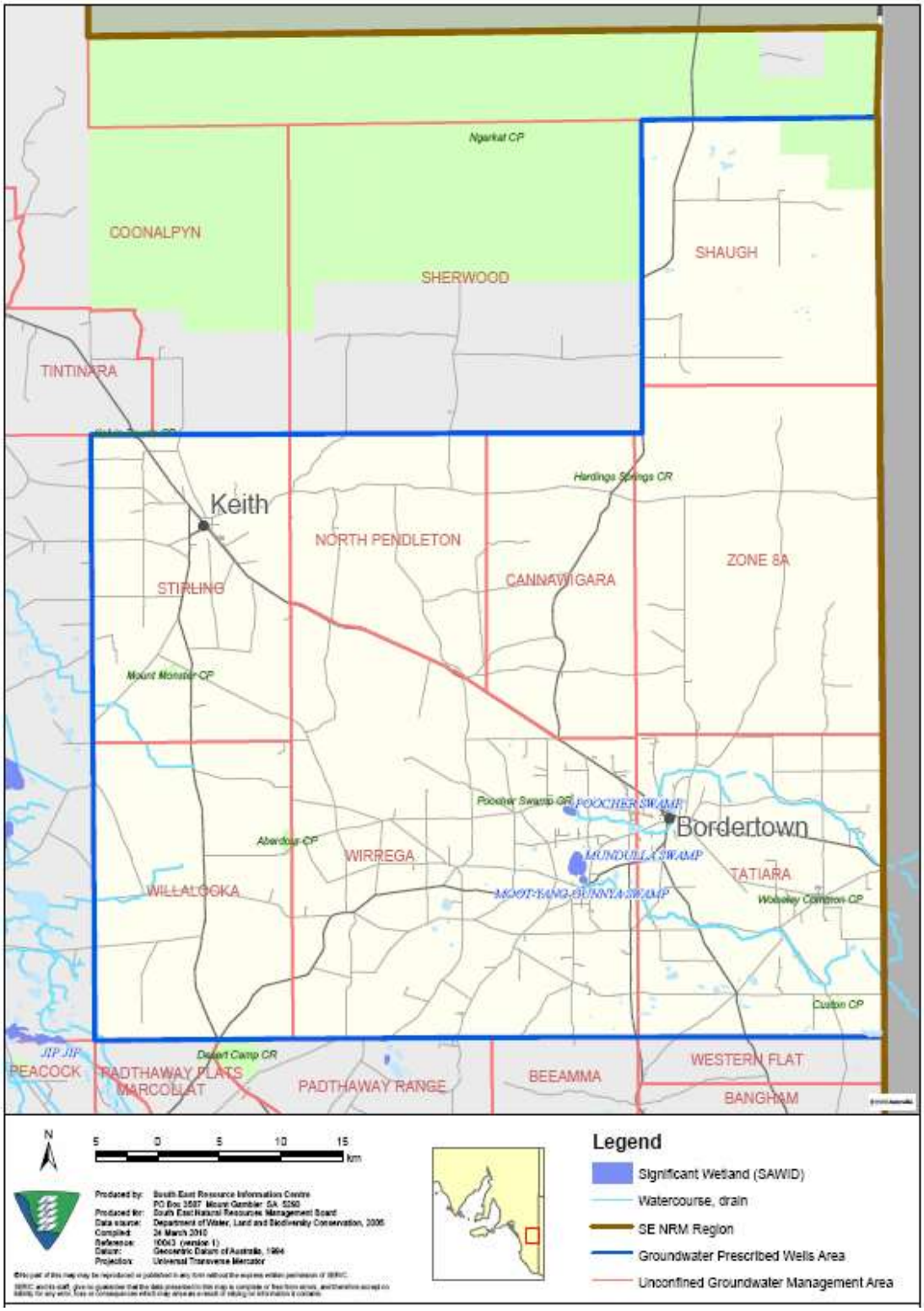

Figure 8 - Unconfined underground water level trends in the South East Natural Resources Management Region – 2003-2008

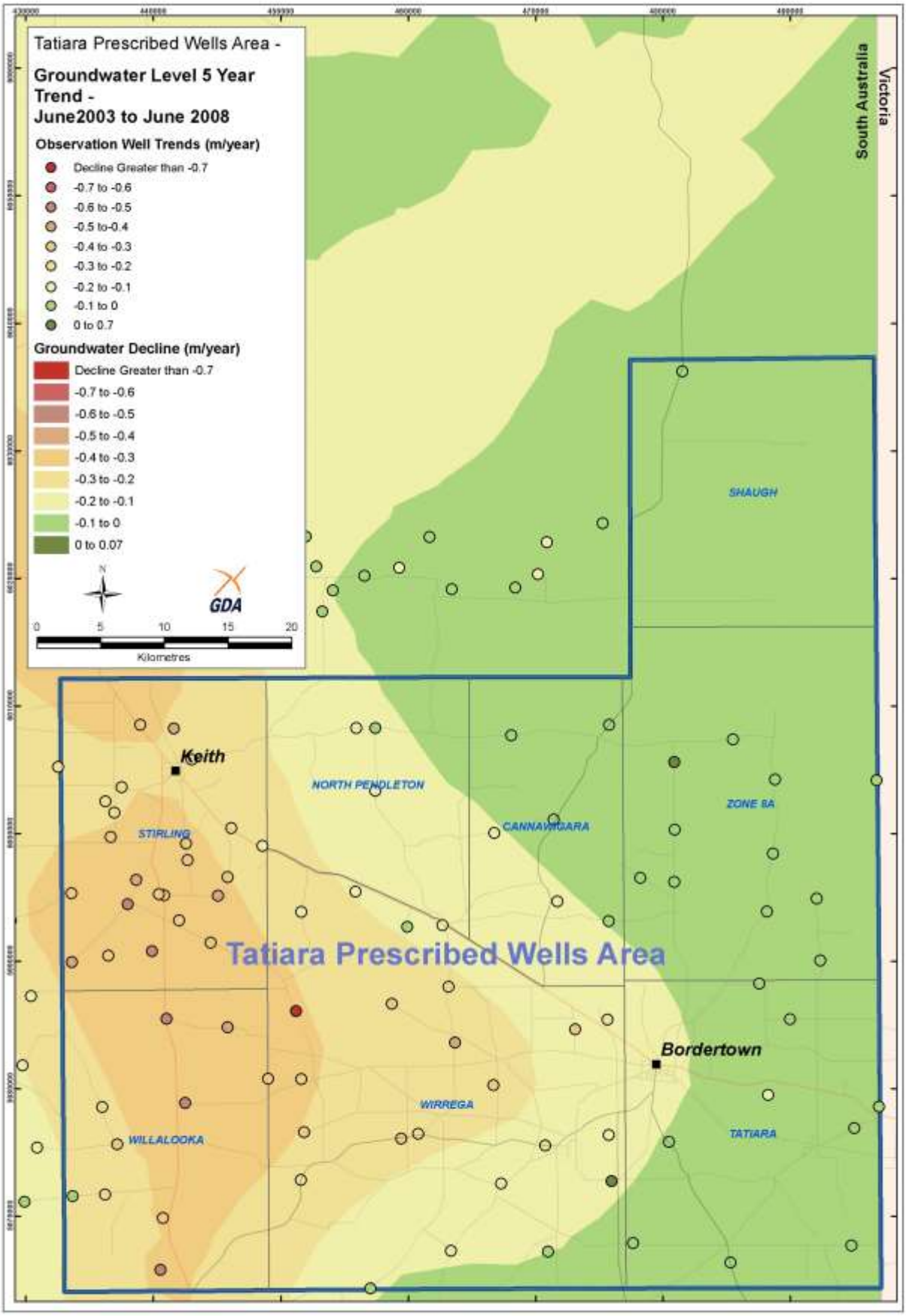

Figure 9. (2004-2009) 5-year water level trend for the unconfined aquifer in the Tatiara PWA and selected hydrographs illustrating the trend over the long term record

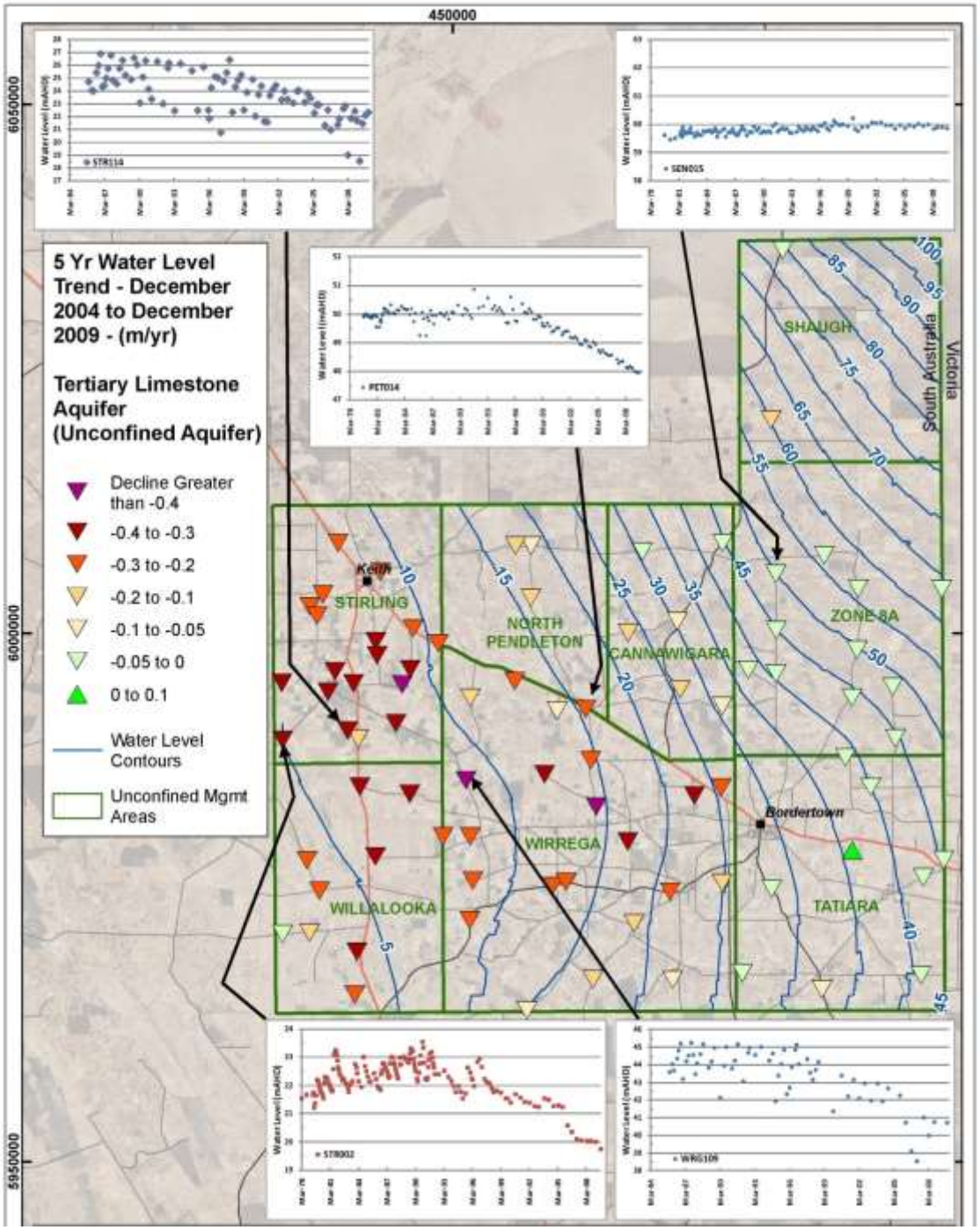

Figure 10. Monthly rainfall (at Keith) and cumulative deviation from mean annual rainfall

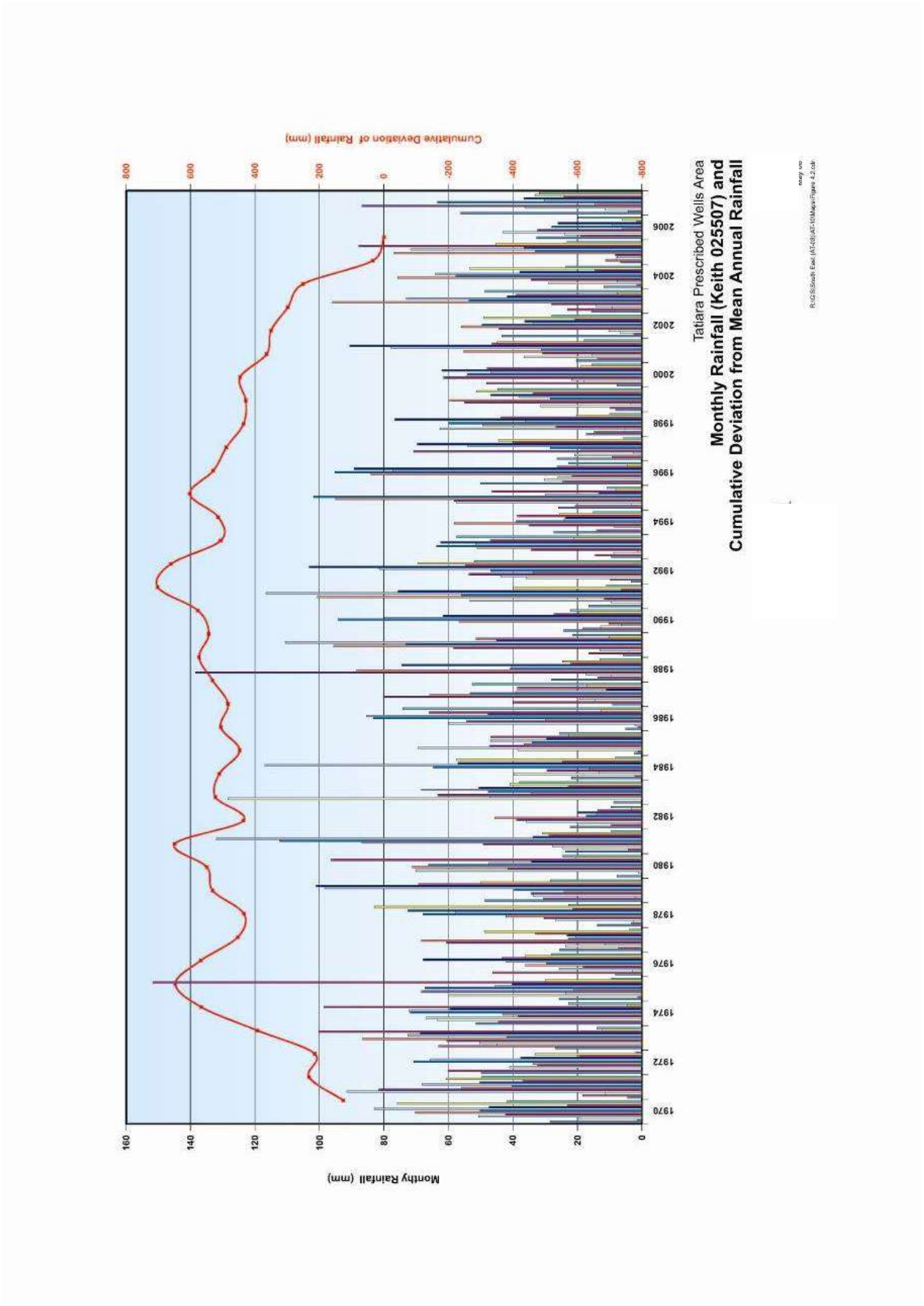

Figure 11. (2004 – 2009) 5- year water level trend for the confined aquifer in the Tatiara PWA and hydrographs illustrating the trend over the long term record

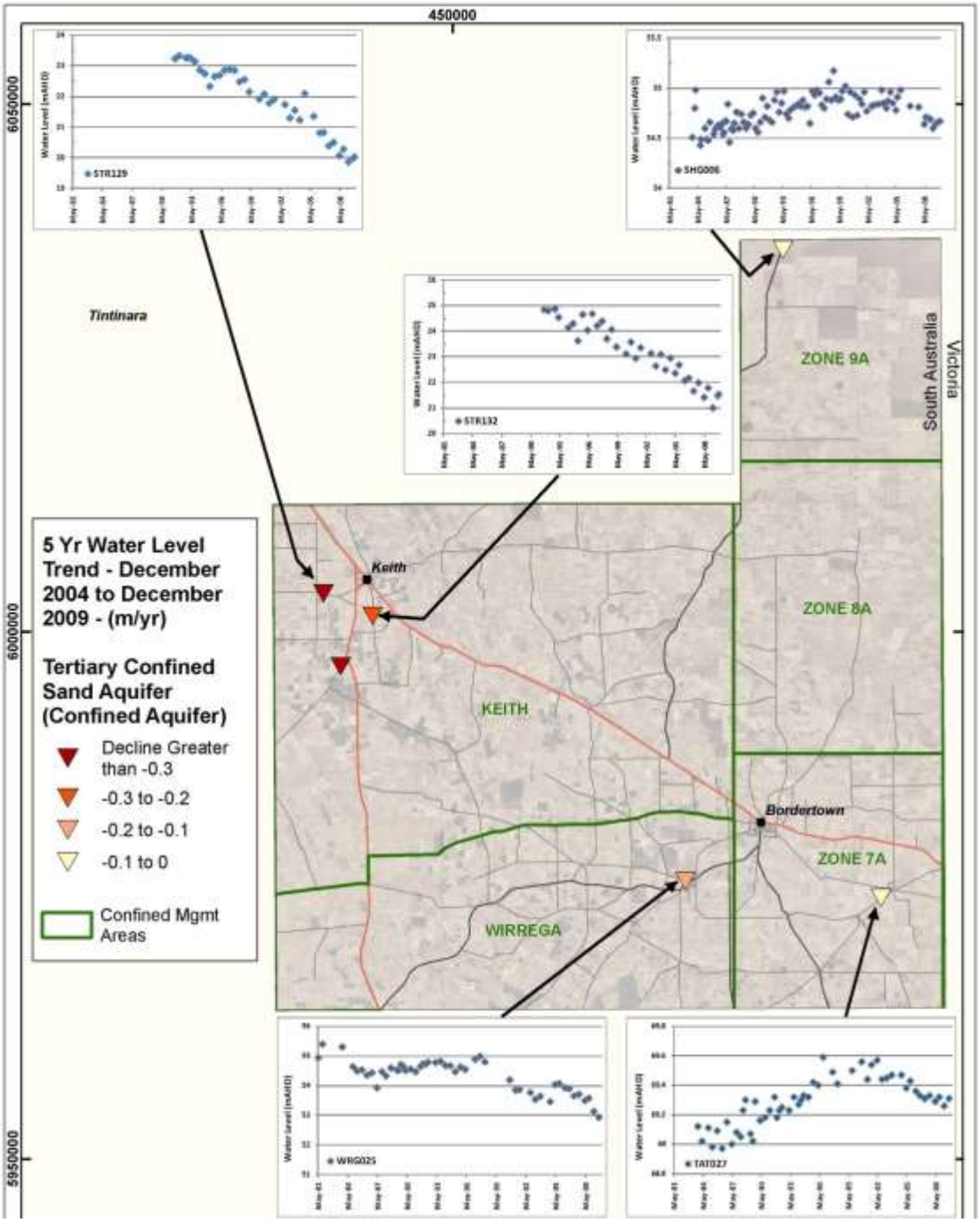

Figure 12. (2004-2009) 5-year salinity trend for the unconfined aquifer in the Tatiara PWA and selected salinity graphs illustrating the trend over the long term record