Water Allocation Plan for the Lower Limestone Coast Prescribed Wells Area

Prepared by the

South East Natural Resources Management Board

Government of South Australia

South East Natural Resources Management Board

Adopted 26 November 2013
Amended 10 December 2014
Amended 20 November 2015
Amended 29 June 2019

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1.1 Background to the Water Allocation Plan

The aquifers of the Lower Limestone Coast (LLC) Prescribed Wells Area (PWA), located in the South East of South Australia, provide the region with large volumes of high quality water. However, this finite resource requires careful management to ensure that future generations can enjoy the lifestyle, economic prosperity and unique environment that water provides in the region.

A Water Allocation Plan (WAP) sets out the rules for managing and taking prescribed water. The South East Natural Resources Management Board (the Board) is responsible for working with the community to develop and review water allocation plans for the region. This WAP is therefore pivotal in providing a clear direction that ensures the long term sustainability of the prescribed wells area's water resources, which underpins the region's people, townships, industries and environments.

The LLC PWA was gazetted on 2 December 2004. The LLC PWA is the product of the amalgamation of the former Lacepede Kongorong, Comaum-Caroline, and Naracoorte Ranges PWAs. These last two areas were proclaimed to give effect to the requirements of the *Groundwater (Border Agreement) Act 1985*, with the aim to equitably manage the underground water along the South Australian/Victorian border, while Lacepede-Kongorong was proclaimed for the purpose of introducing structured resource management in response to potential over-allocation.

The Board is at the forefront of change for water resources management, as an international leader in the introduction of a licensing system for the water requirements of commercial forestry. This Water Allocation Plan for the Lower Limestone Coast Prescribed Wells Area (the Plan) is the result of nine years of development by the Board (formerly the South East Catchment Water Management Board) in association with the community, industry groups and government agencies. The Plan is based on rigorous scientific research of the water resources of the area, combined with extensive community consultation and participation. Particular recognition must be given to the members of the Board's LLC Water Allocation Plan Reference Group for their involvement in the development of the Plan.

The LLC contains significant, often high quality, underground water resources in the form of unconfined and confined aquifers. A core objective of the Plan is to manage these resources for the continued social, economic and environmental benefit of current and future generations. The Plan protects the underground water resources to ensure its ongoing availability to sustain ongoing economic, social and environmental systems, while providing flexibility and equity of access to water. It sets out the principles for allocation, use and transfer of underground water in the LLC PWA. These principles will ensure that allocations are available to sustain economic development, while aiming to bring at-risk management areas back to environmentally sustainable levels of allocation.

The Plan is made pursuant to Chapter 4, Part 2, Division 2 of the *Natural Resources Management Act 2004* (the Act) and is consistent with the objects and requirements of the Act.

The Plan is also consistent, where possible, with the *Lower Limestone Coast Water Allocation Plan Policy Principles* (Department for Water (DFW) 2012). The Policy Principles paper was developed in close consultation with a Stakeholder Reference Group, which included representatives of the dairy, dry-land farming, forestry, potato and viticulture industries, as well as representatives from the South Australian Farmers Federation and the Conservation Council of South Australia. The Policy Principles paper was developed to provide a basis for the preparation of the Plan; it consists of high level policy principles and more specific guidelines which have resulted from an extensive consultation process.

The Act requires the Board to prepare a water allocation plan for each of the prescribed water resources in its region. The Plan replaces the Water Allocation Plans for the Comaum-Caroline, Lacepede Kongorong and Naracoorte Ranges PWAs adopted by the Minister for Water Resources on 29 June 2001 and subsequently amended on 14 October 2001.

1.2 The Prescribed Wells Area

The LLC PWA covers an area of approximately 1,450,000 hectares. The PWA is bordered to the north by the Padthaway and Tatiara PWAs, and to the east by the state border with Victoria. It incorporates the city of Mount Gambier (population ~ 23,000), and the major townships of Naracoorte and Millicent (population ~ 5,000 each). The location and boundaries of the PWA are shown in Figure 1 (*Appendix of Figures and Tables*). The LLC PWA is the product of the amalgamation on 2 December 2004 of the former Comaum-Caroline, Lacepede Kongorong and Naracoorte Ranges PWAs.

A number of confined and unconfined aquifer management areas in the LLC PWA are located within the Designated Area (Figures 2 and 3, *Appendix of Figures and Tables).* As a result, these management areas are under the jurisdiction of the *Groundwater (Border Agreement) Act 1985.* Under the *Groundwater (Border Agreement) Act 1985*, no new allocations should be granted, or temporary allocations renewed, where the limit to the volume of water to be extracted from licensed wells in the relevant Zone of the Designated Area would be exceeded.

1.3 Underground Water Resources

The prescribed water resources of the LLC PWA consist of two distinct underground water systems, the upper unconfined Tertiary Limestone Aquifer (known generally as the unconfined aquifer) and the lower Tertiary Confined Sand Aquifer (known generally as the confined aquifer). Underground water is extracted from the unconfined and confined aquifers within the Murray Basin (northeast) and Gambier Basin of the Otway Basin (remainder). The Plan relates to all underground water in the PWA.

1.3.1 Unconfined Aquifer

The unconfined aquifer consists mainly of calcareous sandstone and limestone. It incorporates the Gambier and Murray Group Limestones in the higher inland plains in the east of the region, and the younger Coomandook, Bridgewater and Padthaway Formations in the low-lying flats, which are interspersed with a series of northwest-trending remnant sand dune ridges.

Underground water flow in the unconfined aquifer in the north east of the PWA is generally from east to west. Underground water flow radiates out from the Nangwarry/Tarpeena area in a northerly, westerly and southerly direction, that is, water flows approximately east to west throughout the northern three quarters of the PWA and from north to south in the lower South East.

There are a number of major faults in the area which impact on underground water flow and gradient. The two most prominent are the northwest trending Kanawinka Fault and the west-northwest trending Tartwaup Fault, referred to as the Tartwaup Hinge. The water level and potentiometric contours of both the confined and unconfined aquifers indicate a significant steepening of slope immediately up-gradient of each fault.

The thickness of the unconfined aquifer varies from ~10 metres thick north west of Mount Gambier, increasing to more than 300 metres thick south of Mount Gambier. The depth to water varies throughout the PWA relative to topography. Generally the depth to water is less than five metres on the plains, up to 20 metres in the ranges and more than 40 metres in the Mount Burr Range (Figure 12, *Appendix of Figures and Tables*). In the southern portion of the PWA there are numerous karst (dissolution) limestone features, of which Ewens Ponds, Piccaninnie Ponds and Hell's Hole are examples.

In general, underground water salinity in the unconfined aquifer increases from the south, where the salinity is less than 500 milligrams per litre (mg/L) Total Dissolved Solids (TDS), to the north, where the salinity is more than 4,000 mg/L TDS (South East Catchment Water Management Board (SECWMB) 2001a, 2001b, 2001c).

1.3.2 Confined Aquifer

The confined aquifers are separated from the unconfined aquifers by a low permeability aquitard (or confining layer), comprised mainly of glauconitic marl and dark brown carbonaceous clay. The combined thickness of the aquitard is generally more than 20 metres. The confined aquifer consists of non-calcareous quartz sands, interbedded with dark brown carbonaceous clays. Together these units make up the Dilwyn Formation, which was deposited during the early part of the Tertiary Period (approximately 50 million years ago), which is equivalent to the Renmark Group in the Murray Basin. Much of the water in the confined aquifer is over 25,000 years old.

For management purposes, the confined aquifer is treated regionally as one aquifer, but is actually a complex multi-aquifer underground water system (Cobb and Brown 2000). The confined aquifer does not have the same lateral extent as the unconfined aquifer as it becomes thinner and absent in the northern margins of the PWA.

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). A 2001 study by the former South Australian 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).

Beneath the Dilwyn Formation is a number of deeper aquifers from the Late Jurassic, Early and Later Cretaceous and Tertiary ages of variable water quality and lateral extent down to 4000+ metres, which demonstrate increasing salinity with depth. These aquifers are not used for irrigation, industrial or town water supplies due to their depth and generally high salinity. The aquifers within these deeper formations are of potential value as targets for petroleum and geothermal exploration and production.

The Eumeralla Formation is a very deep sub-aquifer, ranging in depth from 235 metres in the Killanoola area to 1,240 metres at Geltwood Beach (formation thickness at these locations is 425 metres and 2,509 metres respectively). When aquifers are buried beneath thick sections of thermally insulated rocks, the natural heat of the earth can warm the contained water to 150^{o}C or higher. Although its capacity as an underground water resource has not been explored due to its great depth, studies have shown that in this sub-aquifer, temperature is relatively constant at around 160^{o}C at 4,000 metres depth, and its potential in geothermal energy generation is being investigated (Panax 2008).

The value of the Tertiary and Late Cretaceous formation aquifers below the Tertiary Dilwyn Formation for alternate water supplies has not been investigated and evaluated. The value of these aquifers will depend on their yields and water quality, or potential for water quality treatment such as desalination, depending on the potential purpose for the use of the water and the likelihood of risks associated with extractions from these aquifers such as depressurisation. Targeted research to better understand and characterise these aquifers as a future source of water for beneficial uses would be required to understand their potential.

Underground water flow for the 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 Murray Darling Basin. 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).

Underground water salinity in the confined aquifer system is typically less than 500 mg/L TDS in the south around Mount Gambier, but increases gradually northwards to over 10,000 mg/L TDS as the aquifer thins north of Kingston (Cobb and Brown 2000).

1.3.3 Aquifer interaction

Declines in the unconfined aquifer water level have been observed along the border between South Australia and Victoria. These declines have been attributed to a combination of

reduced rainfall, underground water extraction and interception of recharge to the aquifer. Although there is little water extracted from the deeper, underlying confined aquifer, similar declines to those in the unconfined aquifer have been observed. Funding support was sought from the National Water Commission by the former DFW in South Australia and the Department of Sustainability and Environment in Victoria to study the interaction between the unconfined and confined aquifers. Interstate collaboration was achieved through the involvement of the Border Groundwaters Agreement Review Committee.

The study involved the drilling of eight sites into the confined aquifer to carry out pumping tests from the aquifer, while monitoring drawdown of water levels in the unconfined aquifer, to determine the degree of connection between the two aquifers. The project resulted in a three-dimensional model and revealed that there is moderate to good hydraulic connection between the two aquifers. The results indicate that the two aquifers are more highly connected than assumed in previous models. These results will be considered in ensuring the future sustainability of groundwater resources along the state border (SKM 2012).

1.3.4 Underground water management areas

There are currently 61 unconfined aquifer underground water management areas in the LLC PWA (Figure 2, *Appendix of Figures and Tables*). The confined aquifer is divided into management areas on a regional basis, with 14 confined aquifer underground water management areas that are either wholly or partially located within the LLC PWA (Figure 3, *Appendix of Figures and Tables*). The LLC PWA incorporates Zones 1A to 6A and part of Zone 7A of the Designated Area (*Groundwater (Border Agreement) Act 1985*).

1.4 Climate

The climate of the LLC PWA is typical of the South East with hot, dry summers and cool, wet winters (Daniell 2010). The annual average rainfall in Mount Gambier is 707.3 mm/year (Mount Gambier Airport, 1941-2010) (Daniell 2010). Rainfall decreases in a north-westerly (Robe, 631.7 mm/year (1860-2010)) and north-easterly direction (Naracoorte, 578.3 mm/year (1868-2001)) (Daniell 2010; Australian Government Bureau of Meteorology 2010).

In the South East region, 75% of the annual rainfall falls between April and October. Analysis of long-term data has shown that rainfall in the summer months contributes significantly to above average rainfall years, where rainfall exceeds the average by more than 100 mm/year (Daniell 2010).

The annual point potential evapotranspiration is approximately 1,400 mm in the south of the PWA increasing to more than 1,600 mm in the northern portion of the PWA (Brown *et al*. 2006).

1.5 Landscape

The northern and central portion of the PWA is characterised by sub-parallel northwest trending stranded beach dune ranges, separated by interdunal flats. The Mount Burr Range, Mount Schank and Mount Gambier represent the early phase of volcanic activity in the area. The north eastern part of the PWA can be divided by topography into a low-lying inter-dunal flat located to the south-west of the township of Naracoorte, and an elevated highland area in the northeast. The northwest-southeast lying Kanawinka Fault separates the two terrains. To the south of the PWA is a low-lying coastal plain that gently rises from the coast in the south to ~70 metres above sea level in the north (SECWMB 2001a, 2001b, 2001c).

1.6 Water and land use

Land use in the Limestone Coast Region comprises mainly of livestock grazing of modified pastures (58% of land use in 2008), cropping (9% of land use) and commercial forests (hardwoods and softwoods) (7% of land use) (Primary Industries and Regions South Australia (PIRSA) 2010). The total area in the Limestone Coast Region is 2,346,937 hectares and is a larger area than the LLC PWA, as it extends beyond Keith (PIRSA 2010).

A total of 54,450 hectares of irrigated crops were grown in the LLC PWA in 2008-09, representing 3.8 % of the total land area in the PWA. The major crops irrigated in 2008-09 included pasture for dairy, beef and prime lamb production totalling 24,409 hectares, wine grapes of 11,070 hectares, lucerne pasture/hay of 5,811 hectares, potatoes of 2,886 hectares, lucerne seed of 2,134 hectares and cereals of 2,092 hectares (Hodge 2009).

Commercial forestry forms a significant industry in the LLC PWA. The approximate area of softwood plantations (consisting primarily of Radiata Pine (*Pinus radiata*)) in the South East is 104,000 hectares. Hardwood plantations, primarily Tasmanian Blue Gums (*Eucalyptus globulus*), cover an area of approximately 40,500 hectares. Plantation forestry is predominantly located in the mid to southern areas of the LLC PWA, representing approximately 10% of the total land area in the PWA. The industry supports a significant processing industry for wood and paper products.

Other major water users in the PWA include industry and public water supply. Industrial uses include timber processing, pulp and paper manufacture, operation of farm dairies (including dairy washdown), potato processing, wine making and the operation of abattoirs.

1.7 Surface Water Resources

Prior to the construction of an extensive drainage system which commenced in the 1860s, large areas of the region experienced prolonged inundation each year.

Today, the surface water resources of the LLC PWA consist of a number of ephemeral (seasonally flowing) creeks, many with their headwaters in Victoria, including Naracoorte Creek, Morambro Creek, Mosquito Creek and Glenroy Creek. Approximately four kilometres of the Glenelg River flows through the south-east of the LLC PWA, before discharging to the Southern Ocean in Victoria. A large network of drains in the LLC PWA also contributes to the surface water resources of the region.

South of Mount Gambier there are a number of coastal springs and drains fed by discharge from the unconfined aquifer, including Deep Creek, Eight Mile Creek and Piccaninnie Ponds. Other important surface water features in the northern and central areas of the PWA include the Reedy Creek, Bakers Range, West Avenue, Taratap and Marcollat watercourses, which consist of a series of wetland complexes and floodplains. Coastal lakes extend from Port MacDonnell in the south through to the Coorong, located to the north-west of the PWA (SECWMB 2003), and numerous permanent and seasonal wetlands occur throughout the PWA.

Surface water and the drainage system are currently managed by the South Eastern Water Conservation and Drainage Board under the *South Eastern Water Conservation and Drainage Act 1992* and the *Upper South East Dryland Salinity and Flood Management Act 2002.*

An indication of the increasing interest in surface water for consumptive uses and environmental requirements has been the prescription of the surface water resource and watercourse of the Morambro Creek. The area was prescribed on 19 April 2001 in response to potential significant demand for its water for aquifer replenishment by irrigators at Padthaway. The Water Allocation Plan for the Morambro Creek and Nyroca Channel Prescribed Watercourses (including Cockatoo Lake and the Prescribed Surface Water Area) was prepared by the Board and adopted by the Minister on 13 January 2006.

1.8 Economy

The South East region for the purposes of the *South East of South Australia Regional Profile* comprises the District Councils of Kingston, Naracoorte Lucindale, Robe, Wattle Range, Grant, and the City of Mount Gambier (PIRSA 2010). These boundaries correspond to the South East statistical division as defined by the Australian Bureau of Statistics (ABS), but do not exactly align those of the LLC PWA.

Based on ABS 2006 Census data almost 31,500 people (out of a resident population in 2006 of just over 62,000 people) were employed in the South East region, with the agriculture,

forestry and fisheries sector employing the largest number of people, accounting for approximately 19% of total employment. The manufacturing sector accounted for a further 16% and the retail sector an additional 12% (PIRSA 2010).

Gross Regional Product (GRP) is a measure of the net contribution of an activity to the regional economy. Agribusiness (including forestry) is a significant contributor to GRP. In 2006/07, the greatest value in terms of production in the South East was agriculture and fisheries at the farm gate, yielding approximately $432 million (16% of GRP), with an additional $45 million (1.5% of GRP) from forestry and logging. Drought conditions during that year may have affected the result for agriculture (PIRSA 2010).

The economic data does not necessarily distinguish between irrigated and non-irrigated agriculture. However, in a separate study some years earlier, Econsearch (2006) found that in 2003/04 the most significant irrigated crop types by value in the LLC PWA were wine grapes, pasture seed, pasture and potatoes.

PIRSA (2010) estimated the value of production for 2010 using industry knowledge and where possible published data. In dollar value terms, beef cattle is the most significant agricultural product in the South East, accounting for nearly 20% or around $185 million of the $950 million total estimated value of agricultural and forestry production in the region in 2010. Forestry was the second largest accounting for 17% ($160 million). Sheep and lambs accounted for a further 14% (around $135 million) of the total value of agricultural and forestry production in the region, while wine grapes accounted for 13% (nearly $120 million) and milk production 8% (around $75 million) (PIRSA 2010).

References

Australian Government Bureau of Meteorology 2010, *Climate statistics for Australian locations*, 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.

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

Cobb, M. and Brown, K. 2000, *Water Resource Assessment: Lacepede Kongorong Prescribed Wells Area for the SE Catchment Water Management Board*, PIRSA RB 2000/00049

Daniell, T. 2010**,** 'Literature Review' in *South East Water Science Review*, for the Lower Limestone Coast Taskforce**,** ed J. Brookes, Government of South Australia, through the Department for Water, Science, Monitoring and Information Division, pp.1-1 – 1-79.

Department for Water 2010, *South East Water Science Review*, Lower Limestone Coast Water Allocation Plan Taskforce, Adelaide.

Department for Water 2012, *Lower Limestone Coast Water Allocation Plan Policy Principles*, Lower Limestone Coast Water Allocation Plan Taskforce.

EconSearch Pty Ltd 2006, *Profile of Irrigated Activity in the South East Catchment Region, 2003/04*, a report prepared for the South East Catchment Water Management Board, 17 January 2006.

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

Panax Geothermal 2008, Panax *Geothermal Limited 2008 Annual Report*

Primary Industries and Resources SA (PIRSA) 2010, *South East of South Australia Regional Profile October 2010*

SE Catchment Water Management Board (SECWMB) 2001a, *Water Allocation Plan: Lacepede Kongorong Prescribed Wells Area*.

SE Catchment Water Management Board (SECWMB) 2001b, *Water Allocation Plan: Comaum-Caroline Prescribed Wells Area*.

SE Catchment Water Management Board (SECWMB) 2001c, *Water Allocation Plan: Naracoorte Ranges Prescribed Wells Area*.

SE Catchment Water Management Board (SECWMB) 2003, *South East Catchment Water Management Plan 2003-2008.*

Sinclair Knight Merz (SKM) 2012, *SA-Vic Border Zone Groundwater Investigation, Interaction between the TLA and TCSA, Joint Inter-aquifer Report, 21 May 2012.*

2. Assessment of the needs of water dependent ecosystems

Section 76(4)(a)(i) of the Act provides that a water allocation plan must include an assessment of the quantity and quality of water needed by the ecosystems that depend on the water resource and the times at which, or the periods during which, those ecosystems will need that water.

Section 76(4)(aab) of the Act also requires a water allocation plan to include:

(i) an assessment of the capacity of the water resource to meet environmental water requirements;

(ii) information about the water that is to be set aside for the environment including, insofar as is reasonably practicable, information about the quantity and quality, the time when that water is expected to be made available, and the type and extent of the ecosystems to which it is to be provided; and

(iii) a statement of the environmental outcomes expected to be delivered on account of the provision of environmental water under the plan.

Environmental water requirements and environmental provisions for the PWA are described in Sections 2.2.1 and 2.2.2, respectively. The environmental water provisions for the PWA do not aim to return water-dependent ecosystems to a pristine condition, but to keep them at an acceptable level of risk. This is achieved by setting aside a portion of recharge for through-flow purposes, the maintenance of water tables and underground water salinity and the reduction of allocations in management areas at high or very high risk from current allocation and extraction, as well as reducing the impact of any further development in the vicinity of high ecological value underground water dependent ecosystems by means of setback distances for new water use activities.

2.1 Ecosystems dependent upon underground water in the Lower Limestone Coast PWA

The dependence of ecosystems on underground water varies through time, and with the water requirements of the ecosystem. As well as the hydrological component, underground water contains physio-chemical properties and dissolved nutrients that are important for ecosystem processes. Table 2.1 identifies the range and forms of ecosystem dependence on underground water in the LLC PWA.

Five types of underground water dependent ecosystems can be identified within the LLC PWA:

1. karst
2. streams/watercourses
3. wetlands
4. phreatophytic vegetation
5. marine environment

TABLE 2.1: FORMS OF UNDERGROUND WATER DEPENDENCE – LOWER LIMESTONE COAST PWA (REM 2005, ADAPTED FROM HATTON AND EVANS 1998)

Type of Dependence	*Definition*
Total (obligate)	*Non-resilient ecosystems, where only small changes in groundwater conditions have drastic effect.*
High (high level facultative)	*Ecosystems having low resistance, or low resilience, to altered groundwater condition, where "moderate" change affects species distribution, composition and/or ecosystem function.*
Proportional (facultative)	*Ecosystems exhibiting a degree of resistance, or resilience, to altered groundwater condition, resulting in subdued (or proportional) response.*
Limited (low level facultative)	*Ecosystems having limited reliance on groundwater, typically at the end of dry seasons or during drought.*
None apparent	*Ecosystems not dependent on phreatic water.*

Figure 4, *Appendix of Figures and Tables*, contains a conceptual diagram of the first four types of underground water dependent ecosystems. The interaction of any groundwater resource with a surface water feature or dependent ecosystem can be permanent or seasonal.

2.1.1 Karst

Karst (aquifer) ecosystems occur within the voids (solution features) that have developed within the carbonate rocks making up the unconfined aquifer of parts of the South East.

The limestone units of the LLC PWA geology have numerous sinkholes, cenotes, caves and other karst features, many of which intersect the underground water table. The biotic component of these ecosystems consists largely of invertebrate fauna (mostly crustaceans), and diverse communities of micro-organisms (Humphreys 2008). The underground water dependent ecosystems present within the volcanic crater lakes (e.g. the Blue Lake and Valley Lake) around Mount Gambier bear many similarities to those found within the limestone karst systems found elsewhere throughout the region. Therefore, these ecosystems have been amalgamated for the purposes of this review.

In the vicinity of Mount Gambier, there are many karst systems noted for the underground water dependence of their ecosystems:

- Sheathers Cave;
- Engelbrecht Cave;
- the Blue Lake;
- the Valley Lake;
- Hells Hole;
- Caveton Park Estate Cave;
- Bottlebrush Sinkhole; and
- Grundy's Woodland.

The underground water contained in these systems supports aquatic stygobites that are endemic to the South East, including syncarids, amphipods and stromatolite communities. The Blue Lake has the largest stromatolite community recorded in Australia (>10 metres). These structures in the Blue Lake extend from just below the surface to over 45 metres deep

and are the deepest stromatolites ever recorded (Thurgate 1992; 1995). Caveton Park Estate Cave supports aquatic bacterial colonies which form in sheets. The biology of these colonies is yet to be studied, but they are likely to be endemic.

In a number of features, including the Blue Lake, the surface opening is substantial and provides a lake habitat which supports benthic algae, phytoplankton, invertebrates, fish and birds. Hell's Hole is listed on the Register of the National Estate for its biological significance, due in part to the presence of the endangered fern *Pteris tremula*, which may be dependent on the underground water fed lake environment.

Further south from Mount Gambier towards the coast, the following caves and sinkholes are noted for the underground water dependence of their ecosystems and stygobite communities:

- Horse and Cart Sinkhole;
- Tea Tree Sinkhole;
- Mushroom Cave;
- Hereford Stream Cave;
- The Shaft;
- Allendale Sinkhole;
- Gouldens Hole;
- Gum Road Cave;
- Morgans Cave;
- The Pines; and
- Fossil Cave.

Hereford Stream Cave extends for over 250 metres and has eight permanent pools. At the southern end of the system, water flows out through a permanent underground stream that is up to one metre deep. The cave supports numerous stygobite aquatic invertebrates, including locally endemic syncarids. Mushroom cave provides habitat for syncarids in a permanent three metre deep pool at the base of the cave.

West of Mount Gambier, the sinkholes and karst features of significance include:

- Green Lake;
- One Tree Sinkhole;
- Little Blue Lake;
- The Black Hole;
- Bullock Hole;
- Ten Eighty Sinkhole;
- The Sisters;
- Woolwash Cave;
- Benara Sinkhole;
- Alleyn's Cave (Death Cave);
- Mud Hole; and
- Tank Cave

Many of the flooded karst systems feature stromatolites, which are rare microbial formations. All support stygobite aquatic invertebrate communities that include mollusca, amphipods and syncarids. Many of these systems feature wetland habitats at their surface, including One Tree Sinkhole, The Sisters and Woolwash Cave.

Karst features in the coastal region south of Mount Gambier fall into two categories - caves and sinkholes, which lie inland, and rising springs along the coast. Rising springs are karstic

cavities along the coast which provide discharge points for the water table. The cavities themselves support important and well preserved habitats and also form underground water dependent surface habitats generally comprising a permanent lake, fringing wetland vegetation and a stream draining to the sea. Underground water is the most important source of water in these ecosystems, and small local catchments provide limited and intermittent surface runoff. The ecologically important sinkholes in the coastal region south of Mount Gambier are:

- Pretty Pond which discharges to an artificial drain;
- Stratmans Pond which discharges to Deep Creek;
- Fifty Four Foot Pond which discharges to Fifty Four Foot Drain;
- Unnamed Pond which discharges to an artificial drain;
- Ewens Pond which discharges to Eight Mile Creek;
- Spencers Pond;
- Bones Ponds;
- Crescent Pond;
- Hammerhead Pond;
- Piccaninnie Ponds;
- Tadpole Pond;
- Bugga Bush Pond; and
- Eel Pot Pond.

Other karst ecosystems include the Shaft, Allendale Sinkhole and Black Fellows Cave.

Ewens Ponds, Piccaninnie Ponds, Crescent Pond and Hammerhead Pond are found within Conservation Parks and provide well preserved examples of an integrated surface and sub-surface underground water dependent ecosystem. Both Ewens and Piccaninnie Ponds are listed on the Register of the National Estate for their biological significance. In addition Piccaninnie Ponds was included on the List of Wetlands of International Importance (Ramsar List) in 2013. The Ramsar list also includes the Hacks and Bool Lagoons in the LLC PWA (see below). The Ramsar Convention of Wetlands is an intergovernmental treaty that provides a framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

The permanent discharge of underground water to the surface supports reed and sedge vegetation (*Phragmites australis/Typha domingensis*) on the fringes of pools and tea-tree fen closed scrub (*Leptospermum lanigerum/Melaleuca squarrosa*) in the wetland areas. The open water of the ponds supports aquatic biota including vascular plants (e.g. *Triglochin procerum*), algae and mosses and a variety of fauna including fish, tortoises, water birds and crustaceans.

The endangered marsupial mouse, Swamp Antechinus (*Antechinus minimus*), has been recorded in Piccaninnie Ponds Conservation Park, as well as the nationally listed fish Dwarf Galaxias (vulnerable) and nationally listed Spiny Crayfish (endangered), while the Maroon Leek-orchid *Prasophyllum frenchii* (endangered) is found on the wetland margins. Ewens Ponds provides habitat for vulnerable fish species, including the endemic Ewens Pygmy Perch (*Nannoperca varigata*) and the Australian Grayling (*Prototroctes maraena*), and is the most westerly record for the Australian Grayling.

Karst faunal communities can be impacted by groundwater level decline, which may cause stranding if the decline occurs at a rate greater than that with which the animals are able to move downwards; loss of connectivity between cavities; and an increase in the distance between the aquifer ecosystem and the source of carbon, reducing the amount of organic matter available to aquifer food webs.

2.1.2 Streams, watercourses and drains

Streams, watercourses and drains are dependent on underground water where the discharge contributes to the flow of the stream, watercourse or drain, or to permanent pools or water quality. In the LLC PWA, underground water discharge typically varies seasonally. This is because water levels rise in response to winter rainfall recharge, which in turn means that underground water flow prolongs in late spring and summer, maintaining in-stream permanent pools, and potentially causing an increase in stream salinity at this time. These types of underground water dependent ecosystems are also known as baseflow systems.

Streams that exist to the northern extent of the PWA include Morambro Creek, Naracoorte Creek, Mosquito Creek and Yelloch Creek. Mosquito Creek includes areas of baseflow, and permanent pools within the LLC PWA which have a high likelihood of dependency on underground water. The stream and permanent pools support threatened fish communities including nationally threatened species Yarra Pygmy Perch (*Nannoperca obscura*) and Dwarf Galaxias (*Galaxiella pusilla*).

In the south east portion of the catchment, underground water discharge contributes substantially to the flow of a number of streams and drains on the south coast including Eight Mile Creek, Deep Creek and Fifty Four Foot Drain.

Other Drains receiving input from underground water within the South East, including Drain M, also provide habitat for threatened species and are drought refuges.

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 also contributes to the water in wetlands, but underground water influences the timing, duration and extent of wet conditions during dry periods. Wetlands support particular plants and animals, such as frogs, invertebrates and water birds.

Wetlands historically characterised the landscape in the South East, however, since European settlement, drainage and land clearance has seen their reduction from 44% of the South East Natural Resources Management Region to less than 6%. Recent work has concluded that less than 10% of these remaining wetlands are intact (DFW 2010).

The majority of remaining wetlands in the LLC PWA have some dependence on the unconfined aquifer. A classification of wetland underground water dependence in the South East, based on the depth to water table, indicates that a large proportion of wetlands in the PWA have a high likelihood of seasonal or permanent interaction with the unconfined aquifer (SKM 2009). The South East Water Science Review (DFW 2010) reports that the majority of wetlands in the South East (77% of wetlands by number and 96% of wetlands by area) are highly likely to be dependent on underground water. This relationship is consistent for the LLC Prescribed Wells Area.

While a comprehensive review of all significant underground water dependent wetlands cannot be described in this section, representative examples of the diverse range of wetland ecosystems which occur within the PWA are noted.

Bool Lagoon and Hacks Lagoon in the north eastern portion of the PWA, and Piccaninnie Ponds in the south of the PWA are Ramsar listed, internationally recognised wetlands. Bool and Hacks Lagoons were included on the Ramsar List in 1985 and Piccaninnie Ponds was included in 2013. Since the introduction of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), the inclusion of a wetland on the Ramsar List entails specific management obligations, namely the maintenance of the ecological character of the site and the wise use of resources. Water management is central to these obligations.

The water regime of Bool and Hacks Lagoons and surrounding wetlands (Hacks Lagoon and Mary Seymour Conservation Park) is influenced by a shallow water table and discharge, and the possible formation of underground water mounds beneath them. Mounds, where they occur, affect seepage rates and the duration and extent of surface flooding (Department for Environment and Heritage 2006). Underground water also provides water to phreatophytic vegetation, particularly Swamp Paper-bark (*Melaleuca halmaturorum)* which is present in

Bool Lagoon, and within the wetlands and floodplains of the central and northern areas of the LLC PWA.

Wetlands supported by underground water within the PWA contain populations of EPBC Act listed threatened species, including the nationally vulnerable Southern Bell Frog (*Litoria raniformis*) in Bool and Hacks Lagoons, Lake Ormerod, and Rocky Swamp in the north and north east of the PWA. Populations of nationally vulnerable native fish species Yarra Pygmy Perch (*Nannoperca obscura*) also occur within Bool and Hacks Lagoons.

In the region of the PWA adjacent to the border of South Australia and Victoria, a large number of wetlands are semi-permanent and interact with the water table by forming underground water mounds or by receiving underground water discharge in springs. Penola Conservation Park, which includes Green Swamp, has representative wetland vegetation containing Prickly Tea-tree (*Leptospermum continentale*) and Swamp Gum (*Eucalyptus ovata*).

The Marshes is a seasonally inundated swamp complex located to the east of the Mount Burr Forest. The wetland lies at 76 metres Australian Height Datum (AHD) and is likely to receive underground water discharge from the perched water table which lies under the higher ground to the west. The wetland supports heath vegetation of *Melaleuca squarrosa* and *Leptospermum continentale,* with a sedge understorey on sandy plains and swamp communities within local depressions.

In the coastal regions of the PWA, wetlands support Tea Tree woodlands and coastal sedges including *Lepidosperma, Eucalyptus, Melaleuca* and *Leptospermum* species. These ecosystems support several threatened plants and animals, including the Swamp Antechinus (*Antechinus minimus*) and Swamp Skink (*Egernia coventryi*), which are both listed as endangered within South Australia, the Olive Whistler (*Pachycephala olivaceae*) and Rufous Bristlebird (*Dasyornis broadbenti*) which are listed as vulnerable in South Australia, the Small Sickle Greenhood Orchid (*Pterostylis sp. aff. falcata [furcata])* which is endangered in South Australia, and the Swamp Greenhood Orchid (*Pterostylis tenuissima)* which is listed as nationally vulnerable. These species rely on underground water, either directly or indirectly through other plant associations that are directly dependent on underground water. These ecosystems rely on very specific environmental conditions and appear to be highly susceptible to water level changes.

In the north to north west of the PWA, the waters of the wetlands are generally fresh inland, but become progressively more saline towards the north-west. Inland wetlands, such as the Reedy Creek Watercourse, typically support sedge vegetation with fringing stands of species tolerant to water logging such as *Eucalyptus camaldulensis, Melaleuca* species and *Leptospermum* species.

Lake Hawdon is a brackish wetland complex near Robe. The salinity of this complex and shallow depth to underground water indicates that the area is a likely discharge point for underground water.

Near Kingston, the ground elevation declines to less than five metres AHD. The underground water dependence of ecosystems in this area is indicated by the permanent surface water conditions of the wetlands and the presence of deep-rooted vegetation that requires fresh water. Hog Lake, Salt Lake and Butchers Lake are all examples of coastal salt marsh flats dependent on saline surface water inundation and are fringed by *Leptospermum lanigerum* and *Melaleuca halmaturorum* that depend on fresher water, probably supplied by the underground water table. The water balance of the wetlands is likely to be strongly influenced by underground water discharge. Salt Lake and Butchers Lake lie within Butchers Gap Conservation Park.

The Robe to Beachport area comprises saline wetlands and lakes, and freshwater seeps. Underground freshwater seeps along the base of the Woakwine Range are likely to be fed by local recharge on the range, and support freshwater shrubs and trees on the fringes of the saline lakes, including *Melaleuca lanceolata, M. halmaturorum, Myporum insulare* and *Leptospermum lanigerum*. Lakes St Clair, Eliza, George and Robe were formed as marine lagoons which became isolated from the sea by the formation of beach dune systems. They are saline and recharged by underground water flows, direct rainfall and a small quantity of

local runoff. The area includes the Little Dip Conservation Park, Beachport Conservation Park and Lake Robe Game Reserve (which is on the register of the National Estate), which are of high conservation significance.

In the north west of the PWA**,** the wetland systems generally consist of a series of depressions occurring between parallel quaternary inland dunes, which are linked by extensive floodplains, and are generally known as watercourses. Flow to the watercourses has been extensively modified by drainage. Wetlands in this area have varied relationships to underground water. Wetlands and floodplains may be permanent, semi-permanent or temporary, and have a range of salinities depending upon the depth to and salinity of underground water. Rushy Swamp, the Deep Swamp complex and the West Avenue Watercourse are underground water dependent wetlands of high ecological value in this area.

The Seasonal Herbaceous Wetlands (freshwater) of the Temperate Lowland Plains was recognised as a critically endangered ecological community under the EPBC Act in March 2012. These wetlands are defined as seasonally inundated, freshwater ecosystems of flats and plains, dominated by native wetland grasses and herbs (Department of Sustainability, Environment, Water, Population and Communities SEWPaC 2012). Whilst rainfall is recognised as the main water source, within the LLC PWA, there are examples of wetlands meeting the listing criteria that are reliant on the presence of shallow underground water for sustaining seasonal surface water inundation.

In the last decade, the underground and surface water hydrology of the South East region has changed, with reduced water inflows. This has resulted in a change in the floristic composition of wetlands, with salt sensitive species present pre-2000 being lost and salt tolerant species now occurring. Due to a lack of flushing in-flows to wetlands, salt has been accumulating in wetland sediments, such that when wetlands are full or still filling, the surface water salinities in underground water dependent wetlands are higher than the surrounding underground water (Goodman 2010).

2.1.4 Phreatophytic vegetation

Phreatophytic vegetation is vegetation which exists specifically due to the presence of underground water which sustains deep-rooted plants in an otherwise dry environment. Phreatophytic vegetation is often closely associated with wetlands.

Eucalyptus camaldulensis (in the northern area) is the dominant tree species in many wetlands, depressions and water courses where the underground water table is less than 10 metres below the surface. These trees are likely to be dependent on underground water in many areas, varying from permanent use to temporary dependence during dry periods. Remnants of *Eucalyptus camaldulensis* woodland are also present, along with other communities which are likely to be underground water dependent including *Melaleuca halmaturorum* tall shrubland, *Typha domingensis* closed sedgeland, *Eucalyptus ovata* / *E. viminalis* woodland and *Pteridium esculentum* closed fernland with emergent *Eucalyptus* species.

In the region of the PWA adjacent to the South Australian and Victorian border, there are substantial remnants of vegetation that are likely to be dependent on underground water, including *Eucalyptus ovata*, *E. viminalis* woodland, *Xanthorrhoea caespitosa, Leptospermum continentale* open shrubland, *Melaleuca brevifolia* low shrubland and *Eucalyptus camaldulensis var. camaldulensis* woodland.

2.1.5 Marine environment

The marine environment receives a significant quantity of underground water from aquifer discharge and through baseflow discharging to watercourses which then flow to the ocean. The influx of fresh water will affect the marine habitat along the coast and may support particular species or communities. However, there is little data available to describe such an interaction.

A number of near-shore marine ecosystems, including freshwater beach springs and ecosystems supported by underground water derived surface water flows, have been identified in the coastal region to the south and south west of Mount Gambier.

It is considered that where ecosystems are identified within areas of underground water discharge in the marine environment, alteration to the underground water flux or flow, and water quality is likely to have an impact on the ecosystem.

2.2 Assessment of the quantity and quality of water needed by water dependent ecosystems

Section 76(4)(a)(i) of the Act requires a water allocation plan to provide an assessment of the underground water quantity and quality needed by the ecosystems that depend on the water resource and the times at which, or periods during which, those ecosystems will need that water.

2.2.1 Environmental water requirements

The Act defines 'environmental water requirements' to mean: "those water requirements that must be met in order to sustain the ecological values of ecosystems that depend on the water resource, including their processes and biodiversity, at a low level of risk".

The exact environmental water requirements of groundwater has not been fully studied for wetlands in the South East of South Australia, however, the South East Water Science Review (DFW 2010) states that wetlands in the South East are experiencing prolonged dry conditions and increasing salinity. These ecosystems are at risk due to dropping groundwater levels and/or increases in underground water salinity. An increase in depth to the water table of 1.5 metres past current levels is expected to result in total loss of a wetland. Many wetlands have shown loss of biodiversity and a shift in species composition towards those more tolerant of saline conditions.

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 and can reduce an ecosystem's size or reduce its biodiversity values. As a result, activities affecting these factors, such as vegetation clearance, land use practices, irrigation, underground water extraction and recharge, are proposed to be managed with regard to their impact on underground water dependent ecosystems.

In 2009, Wetland Vegetation Component (WVC) models for 112 wetlands in the South East were developed and/or revised (Ecological Associates 2009). Each WVC represents a specific type of wetland vegetation composition and structure. A model was developed for each WVC to define the ideal water and salinity requirements for supporting the type of vegetation and dependent species (or aquatic fauna). The water and salinity requirements relate to water from all sources (including surface water). As part of the South East Water Science Review, the salinity tolerance ranges and salinity target values for each WVC model were updated (Goodman 2010). In addition, Cooling *et al.* (2010) undertook field work to test the assumptions made regarding the arrangement of WVCs across the elevation gradient, and to incorporate fish into the approach for prescribing the hydrological requirements of wetlands. The resulting revised hydrological and salinity requirements for the 72 wetlands studied are provided in Table 11.22 in Cooling *et al.* (2010).

In general, salinities of wetlands in the LLC WAP area are freshest in the south (<1,000 μScm^{-1}), grading to brackish in the north (1,000 – 10,000 μScm^{-1}), with the presence of saline coastal lakes north of Beachport up to 58,000 μScm^{-1}. The majority of wetlands in the LLC region require inflow salinities <5,000 μScm^{-1}, although ecosystem tolerances to inflow salinities (of surface water or underground water) vary dependent on ecosystem type. Freshwater native fish species recorded in wetlands have limited tolerance to rises in salinity, where moderate to high salinity (>5,000 – 10,000 μScm^{-1}) is likely to be above juvenile or adult tolerance of most species occurring in study wetlands (Cooling *et al.* 2010). Cooling *et al.* (2010) provide target salinity inflows for various wetland types, from <1,000 μScm^{-1} for seasonal freshwater sedgelands, to <58,000 μScm^{-1} for permanent saline coastal lakes.

The depth to underground water has increased in some areas of the LLC PWA. This threatens to reduce underground water discharge or 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.

Cooling *et al.* (2010) found that even relatively small drops in water level will degrade the ecological condition of wetlands. Sixty-three wetlands with a high degree of dependence on underground water were examined. Due to the shallow nature of many wetlands in the South East region, a permanent drop of 60 centimetres in the water level in the wetland would lead to the complete loss of over one third of the 63 wetlands examined. A reduction in water level of 1.5 metres has the potential to cause the loss of all but the deepest wetlands. At best, the ecosystems within these remaining wetlands would be severely degraded, having suffered extensive reductions in the extent and quality of aquatic habitat.

2.2.2 Environmental water provisions

Section 76(4)(b)(i) of the Act provides that a water allocation plan must achieve an equitable balance between environmental, social and economic needs for water.

For the purposes of the Plan 'environmental water provisions' mean those parts of environmental water requirements that can be met at any given time, with consideration of existing users' rights and social and economic impacts.

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

The Plan accordingly sets principles for water management that aim to maintain the current quantity and quality of underground water available for these ecosystems by virtue of:

- no further declines and, where possible, recovery in underground water table 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 that are sensitive to salinity levels; and
- the 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 at which the above conditions can continue to be met has been determined with regard to the 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 Target Management Level (TML) (see section 4 (*Assessment of the capacity of the resource to meet demand*) for further details on the TML). The Plan sets out the principles for the reduction of allocations so as not to exceed the TML.

A minimum of 10% of total available recharge has been set aside to provide for environmental water requirements in general, to ensure levels of underground water across the LLC do not decline and thus provide the water needed by underground water dependent ecosystems (see Section 4 for the calculation of total available recharge). However, as not all available water has been allocated and not all allocations are extracted, the volume of total available recharge not extracted on a regional basis each year currently exceeds 10% (Table 2.2).

TABLE 2.2 TOTAL RECHARGE COMPARED TO ALLOCATION AND TOTAL EXTRACTION IN THE LOWER LIMESTONE COAST PRESCRIBED WELLS AREA (UNCONFINED AQUIFER)

Lower Limestone Coast Prescribed Wells Area						
Total annual average vertical recharge (ML/year)	Total allocation + unlicensed requirements* (ML/year)	Percentage of recharge not allocated (%)	Total estimated extraction 2009/2010 (ML/year)	Percentage of recharge not extracted in 2009/2010 (%)	Total estimated extraction 2010/2011 (ML/year)	Percentage of recharge not extracted in 2010/2011 (%)
1,295,166	963,865	25.6	508,819	60.7	567,472	56.2

*includes allocations for irrigation (except volumes assumed to return to the aquifer through deep drainage), recreation, industry, aquaculture and public water supply and volumes to be allocated to commercial forestry, plus stock and domestic and farm forestry requirements.

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

The Plan intends to provide for the maintenance of the water requirements of underground water dependent ecosystems of high conservation value through an additional assessment (see below) to determine a minimum setback distance for any new wells, increases in underground water extraction, or first rotation commercial forests in the vicinity of these ecosystems.

The provision of environmental water under the Plan – by virtue of the management of depth to the water table and groundwater salinity, together with setback distances for further development around high value ecosystems described above, is expected to maintain groundwater-dependent ecosystems at an acceptable level of risk.

2.2.3 South Australian Wetlands Inventory Database

The South Australian Wetlands Inventory Database (SAWID) is maintained by the Department of Environment, Water and Natural Resources (DEWNR) and contains approximately 16,000 polygons representing approximately 196,500 hectares of wetlands in the South East Region of South Australia. The outline of each of these polygons was derived largely by visual interpretation of aerial photography (Miles *et al.* 2010).

As part of the South East Water Science Review, the validity of wetland mapping in SAWID and the accuracy of wetland mapping were investigated. The first project assessed the overall validity of the SAWID wetland layer, by assessing remotely sensed evidence (LANDSAT imagery) for aquatic ecosystem presence within wetland polygons currently mapped in SAWID (Miles *et al*. 2010). A key finding of this study was that the currently mapped SAWID wetland polygons are largely valid in representing a sizeable proportion of wetlands in the landscape, but that the current SAWID layer is likely to underestimate regional wetland coverage (Miles *et al*. 2010).

The second project sought to verify the presence and accuracy of wetlands mapped within SAWID by undertaking a field based ground-truthing exercise in six trial areas in plantation forests of the South East (Billows *et al*. 2010). It was found that the spatial layer in SAWID is largely valid at the broad scale, with 88% of the 83 polygons visited exhibiting wetland characteristics. However, the accuracy of any individual polygon that has not been ground-truthed can vary considerably with:

- the overall area mapped in the project representing 52% of the previously mapped total area;
- any given individual wetland on average being 74% accurate in terms of area or 57% accurate in terms of the original polygon area overlapped; and
- 36% of new wetlands having some Landsat evidence of previous detected water somewhere within their extent (Billows *et al*. 2010).

It was concluded that "SAWID data, even with its limitations, is the best available source of information for wetland ecosystems in the South East region of South Australia and remains an obvious tool for policy makers interested in wetland conservation to call upon. Given this important role, a long-term plan to address its limitations, utilising methods developed for this project to achieve continuous improvement of the spatial data in SAWID, is recommended" (Billows *et al*. 2010).

2.2.4 Previous policy in the 2001 Comaum-Caroline, Lacepede Kongorong and Naracoorte Ranges Water Allocation Plans

The 2001 Comaum-Caroline, Lacepede Kongorong and Naracoorte Ranges Water Allocation Plans (SECWMB 2001a, 2001b, 2001c) provided an allocation for the environment by setting aside an allowance of 10% of available underground water recharge.

In addition, thresholds were developed for each underground water dependent ecosystem on a land unit scale (URS Australia 2000), based on water quality, water levels and the level of dependence on underground water. These thresholds were determined for underground water dependent ecosystems across the region and, if exceeded, required the management of the underground water resource to be reviewed. These thresholds are set out in the 2001 water allocation plans and are taken into account by DEWNR when processing water transfers and allocations (SECWMB 2001a, 2001b, 2001c).

In 2004, a Technical Reference Group reviewed all the work undertaken in the South East relating to the protection of underground water dependent ecosystems. This group focused on reviewing the methodology and underlying principles which determined the policy in the 2001 Plans.

The group identified four major limitations to the 2001 methodology:

- equal priority was given to all underground water dependent ecosystems, regardless of value;
- setting a limit to the amount of water available for extraction on a management area scale may not protect underground water dependent ecosystems, as it provides a volume of water but not necessarily access to that water for the underground water dependent ecosystem;
- ecosystems were considered on a land unit scale, however information is required for each individual underground water dependent ecosystem; and
- lack of monitoring information to determine where thresholds have been exceeded.

These limitations prompted the Board to undertake a project to develop additional policies to those in the 2001 water allocation plans, to protect significant underground water dependent ecosystems (Resource and Environmental Management 2005, 2006). The results of this project are summarised in the next section.

2.2.5 Identification of priority ecosystems and ecosystems of high conservation value

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. The identification and protection of particularly significant or threatened ecosystems is a priority.

A risk assessment process has been used (by environmental consulting company 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 an adverse impact and the consequences of that impact. It involved a multi-tiered assessment approach (REM 2005) with the following five stages:

1. REM risk assessment ranking;
2. Commonwealth Scientific and Industrial Research Organisation (CSIRO) underground water dependence assessment;
3. Local knowledge rapid assessment;
4. Identification of high value wetlands using SAWID; and
5. Classification of underground water – surface water interactions for water dependent ecosystems (SKM 2009).

REM's ranking of wetland sites was based on conservation value, the threat posed to underground water conditions by water-affecting activities such as 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).

Thirteen priority wetland complexes were identified for immediate protection in the LLC PWA through this method, as follows:

1. Hog Lake Complex;
2. Robe to Beachport Coastal Lakes Complex;
3. Lake Hawdon Complex;
4. Mary Seymour and Bool Lagoon Complex;
5. Deadmans Swamp Complex;
6. Green Swamp Complex;
7. Topperwein and Trail Waterhole Complex;
8. Whennan Complex;
9. The Marshes and Overland Track Complex;
10. Honan and Kangaroo Flat Complex;
11. Lower South East Rising Springs West Complex;
12. Lower South East Rising Springs Central Complex; and
13. Lower South East Rising Springs East Complex.

A map identifying the locations of the thirteen priority wetland complexes in the LLC PWA is shown in Figure 14 (*Appendix of Figures and Tables).*

Furthermore, a significant number of additional underground water dependent wetlands in the South East of South Australia have been identified in SAWID as having high or very high conservation value, as shown in Table 2.3 below and Figure 14 (*Appendix of Figures and Tables*). Where ecosystems are of this value, steps must be taken to prevent their degradation due to the taking and use of underground water.

TABLE 2.3: UNDERGROUND WATER DEPENDENT WETLANDS OF HIGH OR VERY HIGH CONSERVATION VALUE IN THE LOWER LIMESTONE COAST AT NOVEMBER 2012#

UNDERGROUND WATER DEPENDENT ECOSYSTEM	WETLAND COUNT*	UNDERGROUND WATER DEPENDENT ECOSYSTEM	WETLAND COUNT*
Hog Lake and Butchers Gap Complex	12	Telford Scrub	3
Hacket Hill Complex	26	Sheepwash Swamp	1
Green Swamp Complex	1	Robe to Beachport Coastal Lakes Complex	22
Kalandra Swamp Complex	6	Reedy Creek	1
Hanson Scrub	1	Naracoorte Range Wetland	1
Grants Swamp	2	Mosquito and Yellloch Creeks	2
Fairview Wetland Complex	4	Nangwarry & Horshoe Paddock	3
Dirty Joes	1	Moyhall Swamp	1
Deep Swamp Complex	13	Mount Scott	2
Deadmans Swamp Complex	1	Lake Frome & Mullins Swamp Complex	10
Cockatoo Lake & Clay Lake	13	Marcollat Watercourse	15
Broadlands	1	Kangaroo Flat Complex	1
Borderlands	1	LSE Rising Springs Central Complex	3
Bool Lagoon Wetland Complex	8	LSE Rising Spring West Complex	3
Blackfellows Cave Wetland	2	Lower Coorong Lakes	3
Big Heath Complex	21	Lochaber Swamp	1
Del Fabbros Swamp Complex	3	Lake Ormerod	1
West Avenue Complex	34	Yeulba Swamp Complex	2
Toops Gap	1	Lake Hawdon Complex	14
Lake Bonney & Bucks Lake Complex	12	Barnett Road & Rushy Swamp Complex	12
Keilira Swamp	2	McInnes Wetland	1
		Total	**267**

#: sourced from South Australian Wetland Inventory Database for the South East

* : Wetland count indicates the number of separate wetlands located within the complex as mapped in Figure 14 (*Appendix of Figures and Tables*). Some wetlands in this table form part of the same complex as the 13 priority wetlands.

The WAP proposes to protect underground water dependent ecosystems of high or very high conservation value in the LLC PWA, 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 high or very high conservation value in SAWID;

c) any part of the wetland (as mapped in SAWID) falls within a 2.25 kilometre radius from the proposed 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 metres/year (measured over the preceding five years) in the nearest observation well or wells.

2.3 Setback distance

A specified setback distance is used to protect the 13 priority wetland complexes identified in the LLC, as well as for any underground water dependent ecosystems listed as having high or very high conservation value identified for protection according to the criteria described in the previous section.

The setback distance protects underground water availability by requiring that any new wells, increases in extraction, or first rotation commercial forests must be located at a distance from the wetland that will not cause a reduction in the relevant water table. The aim of this is to maintain the available underground water conditions for the wetland. The specified setback distance is calculated specifically for each individual type and size of development (i.e. wells for licensed extraction and commercial forests). A setback distance does not apply to wells exclusively for stock and domestic use, or to farm forests.

2.3.1 Setback distance for unconfined aquifer wells

The setback distance for unconfined aquifer wells is calculated using the Dependent Ecosystems (DE) equation. 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, amongst other parameters. The equation considers these parameters to determine whether the taking or use of water at that point will have a detrimental effect on water levels (identified as a 0.05 metre decline) 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 2.4.

To provide some flexibility for water licensees, the Plan provides for the Minister, on written request by a licensee, to approve a different methodology of determining the set-back distance to that described above, where the licensee can demonstrate to the Minister's satisfaction that the underground water dependent ecosystem(s) will not be detrimentally affected by the proposed well.

Finally, the WAP requires that the location of any replacement well is no closer to the wetland than the original well.

TABLE 2.4: INPUT PARAMETERS FOR CALCULATING THE REQUIRED SETBACK DISTANCE FOR UNDERGROUND WATER EXTRACTION IN THE VICINITY OF UNDERGROUND WATER DEPENDENT ECOSYSTEMS IDENTIFIED FOR PROTECTION

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,* metres/day) x aquifer thickness (*D*, metres)	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)	Length of irrigation seasons (REM 2006, Stage 2 report, Appendix B.2) Lower South East 73 days Mid-South East 73 days Upper South East 66 days
u, dimensionless parameter of the Theis well function	= $r^2S/4KDt$
π, or pi, is a numerical constant that represents the ratio of the circumference of a circle to its diameter, on a flat plane surface.	= 3.1416
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 (in metres)	Maximum drawdown allowed: 0.05 metres.

2.3.2 Setback distance for commercial forests

A setback distance for commercial forests from the 13 priority wetland complexes and the underground water dependent ecosystems of high conservation value identified for protection, shall be calculated by determining whether the use of water by a proposed commercial forest is likely to have a detrimental effect on water levels (identified as a 0.05 metre decline) in the vicinity of the wetland at the end of the forest rotation.

If the Minister is unable to determine a setback distance using this criterion for the 13 priority wetland complexes, the forest shall have a defined setback distance as shown in Table 2.5. The setback distances shown in Table 2.5 have been calculated for each wetland complex using the DE equation, with the pumping rate per day (Q value) determined using the 90th percentile of indicative volumetric allocations for that management area. In all cases, the minimum setback distance shall be 20 metres.

For wetlands of high conservation value identified for protection, if the Minister is unable to determine a setback distance based on the 0.05 metre decline criterion, the setback distance shall be at least 20 metres.

In addition, to provide some flexibility for forest water licensees, the Plan provides for the Minister, on written request by a forest water licensee, to approve a different methodology of determining the set-back distance to that described above, where the licensee can demonstrate to the Minister's satisfaction that the underground water dependent

ecosystem(s) will not be detrimentally affected by the proposed commercial forest being planted.

The Plan also suggests to the Minister that when forest water licences are issued to existing commercial forests following the declaration of a declared forestry area, that the Minister give consideration to endorsing a condition on the licence that following the clearfelling of the forest, that the replacement forest (if any) shall be located at least 20 metres from one of the 13 priority wetland complexes or a wetland of high conservation value identified for protection.

TABLE 2.5: SETBACK DISTANCES FOR FIRST ROTATION COMMERCIAL FORESTS FROM THE 13 PRIORITY WETLAND COMPLEXES

	Priority Wetland Complex	Management Area	Setback distance for commercial forests (metres)
1	Hog Lake Complex	Mount Benson	1,751
2	Robe to Beachport Coastal Lakes Complex	Waterhouse and Lake George	1,410
3	Lake Hawdon Complex	Bray, Waterhouse, Ross	1,410
4a	Mary Seymour Complex	Moyhall	2,330
4b	Bool Lagoon Wetland Complex	Bool	1,977
5	Deadmans Swamp Complex	Joanna	1,961
6	Green Swamp Complex	Monbulla	1,853
7	Topperwein and Trail Waterhole Complex	Zone 2A	1,640
8	Whennan Complex	Riddoch	1,098
9a	Overland Track Complex	Riddoch	1,098
9b	The Marshes Complex	Hindmarsh	1,684
10	Honan and Kangaroo Flat Complex	Young	1,439
11	Lower SE Rising Springs West Complex (Winterfield Creek, Middle Point Swamp)	MacDonnell, Kongorong	1,211
12	Lower SE Rising Springs Central Complex (Cress Creek Spring, Jerusalem Creek Spring, The Woolwash, Ewens Ponds Complex, Stratman Pond)	Donovans	1,169
13	Lower SE Rising Springs East Complex (Piccaninnie Ponds, Green Point, Pic Swamp)	Donovans	1,169

References and Bibliography

Billows, C., Dean, C., Bachmann, M., Herpich, D., Herpich, M., Miles, M. and Farrington, L. 2010, 'Testing the accuracy of SAWID wetland mapping within forest plantations' in *South East Water Science Review*, for the Lower Limestone Coast Taskforce**,** ed J. Brookes, Government of South Australia, through the Department for Water, Science, Monitoring and Information Division , pp.9-1 – 9-30.

Cooling, M., Taylor, B., Faast, R and Hammer, M. 2010, "Water quantity impacts on wetlands', in *South East Water Science Review*, for the Lower Limestone Coast Taskforce**,** ed J. Brookes, Government of South Australia, through the Department for Water, Science, Monitoring and Information Division , pp.11-1 – 11-104.

Department for Environment 2006, *Park Management and Ramsar Plan: Bool Lagoon Game Reserve and Hacks Lagoon Conservation Park*, Government of South Australia.

Department for Water 2010, *South East Water Science Review*, Lower Limestone Coast Water Allocation Plan Taskforce, Adelaide.

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

Ecological Associates, 2009, *Estimation of Water Requirements of Wetlands in the South East of South Australia*. Prepared for the Department of Water, Land and Biodiversity Conservation, South Australia.

Fass T and PG Cook. 2005, Reconnaissance survey of groundwater 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 groundwater dependent ecosystems; Report 2 Field studies. Prepared for Land & Water Australia. December 2006.

Goodman, A. 2010, 'Water quality impacts on wetlands" in *South East Water Science Review*, for the Lower Limestone Coast Taskforce**,** ed J. Brookes, Government of South Australia, through the Department for Water, Science, Monitoring and Information Division, pp.10-1 – 10-32.

Humphreys, W. F. 2008, 'Rising from down under: developments in subterranean biodiversity in Australia from a groundwater fauna perspective'. *Invertebrate Systematics* 22:85-101.

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 2007/1, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Mount Gambier.

Miles, M., Dean, C., Bachmann, M., and Cameron, J. 2010, 'Validation of wetland mapping in the South East region of South Australia. A Landsat-based investigation.' in *South East Water Science Review*, for the Lower Limestone Coast Taskforce**,** ed J. Brookes, Government of South Australia, through the Department for Water, Science, Monitoring and Information Division, pp.8-1 – 1-34.

REM 2005, *A review of the environmental water requirements of the groundwater 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 groundwater 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.

SE Catchment Water Management Board (SECWMB) 2001a, *Water Allocation Plan: Lacepede Kongorong Prescribed Wells Area*.

SE Catchment Water Management Board (SECWMB) 2001b, *Water Allocation Plan: Comaum-Caroline Prescribed Wells Area*.

SE Catchment Water Management Board (SECWMB) 2001c, *Water Allocation Plan: Naracoorte Ranges Prescribed Wells Area*.

SEWPaC (2012). Advice to the Minister for Sustainability, Environment, Water, Population and Communities from the Threatened Species Scientific Committee (the Committee) on an Amendment to the List of Threatened Ecological Communities under the Environment

Protection and Biodiversity Conservation Act 1999 (EPBC Act – Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains Listing advice. Department of Sustainability, Environment, Water, Population and Communities. URL: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/97-listing-advice.pdf

SKM 2009, *Classification of ground water – surface water interactions for water-dependent ecosystems in the South East of South Australia*. Report to the Department of Water, Land and Biodiversity Conservation, Mount Gambier.

Thurgate, M.E. (1992), *Some preliminary observations on the stromatolites of the Blue Lake, South Australia. Proceedings Tenth ASPAB Conference*. Australian Society for Phycology and Aquatic Botany, Sydney.

Thurgate, M., 1995 '*Sinkholes, Caves and Spring Lakes – an Introduction to the Unusual Aquatic Ecosystems of the Lower South East of South Australia'*, South Australian Underwater Speleological Society.

URS Australia 2000, *Assessment of the environmental requirements of groundwater 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 impacts of taking or using water from the LLC PWA upon the quantity or quality of water from other water resources in the LLC PWA and adjacent PWAs. Within the PWA, it considers the potential for impacts upon streams, springs, rivers, wetlands, drains and other surface water bodies, and the possibility of impacts arising from the relationship between the two aquifers.

Science has shown that plantation forestry expansion can significantly impact surface water catchment yield and underground water recharge and that, under some circumstances, plantation species can extract water directly from shallow water tables (Benyon and Doody 2004, Benyon *et al*. 2006, Benyon *et al*. 2008). The impacts of this on dependent environmental ecosystems are not yet known but will be considered during the implementation of the Plan.

There are a number of wetlands, springs, streams, a river (the Glenelg River), drains and other surface water bodies reliant on water from the LLC PWA. Specific water resources within the LLC PWA that may be impacted by the taking of water from the LLC PWA include:

- rising springs, as listed in Section 2 (*Assessment of the needs of water dependent ecosystems*), including Piccaninnie Ponds, Ewens Ponds;
- the Glenelg River;
- Morambro, Naracoorte, Mosquito and Yelloch Creeks;
- streams including Eight Mile Creek, Deep Creek and Fifty Four Foot Drain*;*
- the Blue Lake and Valley Lake;
- Lake Bonney;
- lakes St Clair, Eliza, George and Robe, located in the Robe to Beachport Coastal Lakes Complex; and
- lakes Leake and Edward in the Mount Burr Range.

In addition, as indicated in Section 2, there are numerous wetland areas in the LLC PWA, as well as an extensive system of drains, some of which are believed to drain underground water as well as surface water.

3.1. Springs and Wetlands

Wetlands in the LLC PWA vary in terms of their relationship with, and reliance on, underground water. Where the wetlands are perched above the water table, the taking and use of underground water is unlikely to have a detrimental effect on the quality and quantity of water within these wetlands.

Where wetlands exist in dune-interdune complexes, wetland depressions are fed primarily by surface runoff, but in the western parts of the interdunal flats, underground water is particularly shallow and is thought to discharge to the surface environment.

While a number of wetlands are perched in the region adjacent to the South Australian and Victorian Border and are therefore independent of underground water, most of the wetlands in this region lie at elevations close to the water table, and are likely to form underground water mounds and receive underground water discharge, as well as surface water. It is likely that the taking and use of underground water will have a detrimental effect on these wetlands.

The northern and north eastern areas of the LLC PWA are generally more than 10 metres above the water table and are not believed to support underground water dependent wetlands. Deadman's Swamp and other depressions like it are likely to be dependent on underground water and specifically a shallow water table. This area is characterised by numerous scattered wetlands, many of which have conservation significance. Hacks Lagoon Conservation Park is the only semi-permanent wetland, and the surface flow which enters the wetland from Mosquito Creek is believed to be supplemented by underground water discharge. Hacks Lagoon forms part of the Bool Lagoon Ramsar site.

A number of underground water springs discharge into Mosquito Creek which support base flow and permanent pools within the creek (Sheldon 2007). These pools provide significant permanent refuge areas for aquatic fauna, including nationally threatened native fish species. Underground water is thought to be a significant component of the runoff from the Mosquito Creek Catchment, although the spatial and temporal contributions are not well understood (Ecological Associates 2008).

Where springs and wetlands (known to be dependent on underground water) exist in close proximity to water affecting activities, such as underground water pumping or forestry, it is likely that these activities will affect the quantity and quality of water available to these ecosystems. The extent to which it will detrimentally affect these systems is unknown.

Currently, little information is available for identifying the relationship between underground water extraction and impact on wetlands and drains in the LLC PWA.

There has been a long term decline in water levels in the area surrounding Mount Gambier. The primary influences on the underground water level are assumed to be climate (e.g. rainfall amount and timing) and the rate of extraction of underground water from the aquifer.

A slight decline in water levels has been noted within the southern coastal region. This slight decline can also be largely attributed to a period of consecutive dry years. Underground water extraction may be a contributing factor to this slight decline, but the extent of this contribution is unknown. It is recommended that further monitoring and assessment be implemented to determine if underground water extraction is contributing to this decline, and if so, to determine the degree to which these extractions are affecting the springs, wetlands and drains throughout this region.

3.2. Streams, Rivers and Drains

Glenelg River

The Glenelg River flows through the south eastern corner of the PWA, where a short reach of the river crosses the Victorian Border. The contribution of underground water flow to the river is likely to be minor in comparison to the substantial surface and underground water catchment which lies within Victoria and includes part of the Grampians high rainfall area. Furthermore, the water table in the vicinity of the Glenelg River lies in the Ewens Ponds – Mt Schank Trough and there is a low hydraulic gradient towards the river, therefore taking and use are unlikely to have a detrimental impact on the Glenelg River.

Morambro and Naracoorte Creeks

Morambro and Naracoorte Creeks lie at elevations of greater than five metres above the water table and are not believed to receive significant underground water discharge. They are likely to be predominantly losing (recharging) creeks, with catchments extending into Victoria. Thus use of the unconfined aquifer resource should have no direct effect on the flow regime of the watercourses. Therefore it is unlikely that the taking and use of underground water will have a detrimental effect on the quantity of quality of water available for these creeks.

Mosquito and Yelloch Creeks

The Mosquito and Yelloch Creeks Catchment extends into Victoria and is the major catchment for Ramsar listed Bool and Hacks Lagoons. Permanent pools and stream base flow are important features of Mosquito and Yelloch Creeks, supporting nationally threatened native fish and frog species as well as providing an important drought refuge. Underground water discharges into sections of Mosquito and Yelloch Creeks, and this discharge is accentuated as it flows through the Naracoorte Range. The taking and use of underground water close to areas supporting base flow and permanent pools, is likely to have a detrimental impact on water quantity for these creeks.

Drains

An extensive system of drains exists in the LLC PWA, and underground water is believed to contribute to the flow of water in some drains, which constitute artificial ecosystems. The ecology of these drains is not documented. Largely, the underground water and surface water interaction of these drains is unknown, though it is considered unlikely that the taking and use of underground water will have a detrimental impact.

3.3. The Blue Lake and Other Surface Water Bodies

The Blue Lake

The Blue Lake, located in the centre of Mount Gambier, is a source of water for the city's population of approximately 23,000 people. Underground water from the unconfined aquifer provides the inflow to the Blue Lake. The lake level reflects the underground water table of the unconfined aquifer.

The primary influences on the Blue Lake water level are assumed to be climate (e.g. rainfall amount and timing) and the rate of extraction of underground water from the aquifer that supplies the Blue Lake.

Changes in underground water levels within the regional aquifer will have an influence on water levels in the Blue Lake. Underground water levels can change due to variations in the rate and location of water extraction along with the amount of recharge to the aquifer. A large amount of water is recharged directly into the unconfined aquifer under the City of Mount Gambier each year via stormwater drainage wells.

Blue Lake water levels can be affected by the rate of extraction of water for public water supply, but monitoring data shows that the lake water level responds to changes occurring with the surrounding underground water levels.

Water levels in the Blue Lake and the surrounding Mount Gambier area have been in long term decline since 1925 and hydrographs show that the water levels have declined approximately 3.5 metres since 1972 (South Australian-Victorian Border Groundwaters Agreement Review Committee 2008). The downward trend in Blue Lake water level since the early 1990s can be linked to a long term declining rainfall trend. While water level in the Blue Lake decreased by around 70 cm between 2002 and 2007 and by around 10 cm in the period between 2007 and 2012, it has since increased almost 50 cm over the June 2009 to June 2012 period, in response to a period of above average rainfall. In a similar manner to the Blue Lake water levels, the underground water levels surrounding the Lake have stabilised or fallen only slightly over the last five years.

Currently around 3,700 megalitres of water is extracted from the Blue Lake for public water supply purposes and around 7,300 megalitres of underground water is extracted in total from the Blue Lake Capture and Buffer Zone (Figure 13, *Appendix of Figures and Tables*) each year. The volume of extraction from the Lake has remained reasonably stable over the past 10 years, but the current volume of underground water extracted from the Blue Lake Capture and Buffer Zone each year is around double the estimated volume of annual underground water extracted in the mid-1990's.

Lake Bonney

Lake Bonney, approximately eight kilometres southwest of Millicent, is essentially a freshwater lake, which intersects the water table and also receives substantial surface water flows. The underground water environment of Lake Bonney, as described by records from 1970 to the present, appears to be in a long-term steady state. It is not expected that underground water use will increase significantly in the vicinity of Lake Bonney and therefore the taking and use of underground water is unlikely to have any detrimental effects on the lake.

Lakes Eliza, St Clair, George and Robe

Between Robe and Beachport several large, saline lagoons exist including lakes Eliza, St Clair, George and Robe. These receive inflow water from surface runoff via the artificial drainage scheme established in the South East and from underground water seepage from the water table. Lowering of the local water table through extraction could reduce the gradient towards the lakes and hence underground water inflow to them. The extreme would be reversal of the gradient with the induction of lake water back into the underground water system. However, under the policies and criteria set out in the Plan, neither scenario is considered likely. Therefore the taking and use of water from the LLC PWA is not likely to have a detrimental effect on the quality or quantity of underground water available for these lagoons.

Lakes Leake and Edward

The volcanically derived Lakes Leake and Edward in the Mount Burr Ranges east of Millicent contain water generated by local rainfall runoff. The base levels of both lakes are above the regional water table and the confined aquifer's potentiometric surface. Their only interaction with underground water would be by seepage down to the water table and therefore the taking and use of underground water is unlikely to have a detrimental effect on the quality or quantity of water available for Lakes Leake and Edward.

3.4. Confined Aquifer

Generally the depth to the aquitard or confining bed that separates the unconfined and confined aquifers is considerable (>250 metres at the southern coast), except for localised highs in the Nangwarry-Tarpeena and Glencoe area. Under these circumstances it is unlikely there would be any detrimental impacts on the confined aquifer water resource caused by extraction from the unconfined aquifer. This is reinforced west of Lucindale-Millicent and south of Mount Gambier where an upward hydraulic gradient exists across the confining layer.

In the Nangwary-Tarpeena-Glencoe area the confining layer is thin or absent and the water table is at a higher elevation than the confined aquifer's potentiometric surface. Here recharge to the confined aquifer could be affected by lowering of the water table through extraction or reduction in rainfall recharge by land use changes. However, on the information available it is considered unlikely to have a detrimental impact on the confined aquifer, due to this recharge component constituting a small percentage of overall recharge to the through-flow within the confined aquifer. The aquitard is also often more than 20 metres thick and of very low permeability. It is therefore unlikely that there would be any detrimental impact on the confined aquifer water resource caused by extraction from the unconfined aquifer. In the southern portion of the PWA the hydraulic head in the confined aquifer is higher than the unconfined aquifer. This means the vertical component of underground water flow is upwards. There is therefore very little possibility of downward leakage of underground water from the overlaying unconfined aquifer to the confined aquifer.

3.5. Unconfined Aquifer

Due to the confined and unconfined aquifers being separated by a low permeability aquitard generally of the order of 20 metres thick, there is little likelihood that extraction from the confined aquifer could detrimentally impact on the unconfined aquifer water resource.

There is only a small possibility that if underground water were taken from the confined aquifer and applied to the unconfined aquifer that 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. However, the application of an additional volume of water is unlikely to have any detrimental effect on the unconfined aquifer in the LLC PWA. Studies have shown that there is only a minimal response in the aquifer when additional volumes of water are applied during point source recharge events. The salinity of the underground water in the confined aquifer is generally low, hence it is unlikely that the additional salt load would detrimentally impact on the water quality of the unconfined aquifer.

Prior to 2010, direct leakage of pressure water from the confined aquifer into the overlying unconfined aquifer occurred via a large number of confined aquifer wells in poor condition due to age and construction techniques. During 2001 to 2010, 120 leaking confined aquifer wells in the Kingston-Greenways area were either replaced or back-filled using specialist techniques, as part of the South East Confined Aquifer Well Rehabilitation Scheme. Expenditure on the scheme was estimated to be $5.5 million over nine years, including $1.3 million funding from the Natural Heritage Trust, $1.1 million from State investment and a financial commitment from landowners of up to $3.1 million.

3.6. Water Resources in other PWAs

The taking and use of water in the LLC PWA is not expected to detrimentally affect the water resources in adjacent PWAs.

References and Bibliography

Benyon R G. and Doody T M. 2004, *Water Use by Tree Plantations in South East South Australia*, CSIRO Forestry and Forest Products Technical Report no. 148.

Benyon R., Theiveyanathan T., Doody T. 2006, Impacts of Plantations on groundwater in south-eastern Australia. *Australian Journal of Botany* 54, 181-192.

Benyon R.G., Doody T.M., Theiveyanathan S., Koul V. 2008, Plantation Forest Water Use in Southwest Victoria. CSIRO: Water for a Healthy Country National Research Flagship.

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

Ecological Associates 2008**,** *Determination of Environmental Water Requirements for Mosquito Creek Catchment and Bool and Hacks Lagoon – Issue Paper***.** Report to South East Natural Resources Management Board.

Fass, T. and Cook, P.G. 2005, Reconnaissance survey of groundwater 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 groundwater dependent ecosystems; Report 2 Field studies. Prepared for Land & Water Australia. December 2006.

Humphreys, W. F. 2008, Rising from down under: developments in subterranean biodiversity in Australia from a groundwater fauna perspective. *Invertebrate Systematics* 22: 85-101.

REM 2005, *A review of the environmental water requirements of the groundwater 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 groundwater 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.

Sheldon, R.A. (2007). *Report 1: Knowledge Review and Gap Analysis, Connecting the Catchment: the Integrated Management of Mosquito Creek***.** Department for Environment & Heritage, Mount Gambier, SA.

SKM 2009, *Classification of groundwater – surface water interactions for water dependent ecosystems in the South East, South Australia*. Prepared for Department of Water, Land & Biodiversity Conservation, Mount Gambier.

South Australian-Victorian Border Groundwaters Agreement Review Committee 2008, *Management Review, Tertiary Limestone Aquifer and Tertiary Confined Sand Aquifer in Province 1 of the Designated Area.*

URS Australia 2000, *Assessment of the environmental requirements of groundwater 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 demand

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 and provides for regular monitoring of that capacity.

During the review of the 2001 Comaum-Caroline, Lacepede Kongorong and Naracoorte Ranges WAPs, DFW (now DEWNR) and its predecessor, DWLBC, in collaboration with the Board conducted several major underground water resource management projects, as follows:

- volumetric conversion (Carruthers *et al.* 2006a; Carruthers *et al.* 2006b; Carruthers 2006; Latcham *et al.* 2006; Pudney 2006; Pudney *et al*. 2006). Purpose of the project: to develop an approach to convert area-based water licences to licences with a volumetric basis of allocation;
- review of volumes available from the Tertiary Limestone Aquifer (Brown *et al.* 2006). Purpose of the project: to comprehensively review the underground resource condition and management framework for the unconfined aquifer in the South East;
- combination of the results of the volumetric conversion project and review of volumes available (Latcham *et. al* 2007). Purpose of the project: provides a methodology for incorporating estimates of volumetric allocations and actual extractions into the water balance.

A more recent review of the condition of the resource was carried out in 2012 by DFW (now DENWR). The project required a comprehensive re-evaluation of the capacity of the resource to meet the demand for underground water, and 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.

The project evaluated the aquifer response with the latest water level and salinity monitoring data and adopted the most recent scientific reasoning and assessment tools to provide:

- a methodology for incorporating estimates of volumetric allocations and actual extractions into the water balance, and
- an indication of which areas in the LLC PWA require greatest attention for future underground water resource management (this is further analysed by means of the LLC Groundwater Resources Risk Assessment described in Section 4.2.2).

The science underpinning the Plan has been extensively and independently reviewed, firstly by the Water Resources and Forests Interdepartmental Committee in 2009 (Smerdon 2009; Prosser & Walker 2009), and again by the Lower Limestone Coast Taskforce in 2010 through the South East Water Science Review (DFW 2010). In addition, an independent summary of existing information about the current understanding of the hydrological system (the water cycle), the natural resource management issues and estimates of a regional water balance and its components in the Limestone Coast was undertaken by the Cooperative Research Centre for Irrigation Futures in 2009 (Paydar *et al.* 2009).

4.1. Unconfined Aquifer

4.1.1 Trends in Underground Water Levels

A system of resource condition triggers are used to monitor trends in underground water levels and aid decision making regarding current and future allocations from underground water resources.

Resource condition triggers are designed to protect the underground water resource from degradation by preventing further allocation where a trigger indicates that the resource is currently under stress (i.e. when the trigger is currently being exceeded), or where the granting and subsequent use of a new allocation is likely to cause stress to the resource (i.e. the trigger is likely to be exceeded as a result of a new allocation).

The resource condition trigger that monitors trends in underground water levels considers the changes in depth to the water table in the unconfined aquifer. The trigger is considered to have been exceeded when there is an average water level decline of greater than 0.1 metres/year over the preceding five years. For the purposes of the Plan, water level trend analysis was undertaken using time-series data extracted from the State's underground water monitoring Obswell database. Changes in depth to water over the previous 10 years and trend lines for depth to water over the previous five years were determined to March 2012 (Figure 5, *Appendix of Figures and Tables*).

From the early 1990's, significant declining water levels have been observed in the Frances, Joanna, and Zone 5A management areas. There appears to be a strong relationship between cumulative deviation of annual rainfall from the mean and changes in underground water level. This may be due to above or below average rainfall corresponding with a rise or fall in the water table, or increased underground water extraction to compensate for below average rainfall. It is difficult to determine whether extraction has increased to make up for a deficit in rainfall, due to irrigation allocations currently being area-based and not volume-based.

The review of the change in depth to the water table in the 10 years to March 2012 revealed a general decline in depth to water throughout the LLC, ranging from 0.5 metres to greater than two metres. Declines of up to one metre have been observed in Stewarts, Bool, Moyhall, Grey, Riddoch, Hindmarsh and other management areas. In addition, declines of up to 1.5 metres were observed in Zone 2A, Zone 3A, Zone 5A, Frances, Hynam East, Bangham and Joanna management areas. A decline of as much as two metres was observed in Zone 3A, Zone 5A and Frances (Figure 5, *Appendix of Figures and Tables*). Declines of greater than two metres have been observed in the management areas of Coles, Short, Monbulla, Killanoola, Spence and Joyce.

In the management areas of Beeamma, Western Flat and Bangham, underground water levels rose during the period between 1980 and 2001. The rise has been attributed to increased recharge following historical clearance of native vegetation. Levels stabilised in 2001 to 2004, and then declined between 2004 and 2007. This declining trend has continued to March 2012.

In the majority of the management areas described above, a declining trend in depth to water has also been observed in the last five years (Figure 5, *Appendix of Figures and Tables*).

There are three principal factors affecting the extensive underground water level decline in the LLC PWA:

- underground water extraction;
- reduced rainfall and hence recharge; and
- the effects of land use change, particularly the establishment of commercial forests.

The Ash Wednesday bush fires in February 1983 destroyed about 20,000 hectares of the South East softwood plantation estate. This led to a recovery of the water table in the Nangwarry area due to increased underground water recharge and a cessation of underground water extraction across an area of approximately 15,000 hectares of softwood plantation. A 10-year forest replanting program commenced in the winter of 1983 and a declining trend in water table levels began about 1994. The water table trend generally coincides with the forest canopy closure of the increased area of replanted forest, and the

commencement of underground water extraction from shallow water tables after canopy closure.

In the Mount Gambier area the underground water levels have been in long-term decline since 1925, as observed by the water level in the Blue Lake. The declines at Mount Gambier have occurred despite some recent years of above average recharge to the aquifer. Impacts from forestry, variability of rainfall and its incidence, and increased underground water extraction have contributed to this decline. In addition, the level of stock and domestic water use around Mount Gambier is estimated to be high. The most recent review of changes in depth to water (March 2002-2012), indicates that declines in underground water levels south of Mount Gambier in the last 10 years have not exceeded trigger levels. There has been a declining trend in the water table in Glenburnie and Myora in the last five years, but trends have been recovering (i.e. water levels are increasing) in the remaining management areas south of Mount Gambier (Figure 5, *Appendix of Figures and Tables*).

Water table drawdown in the Coles and Short management areas

A key focus of the South East Water Science Review (DFW 2010) was the underground water resources of the Coles and Short management areas. A cone of underground water table drawdown is centred on the management areas of Coles and Short, and extends into Killanoola and Monbulla to the east, Spence and Joyce to the north, as well as having some impact on other neighbouring management areas.

The most recent underground water observation data (Figure 5, *Appendix of Figures and Tables*) shows that the water level decline in Coles and Short exceeded two metres in the 10 years to March 2012. This is supported by the South East Water Science Review (DFW 2010) that states that the water table has been declining approximately 0.5 metres/year (Figure 5, *Appendix of Figures and Tables*) and that modelling of groundwater levels predicts that drawdown will extend beyond Coles and Short and impact significant wetlands, including many of high conservation value such as the internationally important Bool and Hacks Lagoon complex, and the regionally significant Sheepwash Swamp, Green Swamp, Gooseneck Swamp, Big Heath, Mary Seymour and Broadlands on the Bakers Range Drain.

A total of 21% of all wetland polygons in the Lower South East are within the decline contour of Coles and Short, with 18% of these wetlands with a very high likelihood and 58% with a high likelihood of groundwater dependence. The cone of drawdown (Figure 5, *Appendix of Figures and Tables*) extends towards the Ramsar listed Bool and Hacks Lagoons that include habitat for the following threatened aquatic fauna listed under the federal EPBC Act:

- Growling Grass Frog (Gooseneck Swamp, Bool and Hacks Lagoon);
- Dwarf Galaxias (Bakers Range Drain, Bool and Hacks Lagoon, Drain M);
- Yarra Pygmy Perch (Bakers Range Drain, Bool and Hacks Lagoon).

Gibbs (2010) considered all changes in the water table (including recharge) and determined that the cone of underground water drawdown centred on the Coles and Short management areas is a local phenomenon, which cannot be attributed to wider regional effects, such as reduced rainfall. The depth to underground water since 2004 at pasture sites nearby has not changed, whereas for the same time period under the plantation forestry land use, the depth to the underground water table has been increasing by approximately 0.5 metres/year. Gibbs (2010) concluded that the most obvious explanation for this local effect was the introduction of plantation forestry since 2000.

Gibbs (2010) also examined the probability of the underground water table rebounding to long-term average levels, based on different land uses and the probability of annual rainfall occurring. The results indicate that for most scenarios considered, including irrigated pasture and plantation forestry, the underground water table is not expected to rebound, and is in fact in decline. This means that average extraction is greater than recharge. Rebound is expected for the case of high recharge under non-irrigated pasture. However, Gibbs (2010) went on to state that the assumption that net lateral underground water flow is zero may be conservative, meaning that the probabilities of rebound may be underestimated.

A water modelling investigation of the effects of plantation forestry on underground water resources in the Wattle Range area, which includes the management areas of Coles, Joyce, Killanoola, Monbulla, Short and Spence, was undertaken in 2010 (Aquaterra 2010a, 2010b). As part of this exercise, 18 different plantation management scenarios (including sensitivity analysis for some scenarios) were modelled, and the predicted impacts on underground water levels were examined. The 18 scenarios covered:

- hardwood seedling second rotation;
- hardwood coppice second rotation;
- recharge rate variation;
- forestry extraction rate variation;
- changes in land use management;
- cone of depression management;
- importing of additional water;
- an alternative approach to forestry extraction.

Key findings of these studies include (Aquaterra 2010a, 2010b):

- historical groundwater level decreases since 1999 in the Wattle Range area can be mainly attributed to the effects of direct underground water extraction by plantation forests;
- the 42,000 hectares of modelled plantation forest is predicted to invoke a drawdown in the underground water level over an area that is roughly equivalent to the plantation area, except for the Hundred of Coles, where the drawdown is predicted to extend up to seven kilometres beyond the edge of the plantation;
- the maximum average drawdown is approximately five metres and is centred in the northern half of the Coles management area. The drawdown is predicted to reach Bool Lagoon, with a one metre drawdown contour in its western part;
- reducing the forestry area uniformly by 40% or removing or reducing forestry in several management areas results in the maximum average predicted drawdown of three metres, and practically no detectable impact on Bool Lagoon;
- the six metre limitation on forestry direct underground water extraction may not be strictly applicable as a general rule, at least in the area of the model. i.e. plantation forests may continue to extract water from water tables deeper than six metres; and
- removal of the entire plantation forestry estate after 2011 leads to almost complete recovery of underground water levels to the pre-forestry levels within a few years.

4.1.2 Trends in Underground Water Salinity

The resource condition trigger for salinity in the unconfined aquifer was defined in the previous Plans as an average annual increase in salinity of underground water of greater than 10 mg/L/year over the preceding five years. This resource condition trigger has been redefined in the Plan as an average annual increase in salinity of greater than 2% per year, measured over the preceding five years.

Underground water salinity in the LLC PWA unconfined aquifer varies between less than 1,000 mg/L in the majority of the observation wells in the southern management areas of the PWA to greater than 7,000 mg/L in the northern management areas, as shown in Figure 9 (*Appendix of Figures and Tables*). However, one observation well in the Donovans management area (located at Eight Mile Creek, approximately 1500 metres from the coast) has a salinity of 27,000 mg/L. This observation well, CAR061, was drilled to investigate and monitor the salinity change and the location of and interface between seawater and freshwater that was identified through a geophysical survey during 2002.

Wells located in management areas between the townships of Naracoorte and Penola, including Zone 3A, commonly exceed the salinity trigger value. The increase in salinity levels is likely to be due to either the recycling of irrigation drainage water or vegetation clearance with the resulting mobilisation of salt caused by an increase in vertical recharge.

The Ash Wednesday bush fires in February 1983 destroyed a large area of softwood plantations in the area, which lead to a recovery of water levels of approximately three metres. The rise in water level was largely a response to the cessation of direct underground water extraction by the forest and recharge interception. The rise in water level dissolved the salts within the unsaturated zone that had accumulated around the root system of the forest. A steady increase in salinity was monitored for several years after the bushfire event as a front of higher salinity underground water moved through the system. Salinity has since decreased, returning to the pre-bushfire level.

A study carried out by Wohling (2007) in the management areas of Zones 2A, 3A, 5A, Joanna, Comaum, Glenory, Struan, Frances and Bangham, showed evidence that the historical salt store has been flushed into the aquifer and that further salinisation is possible from recycling of irrigation water. The report recommends that groundwater through-flow be maintained and that three dimensional modelling of groundwater flow would improve information for resource managers.

Risk of seawater intrusion south of Mount Gambier

The coastal area south of Mount Gambier includes sites of underground water discharge such as Piccaninnie Ponds. The water levels in the coastal area were relatively stable up until 1997 with negligible seasonal fluctuation. Since 1997 underground water levels have fluctuated seasonally. The seasonal drawdown is indicative of a water level response to underground water development and extraction, and has resulted in a small declining trend in recovered levels since 1997. It is considered that while the rate of decline in the recovered levels is low, the seasonal fluctuations are large given the proximity to the coast and the potential risk of seawater intrusion.

The South East Water Science Review (DFW 2010) identified the area south of Mount Gambier as an area subject to specific risks. A seawater-freshwater interface in the unconfined aquifer has been detected about 1.5 kilometres inland and 150 metres below the surface, indicating the potential for seawater intrusion in the Donovans management area.

Fresh underground water in coastal aquifers is vulnerable to salinisation by seawater intrusion due to increasing underground water extraction and climate changes, which can cause the lowering of the underground water hydraulic head and reduced recharge to the unconfined aquifer.

Saline underground water intrusion has the potential to result in significant economic and environmental impacts. It is estimated that approximately 2,527 hectares of agriculture may be at risk, equating to a potential current regional economic impact of $31 million (Department of Planning and Local Government 2011). Underground water dependent ecosystems such as the internationally important karst wetland system Piccaninnie Ponds, and the nationally important karst wetland system, Ewens Ponds, may also be at risk.

Previous work had detected a freshwater-salt water interface in the freshwater coastal aquifer as far as 1.5 kilometres inland from the coast, but the risk of seawater intrusion into the coastal aquifer in the region had not been previously studied in detail. A recently completed study into the risk of seawater intrusion into the unconfined aquifer in the LLC (Mustafa *et al*. 2012) was recently completed. Coastal monitoring wells reveal salinity levels exceeding 25,000 mg/L, with the highest risk for seawater intrusion considered to be irrigation extraction which could cause a reversal of underground water movement (currently towards the coast).

The freshwater-saltwater interface has been detected at four locations: Eight Mile Creek, Port MacDonnell, Piccaninnie Ponds/Pick Swamp complex and the area west of the township of Port MacDonnell. However, the detection of a freshwater-saltwater interface does not

automatically mean that active seawater intrusion is occurring in response to underground water extraction. Most sites where the interface was detected lack historical, pre-irrigation development information. The only evidence of a dynamic freshwater-saltwater interface occurs in the Eight Mile Creek area, where underground water salinities are slowly increasing and salinity profiles show seasonal changes.

Intrusion is actively occurring in the Eight Mile Creek area and other areas where the interface between freshwater and seawater has been intersected. Long term monitoring is necessary to monitor the seawater at these locations and determine the level of activity of the seawater intrusion process in the coastal area.

4.1.3 Present and future needs of water users

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

In terms of providing for future expansion in water use, the Plan provides for limited new allocations from the Crown from the unconfined aquifer, including to some existing section 128 authorisations and temporary allocations for mining purposes, subject to a number of conditions. In order to expand or establish a new water-using enterprise for purposes other than these, an individual or organisation must obtain an allocation through trade or transfer, activate their own existing unused allocation or apply to convert a water (holding) allocation to a water (taking) allocation, subject to hydrogeological assessment and a number of other conditions.

In addition, a licensee who has had undergone reductions to allocations is eligible to apply for a water (taking) allocation or an allocation attached to a forest water licence in an under-allocated management area, subject to hydrogeological assessment and a number of other conditions. The volume of allocation may be equivalent to or less than the volume of reduction to the tradeable component or to the allocation attached to a forest water licence.

Transfers between unconfined aquifer management areas are provided for in the Plan, following the completion of the volumetric conversion of existing area-based water licences, and the issuing of allocations attached to forest water licences to existing commercial forests, or commencing on 1 July 2016, whichever is the sooner. These transfers will be subject to there being an equivalent volume of unallocated water in the receiving management area, and subject to a number of other conditions, including hydrogeological assessment.

4.1.3.1 Economic needs – unconfined aquifer

Irrigation

A total of 61,625 hectare irrigation equivalents (haIEs) have been allocated on licences in the LLC PWA. Based on the volumetric conversion model as developed by the former DWLBC and published in 2006 (Carruthers *et al.* 2006a) the volume of water required by irrigators to continue to irrigate this area, based on their system type, climate, predominant soil types and other factors, has been estimated as 493,394 ML/year (Table 4.1). This includes a modified delivery supplement in management areas located in the Border Zones as described in section 4.2.4 *Target Management Levels and the Border Groundwaters Agreement.*

Under flood irrigation, it is assumed that a significant percentage of this volume returns to the unconfined aquifer.

The total volume of water estimated to be taken from wells from the unconfined aquifer in the LLC PWA was 214,490 ML/year in the 2008/09 irrigation year, 201,845 ML/year in 2009/10 and 127,312 ML/year in 2010/11.

The majority of water allocated and used is for irrigation purposes, with the remainder being allocated to industry, recreation and for public water supply. The principal irrigated industries by area and value are described in section 1 of the Plan. There is the potential for irrigation

enterprises to expand in these areas as unused allocations are brought into production, however, the density of existing irrigation may restrict further development in certain areas.

In the South East of South Australia Regional Profile (PIRSA 2010), levels of production of winegrapes, horticulture, livestock, cropping and forestry were forecast to 2025. A low, estimated and high level of growth was provided for each industry, based on a number of key macroeconomic assumptions, as summarised below:

- winegrapes: with a slowing in demand for Australian wine, and strong competition in both the export and domestic markets, the long term annual growth in South East winegrape production could range between -2% (a contraction in growth) and 3% per annum through to 2025.
- horticulture: the general outlook is for further expansion in horticulture other than potatoes and onions. Potatoes and onions are expected to have lower growth due to change in taste by consumers to less traditional vegetables. Growth expectations are dependent on the variety of horticulture, but on average the sector is expected to grow between 0% (low growth scenario) and 3% (high growth scenario) per annum through to 2025.
- livestock and cropping:
    - extensive beef grazing is expected to continue in the South East, with the sector expected to grow between 0% (low growth) and 30% (high growth), through to 2025;
    - wool production is expected to remain steady with the sector expected to contract by -15% or increase as much as 15% (high growth), through to 2025;
    - no further expansion in cropping production through to 2025;
    - lamb production is expected to increase with the sector expected to grow between 0% (low growth) and 45% (high growth), through to 2025;
    - dairy expansion, involving an increasing degree of intensification, with the sector expected to grow between 0% (low growth) and 75% (high growth), through to 2025.

Industry, aquaculture, mining, petroleum and carbon dioxide exploration/production, geothermal exploration and energy generation

A total of 4,419 ML/year and 829 ML/year have been allocated in 2011/12 for use by industry and aquaculture respectively.

Aquaculture

Demand for water for aquaculture is expected to remain steady.

Pulp and paper production

Currently an indenture created under the *Pulp and Paper Mill (Hundreds of Mayurra and Hindmarsh) Act 1964* allows Kimberly-Clark Australia Pty Ltd to operate pulp and paper mills at Snuggery without the requirement for water licences as set out under the Act. The indenture ceases in October 2014. Additionally, under the *Pulp and Paper Mill (Hundreds of Mayurra and Hindmarsh) Act 1964* the Minister has authorised the taking of underground water from the unconfined aquifer for the purposes of pulp and paper mill operations up to a volume of 18,300 ML/year pursuant to a section 128 authorisation under the Act.

In anticipation of the expiry date of the indenture, the Plan sets aside unallocated water in the Hindmarsh and Mayurra management areas to allow for a water allocation to be issued to the pulp and paper mill on expiry of the indenture, should this be required.

Mining

Action 48 of the Water for Good Plan (Government of South Australia 2010) relates to water

used for mining and requires “mining ventures to provide their own water supplies within the sustainable framework of natural resources management planning and regional water demand and supply plans”.

There are a number of extractive mineral mines in the LLC PWA, extracting limestone, sand, and/or gravel. Additionally, a lignite (coal) mine is proposed for an area northeast of Kingston SE.

The Plan allows for allocation of water for the purpose of mining provided that an equivalent volume to that allocated above the TML (if any), is returned to the source aquifer from which the water was originally extracted, with no detrimental change to the quality of the water in the source aquifer, and subject to a number of other conditions.

Petroleum and carbon dioxide exploration/production, geothermal energy generation

The Katnook and Ladbroke Grove gas plants, which are located south of Penola, are involved in the production and processing of petroleum. The Caroline Carbon Dioxide Purification Plant is located southeast of Mount Gambier, and produces liquid carbon dioxide for the soft drink, fire fighting, medical and winemaking industries.

There is currently a Ministerial authorisation under section 128 of the Act (South Australian Government Gazette, 30 August 2001, page 3442) for the taking of water in relation to a hydrocarbon exploration well under the *Petroleum Act 2000* (now *Petroleum and Geothermal Energy Act 2000*). A hydrocarbon includes petroleum, natural gas and coal seam gas. Water extracted during the drilling process comes from the unconfined aquifer.

Petroleum and carbon dioxide is sourced from the deeper confined aquifer(s) which may result in co-produced water (water taken as a by-product of petroleum or carbon dioxide extraction), being extracted during the production process.

Users of hydrocarbon production wells may apply for an allocation to account for the co-produced water extracted from the confined aquifer.

Geothermal energy generation targets the deeper confined aquifers(s). Please see 4.3.3 *Economic needs – confined aquifer* for further information.

TABLE 4.1. SUMMARY OF LOWER LIMESTONE COAST PRESCRIBED WELLS AREA UNCONFINED AQUIFER UNDERGROUND WATER ALLOCATIONS AND USAGE FOR THE 2009/10 AND 2010/11 WATER USE YEARS

Unconfined Management Area	No. of Licences	Total area-based allocations (halE)	Conversion of area based allocation (halE) to ML	Volumetric irrigation allocations in existence at date of adoption (ML)	Public Water Supply (ML)	Aquaculture (ML)	Industrial (ML)	Recreational (ML)	Total volumetric allocations (ML) (at date of adoption) excl WHAs (D+E+F+G+H+I)	Holding allocations (ML) (excluding those offsetting forestry)	Total indicative allocations (excluding commercial forests) (J+K) (ML)	Total Use 2009/10 (ML)	Total Use 2010/11 (ML)
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Bangham	37	692	5,629	0	0	0	25	10	5,664	0	5,664	2,775	1,858
Beeamma	30	1,022	8,122	0	0	0	0	0	8,122	0	8,122	3,838	2,141
Benara	78	1,242	7,778	3,621	0	0	118	0	11,517	2,586	14,103	5,796	4,392
Blanche Central	37	505	2,941	8	0	0	31	4	2,984	0	2,984	1,577	742
Bool	17	194	1,382	268	0	0	0	0	1,650	498	2,148	670	51
Bowaka	41	1,181	12,597	0	0	0	0	0	12,597	1,588	14,185	3,311	2,525
Bray	34	274	2,237	2,091	0	0	0	0	4,328	3,738	,8,066	54	57
Coles	24	785	6,599	664	0	2	17	0	7,282	1015	8,297	1,316	560
Comaum	24	411	2,829	0	0	0	41	4	2,874	0	2,874	913	503
Compton	33	41	232	389	0	0	22	0	643	348	991	105	162
Conmurra	71	1,510	13,692	3,803	0	29	0	0	17,524	5,844	23,368	3,605	2,052
Donovans	69	2,979	19,370	0	0	164	333	0	19,867	0	19,867	11,319	8,834

Unconfined Management Area	No. of Licences	Total area-based allocations (halE)	Conversion of area based allocation (halE) to ML	Volumetric irrigation allocations in existence at date of adoption (ML)	Public Water Supply (ML)	Aquaculture (ML)	Industrial (ML)	Recreational (ML)	Total volumetric allocations (ML) (at date of adoption) excl WHAs (D+E+F+G+H+I)	Holding allocations (ML) (excluding those offsetting forestry)	Total indicative allocations (excluding commercial forests) (J+K) (ML)	Total Use 2009/10 (ML)	Total Use 2010/11 (ML)
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Duffield	5	0	0	0	0	0	0	0	0	634	634	0	0
Fox	41	880	7,203	3,113	0	0	0	0	10,316	6,357	16,673	3,765	1,818
Frances	20	744	5,546	0	0	0	60	26	5,632	0	5,632	3,362	2,145
Glenburnie	238	2,524	15,110	18	4,000	0	960	483	20,571	0	20,571	8,874	6,387
Glenroy	30	1,098	8,571	0	0	0	13	0	8,584	0	8,584	3,175	2,424
Grey	84	3,626	25,270	501	0	17	50	0	25,838	0	25,838	5,315	3,283
Hacks	9	667	6,396	0	0	0	0	0	6,396	0	6,396	806	282
Hindmarsh	110	1,317	7,962	270	0	0	324	35	8,591	437	9,028	3,673	2,000
Hynam East	26	919	6,962	0	0	0	0	0	6,962	0	6,962	3,134	1,404
Hynam West	12	680	9,269	0	0	0	0	0	9,269	0	9,269	3,943	2,835
Joanna	110	1,921	13,140	82	0	0	56	13	13,291	0	13,291	4,621	2,422
Joyce	84	1,217	10,095	2,383	0	103	20	183	12,784	3,443	16,227	3,677	2,040
Kennion	70	522	4,280	1,098	0	0	5	14	5,397	9,981	15,378	1,457	1,239
Killanoola	53	1,593	13,274	1,277	0	0	37	0	14,588	1,402	15,990	3,769	1,385
Kongorong	51	2,012	13,044	344	0	0	152	0	13,540	0	13,540	7,603	6,351
Lacepede	43	117	833	325	0	0	0	234	1,392	4,506	5,898	470	297
Lake George	17	173	1,147	300	0	0	0	0	1,447	2,616	4,063	753	225

Unconfined Management Area	No. of Licences	Total area-based allocations (halE)	Conversion of area based allocation (halE) to ML	Volumetric irrigation allocations in existence at date of adoption (ML)	Public Water Supply (ML)	Aquaculture (ML)	Industrial (ML)	Recreational (ML)	Total volumetric allocations (ML) (at date of adoption) excl WHAs (D+E+F+G+H+I)	Holding allocations (ML) (excluding those offsetting forestry)	Total indicative allocations (excluding commercial forests) (J+K) (ML)	Total Use 2009/10 (ML)	Total Use 2010/11 (ML)
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Landseer	8	121	1,847	0	0	0	0	0	1,847	1,016	2,863	0	0
Lochaber	39	341	2,533	2,428	0	29	0	0	4,990	3,220	8,210	1,804	978
MacDonnell	84	3,471	22,453	142	0	2	364	30	22,991	0	22,991	17,428	14,731
Marcollat	6	57	1,122	0	0	0	0	0	1,122	1,319	2,441	0	0
Mayurra	75	246	1,452	2,511	0	0	101	8	4,072	4,484	8,556	3,537	2,469
Minecrow	25	386	4,738	230	0	0	0	0	4,968	4,033	9,001	0	39
Monbulla	63	1,415	10,980	881	0	0	24	0	11,885	2,509	14,394	3,777	1,404
Moorak	46	529	3,226	16	0	0	30	0	3,272	124	3,396	1,472	1,194
Mount Benson	70	620	3,928	606	0	0	10	0	4,544	3,607	8,151	2,267	1,796
Mount Muirhead	139	248	1,966	2,332	580	60	14	105	5,057	10,373	15,430	1,366	532
Moyhall	8	164	2,148	25	0	0	0	0	2,173	1,039	3,212	776	494
Murrabinna	13	12	168	1,388	0	0	0	0	1,556	3,057	4,613	97	71
Myora	54	704	4,212	13	0	0	62	0	4,287	749	5,036	2,774	1,917
Ormerod	7	74	604	0	0	0	0	0	604	0	604	196	78
Peacock	10	0	0	0	0	0	0	0	0	2,581	2,581	0	0
Riddoch	82	1,688	12,560	582	130	4	10	88	13,374	1,364	14,738	2,060	859
Rivoli Bay	46	33	229	339	0	0	52	24	644	5,214	5,858	510	258

Unconfined Management Area	No. of Licences	Total area-based allocations (halE)	Conversion of area based allocation (halE) to ML	Volumetric irrigation allocations in existence at date of adoption (ML)	Public Water Supply (ML)	Aquaculture (ML)	Industrial (ML)	Recreational (ML)	Total volumetric allocations (ML) (at date of adoption) excl WHAs (D+E+F+G+H+I)	Holding allocations (ML) (excluding those offsetting forestry)	Total indicative allocations (excluding commercial forests) (J+K) (ML)	Total Use 2009/10 (ML)	Total Use 2010/11 (ML)
A	B	C	D	E	F	G	H	I	J	K	L	M	N
Ross	17	393	4,990	0	0	1	0	0	4,991	5,515	10,506	182	567
Short	43	1,298	18,011	14	0	0	0	0	18,025	313	18,338	1,116	520
Smith	26	305	2,964	0	0	0	0	0	2,964	9,004	11,968	1,124	561
Spence	41	395	4,525	1,015	0	21	0	150	5,711	5,218	10,929	899	544
Stewarts	84	2,450	42,065	10	0	0	10	362	42,447	0	42,447	20,641	12,027
Struan	22	775	5,809	0	0	0	0	0	5,809	0	5,809	2,417	2,283
Symon	58	410	2,416	1,355	0	0	0	0	3,771	6,575	10,346	959	99
Townsend	34	732	8,117	1,401	0	0	0	0	9,518	3,298	12,816	3,754	1,282
Waterhouse	116	907	7,063	1,226	0	340	35	112	8,776	2,198	10,974	3,780	2,402
Western Flat	6	158	1,331	0	0	12	0	0	1,343	0	1,343	126	90
Woolumbool	19	242	3,526	0	0	20	0	0	3,546	5,763	9,309	1,671	1,115
Young	98	415	2,487	722	0	0	126	0	3,335	2,291	5,626	587	403
Zone 2A	130	4,151	25,718	918	120	0	313	38	27,107	324	27,431	10,084	5,285
Zone 3A	258	4,689	33,926	0	170	1	560	205	34,862	0	34,862	9,219	5,083
Zone 5A	140	3,350	24,770	0	0	24	444	150	25,388	0	25,388	13,546	7,817
Grand Total	**3,365**	**61,625**	**493,394**	**38,709**	**5,000**	**829**	**4,419**	**2,278**	**544,629**	**130,181**	**674,810**	**201,845**	**127,312**

Commercial plantation forests

Commercial forestry outlook

The commercial plantation forest industry is made up of two main sectors, the long-established softwood industry that grows primarily *Pinus radiata* or Radiata Pine trees for sawlog, woodchips and preservation roundwood, and the more recent hardwood sector that grows primarily *Eucalyptus globulus* or Tasmanian Blue Gum for pulpwood production. Commercial plantation forestry currently comprises about 145,000 hectares, an area equivalent to approximately 10% of the LLC PWA. The softwood industry has a history dating back about 120 years, whilst the hardwood sector (comprising about 40,500 hectares) has been established over the last 14 years.

The area of pine in the LLC has been expanding at a rate of approximately 1% to 2% per year. Tasmanian Blue Gum plantations underwent a major expansion phase during the period 2000 to 2006, largely planted through Managed Investment Scheme (MIS) companies. The two largest MIS plantation companies in the region went into receivership or were placed under some form of administration in 2009 and have since either changed ownership or management.

As part of the South East Water Science Review, Meyer (2010) used soil and land attribute modelling to identify potential areas suitable for plantations of Radiata Pine and Tasmanian Blue Gum. The maps, shown in the report, are considered to be a conservative estimate of this potential (Meyer 2010). The soil and land attributes suitable for pines and blue gums are considered to be only marginally different, hence the maps of potential areas are very similar between the two species. Of note, the majority of the blue gum plantations have been established to the west and north-west of Penola, in an area that the soil and land attribute modelling defines as only having moderate to low potential for blue gums. This is thought to be due to their recent establishment and the availability of suitably priced land (Meyer 2010).

PIRSA (2010) estimated a low, expected and high growth scenario for primary and secondary forestry production in the South East. They predict that the value of annual plantation growth between 2010 and 2025 is expected to be in the range of 3-6% per annum for primary production and 0%-4% per annum for secondary production (manufacturing/processing).

The high growth scenario assumes four key developments: that a long-term supply level of 3.7 million m^3/year of hardwood pulpwood harvesting is reached in the next 5-10 years, the establishment of the Penola Pulp Mill, the establishment of a wood pellet mill and improvement in efficiency and returns from increasing processor economies of scale.

In the low growth scenario, only the hardwood harvesting is forecast to occur prior to 2025, and a reduction in harvesting volumes of 20% for hardwoods and 10% for softwoods is assumed. These forecasts were based on supplies from existing plantations and replanting of existing areas, with an increase in the value of output coming from price changes rather than quantities of output (PIRSA 2010).

Accounting for the impact of commercial forestry

Science has shown that plantation forestry expansion can significantly impact surface water catchment yield and underground water recharge and that, under some circumstances, plantation species can extract water directly from shallow water tables (Benyon and Doody 2004, Benyon *et al*. 2006, Benyon *et al*. 2008).

It is impractical to commercially measure actual forest water consumption, whether in terms of impacts on surface water yield, underground water recharge, or as direct extraction from shallow water tables. Based on biophysical principles and assumptions, a system of forest water models with outputs expressed in annualised deemed values have been developed in consultation with the forestry industry. These are not point impact measurements, but a characterisation of plantation forests of the same type in the same underground water management area, that is, they ‘smooth’ the hydrologic impacts of the forest over the full forest rotation period.

Deemed rates of recharge interception by commercial forests

The forest water recharge models manage each forest type (softwood plantations and hardwood plantations) as a separate class and express the forest impact as a percentage of the estimated annual average vertical recharge of the respective underground water management area.

For the purposes of estimating recharge interception, each forest type was defined and characterised in consultation with the forestry industry and other stakeholders. The then Department for Water Resources convened a technical workshop in 2001 which was attended by CSIRO Land and Water, CSIRO forestry divisions, the South East forestry industry, the South East Catchment Water Management Board and staff of the Department for Water Resources. This workshop adopted the biophysical principles that underpin the deemed rate models. It is assumed in the forest water recharge models that plantations intercept 100% of recharge following canopy closure and that prior to canopy closure, and following each thinning, there is some underground water recharge, which has been estimated in order to enable the development of forest water impact models. Essentially, the estimated recharge has been averaged over the full life of the plantation and expressed as a percentage of the mean recharge that is estimated to occur across the management area.

The assumption that plantations intercept 100% of recharge following canopy closure was later confirmed through research work by Benyon *et al.* (2008).

Some preliminary work on estimating recharge following planting and prior to forest canopy closure, was commenced by Benyon and Doody (2009), on three sites (one blue gum and two radiata pine). Due to funding constraints and site problems, no measurements were made in the forest fallow year, or for the full period leading to canopy closure. Measurements were made in the year of planting and up to two years following planting. While Benyon and Doody (2009) observed higher recharge in the year of planting and the subsequent two years than assumed in the deemed rate models, further research is required to determine whether any changes to recharge estimates for policy purposes should be made.

A detailed description of the assumptions made in the forest water recharge models is contained in the DWLBC report 2009/13 (Harvey 2009). A summary of the models is provided here.

Softwood plantations

For water resource management purposes, the plantation forest industry characterised a softwood plantation as 35 years from planting to clearfelling, with one year of forest fallow prior to planting, and four thinnings during the forest rotation. It is assumed that there is no recharge during the forest fallow year, some recharge following planting and prior to canopy closure, zero recharge following canopy closure (six years after planting), and some recharge following each thinning, as described in Table 4.2. The annualised recharge impact over the 36 year period of the softwood plantation cycle, expressed as a percentage of the annual average vertical recharge rate, is 17%. This means that softwood plantations are deemed to intercept, on average, 83% of the annual average vertical recharge in the management area during the rotation.

Hardwood plantations

For the purposes of estimating recharge interception, the forest rotation length for hardwood plantations is characterised as 10 years from planting to clearfelling, with one year of forest fallow prior to planting, and no thinnings during the forest rotation. It is assumed that there is no recharge during the forest fallow year, some recharge following planting and prior to canopy closure, and zero recharge following canopy closure (three years after planting), as described in Table 4.2. The annualised recharge impact of hardwood plantations over the 11 year forest cycle, expressed as a percentage of the annual average vertical recharge rate, is 22%. This means that hardwood plantations are deemed to intercept, on average, 78% of the annual average vertical recharge in the management area, during the rotation.

TABLE 4.2. ASSUMED RECHARGE RATES FOR COMMERCIAL FORESTS AS A PERCENTAGE OF ANNUAL AVERAGE VERTICAL RECHARGE OF THE RELEVANT MANAGEMENT AREA.

Year of rotation	*Softwood plantations (primarily P. radiata)*	*Hardwood plantations (primarily E. globulus)*
0 (year of planting)	120	120
1	100	80
2	80	40
3	60	0
4	40	0
5	20	0
After year 5	0	0
Year after thinning	50	Not applicable

Deemed rates of direct underground water extraction by commercial forests

Studies by the CSIRO (Benyon and Doody 2004, Benyon *et al*. 2006, Benyon *et al*. 2008) indicate that where the median depth to the water table is six metres or less, plantations can extract underground water. A Digital Elevation Model has been used to develop a map showing where the depth to underground water is less than a median six metres at 30 June 2004 (Figure 12, *Appendix of Figures and Tables*).

The characterised forest rotations described above were also used in the calculation of an annualised direct extraction impact for each forest type, as briefly described below. The mean annual underground water extraction value of 3.64 ML/hectare/year is the adopted base extraction rate for the respective models. This value was derived from CSIRO technical investigations conducted west of Penola in commercial blue gum plantations and is lower than the average annual value of 4.35 ML/hectare/year reported by Benyon & Doody (2004). A detailed description of the forest water extraction models, with the associated assumptions, is contained in Harvey (2009).

Softwood plantations

For softwood plantations where the median depth to the water table is six metres or less, it is assumed that no direct extraction occurs before canopy closure and that extraction commences in the 7th year after planting. Extraction increases from zero at canopy closure until peak productivity in the 11th year after planting, when extraction reaches 3.64 ML/hectare/year. Direct extraction reduces linearly from the peak of 3.64 ML/hectare/year to 1.0 ML/hectare/year in the year prior to clearfelling, except that in the year after each of four thinnings extraction is assumed to decline to 1.0 ML/hectare/year. Extraction ceases with clearfelling. This results in an annualised extraction impact over the 36 years of 1.66 ML/hectare/year.

Hardwood plantations

For hardwood plantations where the median depth to the water table is six metres or less, and planted with tree seedlings, it is assumed that no direct extraction occurs before canopy closure at three years after planting, and that extraction increases from zero at canopy closure until peak extraction in the 7th year after planting when extraction plateaus at 3.64 ML/hectare/year. Extraction ceases with clearfelling. This results in an annualised extraction impact over the 11 years of 1.82 ML/hectare/year.

Coppicing refers to trees which have been regenerated from shoots formed from the stumps of the previous crop of trees, root suckers, or both, and may be used to produce another tree crop following harvesting of hardwood plantations. Where the second or a later rotation is coppiced, from the second year after harvesting, when coppice regrowth has occurred,

extraction is assumed to increase over the next three years to the peak rate of 3.64 ML/hectare/year, which continues until clearfelling, when extraction ceases. This results in an average annualised impact over the eight years of the coppiced period of 2.50 ML/hectare/year. Coppicing may have a minor recharge impact however, for the purposes of the Plan, it is ignored.

A summary of the assigned deemed annualised recharge interception and direct underground water extraction values for plantations located in the LLC PWA are detailed in Table 4.3.

TABLE 4.3 SUMMARY OF CURRENT ASSIGNED DEEMED ANNUALISED RECHARGE INTERCEPTION AND DIRECT UNDERGROUND WATER EXTRACTION VALUES FOR LOWER LIMESTONE COAST COMMERCIAL FORESTS

Commercial forest type	**Nominal Rotation length – planting to clear felling**	**Recharge under forest relative to management area annual average vertical recharge rate**	**Extraction rate per hectare, where median water table is 6 metres, or less at 30 June 2004 (Figure 12, *Appendix of Figures and Tables*)**
	Years	%	ML/hectare/year
Hardwood	10	22	1.82
Softwood	35	17	1.66
Hardwood coppiced after date of declaration	8	22	2.50

Additional deemed rates

The *Lower Limestone Coast Water Allocation Plan Policy Principles* (DFW 2012) recommends that a selection of additional deemed rates should be made available to estimate forest water impacts according to additional silvicultural practices adopted. The practices are listed as:

- with or without a year of forest fallow;
- shorter or longer plantation rotations;
- additional plantation thinning;
- establishment from coppice;
- change of species.

As a result, the Plan contains principles providing for additional deemed rates to account for additional silvicultural practices, based on the methodology developed by the Board and the former DWLBC (now DEWNR) in conjunction with stakeholders (Harvey 2009).

The Plan provides for a revised deemed rate in determining the minimum volume of water required to account for the annualised interception of annual average vertical recharge to underground water by a commercial forest, to be calculated on written request from a forest water licensee, where:

a) more than one year of forest fallow occurs prior to the start of the forest rotation;

b) no forest fallow year occurs prior to the start of the forest rotation, and the forest is not a hardwood plantation established after the date of declaration through coppice regrowth;

c) a softwood plantation undergoes five or more forest thinning operations; or

d) a softwood plantation undergoes three or less forest thinning operations.

The revised deemed rate or rates of annualised interception of annual average vertical recharge to underground water by a commercial forest, shall be calculated in accordance with Harvey (2009) assuming:

a) each extra year of forest fallow results in 120% of average annual vertical recharge, and the time period for determining the deemed rate is extended by the number of extra forest fallow years;

b) a forest with no forest fallow year results in the time period for determining the deemed rate being reduced by one year;

c) each extra forest thinning for a softwood plantation results in 50% of average annual vertical recharge occurring in the year following forest thinning;

d) one less forest thinning for a softwood plantation results in 50% of average annual vertical recharge not occurring.

The following calculation may be used to determine the deemed rate of recharge interception in ML/hectare/year:

Deemed rate of recharge interception in ML/ha/year =[(100% - x)/100%] * [adopted recharge rate (in mm/year)/100]

where the adopted recharge rate is listed in Table 1 (*Appendix of Figures and Tables*) for the relevant management area; and

where the commercial forest is a hardwood plantation:
x = [(120% x no. of additional years of forest fallow) + 120% + 80% + 40%] / (10 + no. of years of forest fallow);

or

where the commercial forest is a softwood plantation:
x = [(120% x no. of additional years of forest fallow) + 120% + 100% + 80% + 60% + 40% + 20% + (50% x no. of forest thinnings)] / (35 + no. of years of forest fallow).

The percentages in the calculation of x are the assumed recharge rates as a percentage of average annual vertical recharge of the relevant management area, as listed in Table 4.2.

Extended and shortened rotations

The deemed recharge interception rate of 83% for softwoods and deemed rate of direct underground water extraction of 1.66 ML/hectare/year for softwoods is based on 35 years from planting to clearfelling, plus one year of forest fallow. The deemed recharge interception rate of 78% for hardwoods and deemed rate of direct underground water extraction of 1.82 ML/hectare/year for hardwoods is based on 10 years from planting to clearfelling, plus one year of forest fallow.

Rotations extended beyond these years result in additional recharge interception in those years of 100% of recharge, as closed canopy forests have been found to intercept 100% of

recharge following canopy closure (Benyon *et al*. 2008). Similarly, a shorter rotation length will result in a reduction in the overall interception of recharge during the forest rotation.

In addition, rotations extended beyond these years result in greater direct underground water extraction during the forest rotation for hardwood forests, and less direct underground water extraction for hardwood forests with a shorter rotation length. The opposite applies to direct underground water extraction for softwood plantations; less direct underground water extraction with a longer forest rotation, and more direct underground water extraction with a shorter forest rotation. This difference between forest types is due to the nature of the direct underground water extraction models described in Harvey (2009).

In a number of management areas the underground water resource has been identified as at risk from the current demand for water (see 4.2.2) and reductions to allocations are proposed. Under the Act, forest licensees are required to hold sufficient water to offset the forest impact. In areas undergoing reductions to allocations, this could result in allocations being insufficient to offset the impact of extended forest rotations if recharge interception is considered to be 100%, or if a higher deemed rate of direct underground water extraction is considered to apply with an extended hardwood rotation or a shortened softwood rotation.

For simplicity, once a plantation forest is older than 35 years for softwoods or 10 years for hardwoods, the Plan continues to assume recharge interception rates of 83% for softwoods and 78% for hardwoods, and direct underground water extraction rates of 1.66 ML/hectare/year for softwoods and 1.82 ML/hectare/year for hardwoods (2.50 ML/hectare/year if coppiced after date of declaration). The same assumption is made for shortened rotations: the deemed rates for recharge interception continue to be 83% for softwoods and 78% for hardwoods, and direct underground water extraction rates of 1.66 ML/hectare/year for softwoods and 1.82 ML/hectare/year for hardwoods (2.50 ML/hectare/year if coppiced after date of declaration).

Establishment from coppice

The Plan provides for a revised deemed rate for direct groundwater extraction where a second or subsequent forest rotation of hardwood plantations is established after date of declaration of the Plan, from the coppice regrowth from the existing stumps following clearfell. The Plan determines an additional impact from the forest of 0.68 ML per hectare per year for the area of forest which overlies shallow water tables of six metres or less depth to water (Figure 12, *Appendix of Figures and Tables*).

Change of species

The Plan provides for a change in deemed rate for recharge interception where the second or subsequent forest rotation after date of declaration is to be established as a different forest type relating to its pre-clearfell status. This will occur by requiring the forest licensee to report forest water use at the deemed rate corresponding to the forest type (i.e. softwood or hardwood).

Allocation for existing commercial forests

Consistent with the *Lower Limestone Coast Water Allocation Plan Policy Principles* (DFW 2012), the Plan allocates water to existing commercial forests at the date of declaration based on recharge interception at the time of canopy closure (100% recharge interception of the annual average vertical recharge for the management area).

In addition, where the forests are located over a shallow water table where the median depth to the water table is six metres or less at 30 June 2004, the Plan allocates water for direct underground water extraction based on the deemed rates of 1.82 ML/hectare/year for hardwoods and 1.66 ML/hectare/year for softwoods.

Following the declaration of the declared forestry area by the Minister, the Forest Threshold Expansion Opportunity shall cease to exist. This is consistent with the *Lower Limestone Coast Water Allocation Plan Policy Principles* (DFW 2012).

The Forest Threshold Expansion Opportunity was established in 2004 based on an agreed total area of expansion opportunity for commercial plantation forestry within each unconfined underground water management area. This expansion was based on 2002 information and totalled about 59,000 hectares. The expansion areas allowed for recharge impacts only as direct underground water extraction was still being investigated and was not quantified at the time.

The establishment of the Forest Threshold Expansion Opportunity was predicated on the basis that all recharge impacts were taken into account and the impact of reduced recharge to the underground water system would not affect existing water users, whilst maintaining sustainable management of the resource. At 14 September 2012, the remaining Forest Threshold Expansion Opportunity was 42,412 hectares (19,751 hectares hardwood and 22,661 hectares softwood), including 5,999 hectares which was quarantined by the Minister in 2007.

Total plantation forestry impacts

The current total estimated impact of the 145,000 hectares of commercial forest plantations in the LLC is 307,834 ML/year, as shown in Table 4.4.

This is based on 100% recharge interception at canopy closure plus direct underground water extraction at the deemed rates, where the forest is located over a shallow water table where the median depth to the water table is six metres or less at 30 June 2004.

Declared forestry area

Except as provided below, pursuant to section 76(9)(b) of the Act, all commercial forests within the LLC PWA are designated as commercial forests that, on account of assessments undertaken by the Board, have been identified as being appropriate to bring within the ambit of Part 5A Division 2 of Chapter 7 of the Act on account of their impacts on the prescribed water resource and taking into account the requirements of that Part.

Pursuant to section 76(10)(c) of the Act, forests that fall within the definition of farm forestry in the Plan are excluded from the designation under section 76(9)(b) (so as to exclude them from the operation of Part 5A Division 2 of Chapter 7). Section 14 of the *Natural Resources Management (Commercial Forests) Amendment Act 2011*, which amends the NRM Act by inserting Part 5A Division 2 of Chapter 7, has not yet come into operation, but will do so before the Plan is adopted by the Minister.

Farm forestry

Farm forestry means the integration of forestry activity with cropping and/or livestock production. The focus of the forestry activity may be primarily commercial, but other objectives for this forestry may include shade and shelter for stock or crops, natural resource management including soil and water protection, habitat conservation, biodiversity, landscape and amenity values.

Farm forestry can take many forms, including plantations on farms, woodlots, timber belts, alleys, wide-spaced tree plantings and sustainably managed private native forests. Farm forestry plantations are of a smaller scale than commercial plantations and may have less emphasis on timber or fibre production as a primary output. Farm forestry is practised by farmers and graziers. The farmer or landholder makes the critical decisions, from establishment and management to marketing of products and services, albeit following professional or other sources of specialist advice.

For the purposes of the Plan, farm forestry is defined as commercial plantation forest where the net planted area does not exceed, or will not exceed 10 per cent of the total area of land described in a Certificate of Title or Crown Lease or 20 hectares per Certificate of Title or Crown Lease, whichever is greater and is situated on a farm.

From a water management perspective, small areas of farm forestry, generally widely dispersed throughout the landscape, are of minor consequence to the water budget. Where the net planted area does not exceed, or will not exceed 10 per cent of the total area of the land described in a Certificate of Title or Crown Lease or 20 hectares per Certificate of Title or

Crown Lease, whichever is greater and is situated on a farm, a forest water licence is not required. Where the proposed area of forest exceeds these limits, it is considered to be commercial scale plantation forest and therefore a forest water licence is required.

As at 2012, farm forestry in the lower South East comprised 6,950 hectares (5,115 hectares softwood and 1,835 hectares hardwood) and is therefore currently a minor land use. The Plan excludes farm forestry, as defined, from requiring a water allocation. An allowance is made, however, in the water budget for existing farm forestry, assuming 100% recharge interception and direct groundwater extraction at the deemed rates (where the farm forest is located over a shallow water table where the median depth to the water table is six metres or less at 30 June 2004). Across the PWA farm forestry total water use (both recharge interception and direct underground water extraction) is estimated at 11,454 ML/year (Table 1, *Appendix of Figures and Tables*).

Demand by landholders to establish additional farm forestry is expected to remain low.

TABLE 4.4 SUMMARY OF COMMERCIAL FORESTRY IMPACTS ON THE UNCONFINED AQUIFER RESOURCES OF THE LOWER LIMESTONE COAST PWA

Unconfined Management Area	Area of Softwood Commercial Forests as at 2011 (ha)	Area of Hardwood Commercial Forests as at 2011 (ha)	Commercial forestry recharge interception (ML/year)	Commercial forestry direct underground water extraction (ML/year)	Total Impact (ML/year)
BANGHAM	0.0	0.0	0	0	**0**
BEEAMMA	0.0	0.0	0	0	**0**
BENARA	3,863.9	0.0	6,569	1,478	**8,047**
BLANCHE CENTRAL	2,448.2	20.8	4,321	2	**4,323**
BOOL	0.0	0.0	0	0	**0**
BOWAKA	79.7	0.0	68	120	**188**
BRAY	639.2	0.7	576	151	**727**
COLES	531.8	13,438.5	16,764	24,492	**41,257**
COMAUM	2,267.2	5.0	1,363	157	**1,520**
COMPTON	701.4	0.1	1,228	32	**1,260**
CONMURRA	4.0	1,231.9	1,174	909	**2,083**
DONOVANS	3,596.6	81.4	6,437	0	**6,437**
DUFFIELD	0.0	0.0	0	0	**0**
FOX	558.3	1,356.9	1,915	3,105	**5,020**
FRANCES	0.0	0.0	0	0	**0**
GLENBURNIE	8,299.9	158.7	12,688	0	**12,688**
GLENROY	0.0	0.0	0	0	**0**
GREY	76.7	351.5	642	657	**1,300**
HACKS	0.0	0.0	0	0	**0**
HINDMARSH	10,409.6	182.3	15,888	3,606	**19,494**
HYNAM EAST	0.0	0.0	0	0	**0**
HYNAM WEST	0.0	0.0	0	0	**0**
JOANNA	1,626.4	0.0	813	339	**1,152**
JOYCE	0.0	2,534.4	3,041	4,598	**7,639**
KENNION	1,959.1	477.0	2,923	2,703	**5,626**
KILLANOOLA	0.0	2,476.9	3,592	4,505	**8,097**

Unconfined Management Area	Area of Softwood Commercial Forests as at 2011 (ha)	Area of Hardwood Commercial Forests as at 2011 (ha)	Commercial forestry recharge interception (ML/year)	Commercial forestry direct underground water extraction (ML/year)	Total Impact (ML/year)
KONGORONG	5,629.9	0.0	9,571	466	**10,037**
LACEPEDE	0.0	0.0	0	0	**0**
LAKE GEORGE	0.0	0.0	0	0	**0**
LANDSEER	0.0	0.0	0	0	**0**
LOCHABER	0.0	0.0	0	0	**0**
MACDONNELL	0.0	0.0	10	0	**10**
MARCOLLAT	0.0	0.0	0	0	**0**
MAYURRA	0.0	0.0	0	0	**0**
MINECROW	0.0	0.0	0	0	**0**
MONBULLA	48.7	2,177.3	4,007	3,905	**7,912**
MOORAK	83.6	0.0	146	0	**146**
MOUNT BENSON	5,114.6	0.0	3,069	211	**3,280**
MOUNT MUIRHEAD	1,979.8	35.5	2,217	1,700	**3,917**
MOYHALL	0.0	0.0	0	0	**0**
MURRABINNA	0.0	0.0	0	0	**0**
MYORA	7,784.9	0.0	12,456	3,397	**15,852**
ORMEROD	0.0	0.0	0	0	**0**
PEACOCK	0.0	0.0	0	0	**0**
RIDDOCH	6,563.4	477.7	9,153	1,040	**10,194**
RIVOLI BAY	205.5	0.0	206	103	**309**
ROSS	0.0	0.0	0	0	**0**
SHORT	1,095.0	10,855.4	17,926	21,421	**39,347**
SMITH	549.5	67.8	617	909	**1,526**
SPENCE	0.5	3,481.6	4,004	5,736	**9,740**
STEWARTS	0.0	0.0	0	0	**0**
STRUAN	0.0	0.0	0	0	**0**
SYMON	1,336.9	0.2	1,471	557	**2,028**
TOWNSEND	0.0	0.0	0	0	**0**
WATERHOUSE	426.0	0.0	341	10	**351**
WESTERN FLAT	0.0	0.0	0	0	**0**
WOOLUMBOOL	0.0	0.0	0	0	**0**
YOUNG	4,051.1	203.2	8,509	3,123	**11,631**
ZONE 2A	20,453.3	503.5	29,340	8,610	**37,950**
ZONE 3A	11,536.3	316.3	14,223	12,528	**26,751**
ZONE 5A	0.0	0.0	0	0	**0**
TOTAL	**103,921.0**	**40,434.6**	**197,266**	**110,568**	**307,834**

4.1.3.2 Social needs - unconfined aquifer

Public Water Supply

SA Water has a number of licensed allocations across the LLC PWA townships for public water supply from both the confined and unconfined aquifers (Table 4.5).

TABLE 4.5 SA WATER PUBLIC WATER SUPPLY ALLOCATIONS

Management Area	Township	Aquifer	Allocation (ML/year)	Estimated Future Demand 2029/30 ML/year (SA Water)[1]
Millicent	Beachport	confined	180	150
Kalangadoo	Kalangadoo	confined	50	30
Kingston	Kingston	confined	560	340
Lucindale	Lucindale	confined	100	70
Mount Muirhead	Millicent	unconfined	580	475
Riddoch	Mount Burr	unconfined	130	40
Glenburnie Zone 1A	Mount Gambier	unconfined (Blue Lake) confined	4000 unconfined 210 confined	4,430
Zone 2A	Nangwarry	unconfined	120	50
Lucindale	Naracoorte	confined	800	650
Zone 3A Zone 3A	Penola	unconfined confined	170 unconfined 250 confined	225
Millicent	Port MacDonnell	confined	110	85
Kingston	Robe	confined	550	455
Zone 2A	Tarpeena	confined	60	35

[1]Demand estimates are impacted by changes in development rates, economic conditions, changes in water efficiency, uptake of alternate water supplies and changes in climatic conditions. For these reasons, estimates are subject to ongoing review and monitoring.

Mount Gambier public water is supplied from the unconfined aquifer. Subject to further investigations it is envisaged that the confined aquifer could be the source of water for any future additional demand for the Mount Gambier public water supply. Public water use is stable and SA Water has estimated that customer demand could reach 4,430 ML/year in 2029/30. Monitoring indicates the water level in the Blue Lake has fallen only slightly between 2007 and 2012 (around 10 centimetres) which is a contrast to the period between 2002 and 2007 when the Lake water level fell by around 70 centimetres. Similar to Blue Lake water levels, the underground water levels surrounding the Lake have stabilised or fallen only slightly over the last five years. From June 2009 to June 2012, the Lake water level has risen almost 50 centimetres in response to a period of above average rainfall.

Water use by the township of Millicent is stable and SA Water has estimated that customer demand could reach 475 ML/year in 2029/30. SA Water has conducted investigations into the protection needs of public water supply and has identified that protection is required against interception from up-gradient extractions and surface contamination. SA Water is working with the Wattle Range Council to include a Water Protection Zone for the public water supply. This has been included in a Development Plan alteration proposal for the area.

Water use by the township of Mount Burr is stable and SA Water has estimated that customer demand could reach 40 ML/year in 2029/30. Mount Burr public water supply is at risk and requires protection from excessive up gradient extraction.

Water use by the township of Nangwarry is stable and SA Water has estimated that customer demand could reach 50 ML/year in 2029/30. Although a Water Protection Zone exists in the Wattle Range Council Development Plan for this water supply, a review of the boundaries should be considered for continued protection for future water quality and availability.

Penola public water is supplied from the confined aquifer. This follows the drilling of a second well into this water resource. SA Water has a total allocation from the confined aquifer of 250 ML/year which will cater for the total demand of the township now that the unconfined supply is phased out. SA Water has estimated that customer demand could reach 225 ML/year in the year 2029/30.

During 2003 the Cape Jaffa Development Company applied for a water allocation for the Cape Jaffa Anchorage. The water allocation is required to address the public water supply needs of 520 residential allotments with private marina berths, as well as a proposed tourist accommodation and service facility. The Plan provides for the allocation of 221 ML/year of water to this development from the Mount Benson management area, subject to a number of conditions.

Recreational Use

A total of 2,278 ML/year of underground water has been allocated for recreational use (Table 4.1). These licences are largely held by sporting clubs for watering sports fields, greens and gardens, and Local Government for the watering of parks and gardens. Demand for underground water for recreational use is expected to remain steady.

Stock and Domestic Use

As stock and domestic water use is not required to be licensed, the level of actual use is unknown. Stock use was determined by predicting the potential stocking rate in terms of Dry Sheep Equivalents (DSE), based on a potential stocking rate of 1.3 DSE per hectare for each 25 mm/year of rainfall which exceeds 250 mm/year, as developed by French (1987). As a result, potential stocking rate per hectare is determined in the Plan as:

Potential stocking rate per hectare = ((Annual rainfall in mm-250 mm)/25) x 1.3 DSE

A map of rainfall zones in the PWA was developed based on current average rainfall for the major towns in the LLC. Water use is estimated at 6 L/DSE/day. Across the 61 management areas in the PWA, stock water use is estimated at 44,000 ML/year.

Domestic use was estimated by subtracting the population of every town and city in the South East from the total population of 65,000 people, to determine an approximate number of people who reside outside the major towns and cities. This number was then divided by the number of management areas in the PWA and thus each management area averages 330 people. This was multiplied by 450 L of water use per day per person, which equates to 55 ML/year domestic water use per management area. For the 61 management areas in the PWA, total domestic use is estimated at 3,355 ML/year.

Total stock and domestic water use has been estimated at 47,355 ML/year, and is not expected to vary significantly in the future.

4.1.3.3 Environmental needs

The environmental water requirements have been described in section 2 of the Plan. The future needs of the environment are expected to remain the same as present needs.

4.1.3.4 Indigenous and cultural needs

Access to, and use of, water from prescribed water resources by Aboriginal people is exempt from licensing for the purpose of social, cultural or spiritual use, 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 Minister has issued a state-wide authorisation (under section 128 of the Act) to take water for Native Title purposes.

The traditional owners of the land that is now the LLC PWA are the Tanganekald, Meintangk, Bungandiji, Potaruwutj and Marditjali people. Representatives of all traditional owners in the South East region are working closely with the Board through the South East Indigenous Focus Group to identify and quantify current and future Aboriginal needs for water. The Group considers that all water is important to Aboriginal people. A number of culturally significant underground water-dependent ecosystems have been identified through members of this Group, including the Crater Lakes (Blue Lake, Valley Lake, Leg of Mutton Lake and Browns Lake), Little Blue Lake, Bool and Hacks Lagoons, the Coastal Lakes (including Lake George) and the wetlands of the upper northwest of the LLC including the management areas of Duffield, Landseer, Peacock and Marcollat. The cultural value of these sites has been considered in the LLC risk assessment described in 4.2.2.

4.2 Capacity of the resource to meet demand – unconfined aquifer

The Plan follows a precautionary approach in the aquifer response management of the underground water resource for which it is responsible. It has provided for the collection of recent monitoring data and adopted the most current scientific reasoning, with the aid of assessment tools, to consider and balance the uncertainties associated with this data in a manner that is consistent with the objectives of the Act.

Determinations have been made bearing such uncertainties in mind and in a manner which strives to minimise the risk of long-term adverse effects on the underground resource, rather than delaying decisions until all necessary data is available.

Measuring the demand for unconfined aquifer water

Until the adoption of the Plan, licensed underground water extracted in the LLC PWA was allocated on an area basis rather than by volume of water applied. However, under this allocation system it was difficult to accurately determine levels of extraction from the resource to identify and manage areas with resource condition issues, as the 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). Several major water resource projects were conducted during the review of the 2001 Comaum-Caroline, Lacepede Kongorong and Naracoorte Ranges Water Allocation Plans (Brown *et al.* 2006, Carruthers *et al.* 2006a, Pudney 2006, Pudney *et al.* 2006, Carruthers 2006, Carruthers *et al.* 2006b, Latcham *et al.* 2006, Latcham *et al* 2007) and have been integrated to develop a volumetric conversion model that allows a more realistic representation of the true level of development of underground water resources in the region.

The re-issuing of existing area-based water licences as licences endorsed with volumetric allocations and the issuing of allocations to existing commercial forests, shall commence with the adoption of the Plan.

4.2.1 Total Available Recharge

The annual rate of net removal of underground water from the unconfined aquifer should roughly equate to the estimated annual average vertical recharge to the water table. Underlying this approach is the principle of lateral through-flow maintenance in the aquifer, which allows any salts accumulated during recharge to be flushed down-gradient. In the previous Plan, the term Permissible Annual Volume (PAV) was used to describe the volume

of water that could be sustainably used or assigned from the unconfined aquifer on an annual basis, in a particular management area. However, the approach for setting PAVs was not consistent across all management areas. In addition, estimates of PAV in the previous Plans accounted for the impacts of commercial plantation forests (based on the scientific information available at the time) by assigning a recharge rate of zero to all forested areas, and variable rates in the Designated Area (Brown *et al*. 2006).

A comprehensive review of the underground water resource condition and management framework for the unconfined aquifer, prepared by Brown *et al.* (2006), involved the development of a transparent and consistent methodology for estimating sustainable underground water extraction rates in the LLC PWA. As a result of this review, annual average vertical recharge rates were updated to reflect new understandings of this component of the water balance for the region. A detailed explanation of the estimation of the annual average vertical recharge rates is included in Brown *et al.* (2006). A key recommendation of this review was that the impacts of commercial plantation forestry on underground water recharge rates should no longer be considered on the input side of the water balance ledger, but be considered on the output side, as a user of the resource.

Brown *et al.* (2006) used the Water Table Fluctuation (WTF) Method to estimate the average annual vertical recharge rates for 37 of the 61 management areas in the LLC PWA. Gibbs (2010), as part of the South East Water Science Review (DFW 2010), reported that Paydar *et al.* (2009) compared the results of Brown *et al*. (2006) to a one-dimensional SWAGMAN-Density soil profile model. The study concluded that the one-dimensional model overestimated recharge, and that the recharge estimates derived by Brown *et al.* (2006), using the WTF method, were likely to be more accurate.

Gibbs (2010) also compared the annual water table fluctuation to the observed rainfall for that year to investigate the relationship between recharge and rainfall. There is a strong dependence between winter rainfall and observed recharge, with statistically significant linear relationships between winter rainfall and recharge rate identified at 31 of the 41 wells considered in the study. Recharge rates were found to vary markedly over the region, with a high recharge zone in the management areas of Short, Kennion and Riddoch. It was also found from this study that the recharge expected from average rainfall corresponded well with the values reported by Brown *et al. (*2006) (Gibbs 2010).

A nominal 10% of the annual average vertical recharge to each management area is set aside for environmental water requirements, including the maintenance of underground water dependent ecosystems and a component of lateral underground water through-flow to mitigate possible adverse salinity impacts. The resulting volume is now called the Total Available Recharge (TAR) and is calculated as follows:

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

4.2.2 Lower Limestone Coast Groundwater Risk Assessment

The South East Water Science Review (Department for Water 2010) states that there is a need to set extraction limits so that underground water levels are maintained in order to provide for underground water dependent ecosystems.

As a result of several underground water resource science and management projects undertaken over the last five years, new methodologies have been developed for estimating the volume of underground water that can be extracted sustainably by licensed underground water users from the unconfined aquifer at a management area scale. The studies found that water allocation at the prescribed wells area level is currently within sustainable limits however, several hot-spots of over-extraction/over-use exist. The potential demands on the unconfined aquifer exceeds the capacity of the resource in a number of management areas and the capacity of the resource is insufficient to meet demand on a continuing basis.

Management areas in which the resource and the underground water-dependent community, industries and ecosystems, is considered at risk of degradation from the current level of demand were identified through a risk assessment process (DEWNR, in press). The risk assessment process was developed using DEWNR's recently adopted risk assessment

framework as a basis (DFW 2012a). The risk assessment poses the following question for each management area:

"Is there potential that the level of demand for water from both licensed and unlicensed users and current levels of extraction and recharge interception in management areas in the Lower Limestone Coast will lead to (further) declines in water tables and resource quality which will have detrimental impacts on the community, industry and ecosystems dependent on the groundwater?"

Sources of risk which could lead to adverse impacts on the resource, and therefore its users (water dependent industries, stock and domestic water users, groundwater-dependent ecosystems), were identified as: groundwater extraction and interception, climate variability, drought, and climate change. The risk assessment considered the risk of an adverse change occurring in the short term (i.e. during the life of the Plan). Climate change is not considered a risk within the next five to 10 years[1]. Although climate variability can be considered a risk in the short term, it has been well studied in the South East (Skewes 2006) and the Plan includes policy for its management through a system of carry-over and temporary transfer of allocation. The potential consequences of continued groundwater extraction and interception were therefore evaluated through the risk assessment.

The value of the groundwater resource was determined for both the community and the groundwater-dependent ecosystems, as water users. Value of the groundwater resources to the community was determined by the extent and level of activity of a variety of water-dependent industries, as well as stock and domestic and public water supply requirements in each management area. Where available, knowledge of the cultural value of the water resources was also considered. Groundwater dependent ecosystem value was determined according to SAWID and the level of groundwater dependency.

Resource vulnerability was determined by aquifer saturated thickness (Figure 15, *Appendix of Figures and Tables*) and evidence that an impact is imminent or already occurring, was determined from trends in depth to the water table and groundwater salinity over the last five and 10 years (Figures 5 and 9, *Appendix of Figures and Tables*). The consideration of longer term trends (20-30 years) in management areas with declining trends in the last five to 10 years, also showed a decline in depth to groundwater. A consequence level from adverse impacts was then determined by multiplying the value by the vulnerability for both the community and underground water dependent ecosystems.

The likelihood of each consequence occurring was based on the level of allocation and level of net extraction (volumes pumped for the purpose of delivery supplements were assumed to return to the resource through deep drainage) compared to TAR in each management area. For example, an area which is both over-allocated and over-extracted with respect to TAR scored a higher likelihood than an over-allocated but not over-extracted area, which in turn scored a higher likelihood than areas which are not over-allocated (and therefore should not have the potential to become over-extracted).

Risk was assessed using a consequence and likelihood table, taking into account the level of confidence in the data. Tolerability analysis was used to determine which management areas required treatment in the form of reductions to allocations, according to the level of risk.

The risk assessment showed that in three management areas (Zone 2A, Coles and Short) the current levels of allocation and extraction present a very high risk to the groundwater resource. An additional five management areas (Frances, Hynam East, Myora, Zone 3A and Zone 5A) were determined to be at high risk from current demands. Allocation in all eight management areas exceeds the TAR and, in the case of Coles and Short, extraction also exceeds TAR, as determined in 2007 (Latcham *et al*. 2007). The balance of management

[1] The South East Water Science Review (Department for Water 2010) states that "Existing variability in rainfall patterns is likely to be larger in scale than that caused by human-induced climate change for some time. The region will continue to experience high climate variability, where rainfall and temperature may deviate significantly from the mean for decades at a time"

areas were determined to be at low or moderate risk of degradation. The management responses proposed for each category of risk are described in Table 4.7.

TABLE 4.6 RISK RANKING OF MANAGEMENT AREAS IN THE LOWER LIMESTONE COAST

Unconfined Management Area	RISK RANKING	Unconfined Management Area	RISK RANKING	Unconfined Management Area	RISK RANKING
BANGHAM		JOYCE		ROSS	
BEEAMMA		KENNION		SHORT	
BENARA		KILLANOOLA		SMITH	
BLANCHE CENTRAL		KONGORONG		SPENCE	
BOOL		LACEPEDE		STEWARTS	
BOWAKA		LAKE GEORGE		STRUAN	
BRAY		LANDSEER		SYMON	
COLES		LOCHABER		TOWNSEND	
COMAUM		MACDONNELL		WATERHOUSE	
COMPTON		MARCOLLAT		WESTERN FLAT	
CONMURRA		MAYURRA		WOOLUMBOOL	
DONOVANS		MINECROW		YOUNG	
DUFFIELD		MONBULLA		ZONE 2A	
FOX		MOORAK		ZONE 3A	
FRANCES		MT BENSON		ZONE 5A	
GLENBURNIE		MT MUIRHEAD			
GLENROY		MOYHALL			
GREY		MURRABINNA			
HACKS		MYORA			
HINDMARSH		ORMEROD			
HYNAM EAST		PEACOCK			
HYNAM WEST		RIDDOCH			
JOANNA		RIVOLI BAY			

Key to Table 4.6:

COLOUR	RISK RANKING	TOLERABILITY
	Very High	Intolerable
	High	Intolerable
	Moderate	Tolerable subject to being the focus of further investigation where possible
	Low	Broadly acceptable

It is the Board's intention that the above risk assessment methodology is used to determine risk to the resource during the life of the Plan, with opportunity provided for continued improvements to the assessment. In addition, where feasible, the risk assessment may be expanded to include an assessment of the social and economic impacts of any decisions. Finally, the Board intends to continue to involve the community in decision-making throughout the life of the Plan where possible.

4.2.3 Target Management Level

In recognition of the fact that TAR may not be the sustainable limit to extraction in all situations, the Plan incorporates the term “Target Management Level” or TML. The method of calculation of TML is dependent on the level of risk to the water resources and the community, industry and ecosystems that rely on the groundwater, from current demand.

TML is the level of net losses allowable in each management area. The Plan sets a pathway towards reducing net losses (through reductions in allocations) within 10 years, with reductions to occur in steps every two years for all licensees excluding forest water licensees.

In the case of forest water licensees, the volume of allocation for commercial forests in management areas undergoing reductions is equal to 100% recharge interception less a volume equivalent to the reductions required to allocations for that management area, or the deemed rates of recharge interception (78% for hardwoods, 83% for softwoods), whichever is the greater. Any additional reductions required are proposed to occur in accordance with section 169E of the Act, at the time, or within the prescribed period following the time, when a part (or all) of the forest is clearfelled, or in accordance with a scheme relating to the management of the forest (including as to the planting and harvesting of trees constituting the forest) approved by the Minister under section 169E of the Act.

Allocations for public water supply, industry, intensive farming and recreational purposes are exempt from reductions.

Net losses include allocations for irrigation, industry, commercial plantation forests, public water supply, aquaculture, recreational use, specialised production requirements as well as unlicensed provisions for stock and domestic requirements or farm forestry, but excludes allocations for seasonal carryover, bridging volume or delivery supplement.

The TML is proposed to be set as follows, depending on the level of risk to the water resource:

a) TML= current level of demand or TAR, whichever is the higher, in management areas in which the risk to the water resources (and the community, industry and ecosystems that rely on the groundwater) from current demand has been identified as low or moderate;

b) TML=TAR, in management areas in which demand exceeds TAR and the risk to the water resources (and therefore the community, industry and ecosystems that rely on the groundwater) from current demand has been identified as high or very high.

The risk assessment method used to determine the level of risk is described in 4.2.2 above and Table 4.7 provides a summary of the level of risk, the method of calculating TML and the corresponding management response for each management area.

The Plan also provides for a risk assessment to be undertaken prior to 1 July 2019, in order to evaluate changes in the condition of the resource in response to climate conditions and reductions to allocations. The TML at date of adoption for each unconfined aquifer management area is shown in Table 1 (*Appendix of Figures and Tables*).

TABLE 4.7: METHOD OF CALCULATING THE UNCONFINED AQUIFER TARGET MANAGEMENT LEVEL (TML)

Level of risk to the water resources and the dependent community and ecosystems*	Unconfined Aquifer Management Areas in the Lower Limestone Coast PWA	Method of calculation of TML at date of adoption	Management response #
Low	Blanche Central, Bool, Bowaka, Bray, Compton, Conmurra, Duffield, Hacks, Joyce, , Lacepede, Lake George, Lochaber, Mayurra, Minecrow, Moorak, Moyhall, Murrabina, Ormerod, Peacock, Rivoli Bay, Ross, Smith, Spence, Symon, Townsend, Woolumbool	TML = TAR	No reductions to allocations required since management areas are not over-allocated with respect to TML. Re-assess level of risk prior to 1 July 2019.
Moderate	Bangham, Beamma, Benara Comaum, Donovans, Fox, Glenburnie, Glenroy, Grey, , Hindmarsh, Hynam West, Joanna, Kennion Killanoola, Kongorong, Landseer, MacDonnell, Marcollat, Monbulla, Mount Benson, Mount Muirhead, Riddoch, Stewarts, Struan, Waterhouse, Western Flat, Young.	TML = current level of allocation or TAR, whichever is the higher. TML = current level of allocation in Bangham, Beeamma, Comaum, Fox, Glenroy, Joanna, Killanoola, Stewarts and Western Flat.	No reductions to allocations required since management areas are not over-allocated with respect to TML. Where possible, prioritise further investigations in these areas over the low risk management areas. Re-assess level of risk prior to 1 July 2019. If level of risk has become high or very high and allocations exceed TAR, implement reductions to TAR as follows: For non-forestry licensees where the total reduction required is less than 10%, the full reduction to be implemented at 1 July 2020. For non-forestry licensees where the total reduction required is between 10% and 34%: 1/4 of the required reduction to occur at 1 July 2020, with an additional 1/4 of the required reduction to occur every 2 years after that. For non-forestry licensees where the total reduction required is greater than 34%: 8.5% reduction to allocation at 1 July 2020, followed by 8.5% reduction at 1 July 2022 and the remaining reduction to be implemented in two equal steps at 1 July 2024 and 1 July 2026. Allocations attached to forest water licences to be reduced at clearfell.
High	Frances, Hynam East, Myora, Zone 3A and Zone 5A	TML = TAR	Reductions to TML to be implemented as follows: • For non-forestry licensees where the total reduction required is less than 10%

Level of risk to the water resources and the dependent community and ecosystems*	Unconfined Aquifer Management Areas in the Lower Limestone Coast PWA	Method of calculation of TML at date of adoption	Management response #
			(Myora), the full reduction to be implemented at 1 July 2016. • For non-forestry licensees in Frances, Zone 3A and Zone 5A: 1/4 of the required reduction to occur at 1 July 2016, with an additional 1/4 of the required reduction to occur every 2 years after that. • For non-forestry licensees in Hynam East: 8.5% reduction to allocation at 1 July 2016, followed by 8.5% reduction at 1 July 2018 and the remaining reduction to be implemented in two equal steps at 1 July 2020 and 1 July 2022. In the case of forestry licensees, reductions to excess water to occur at date of allocation, prior to attaching allocations to forest water licences. Any additional reductions to occur at clearfell. Re-assess level of risk prior to 1 July 2019. If level of risk changes to low or moderate, set the TML at level of allocation at that time and discontinue reductions. If risk continues to be high or very high, continue reductions.

Level of risk to the water resources and the dependent community and ecosystems*	Unconfined Aquifer Management Areas in the Lower Limestone Coast PWA	Method of calculation of TML at date of adoption	Management response #
Very high	Zone 2A, Coles and Short	TML = TAR	Reductions to TML to be implemented as follows: In Zone 2A, for non-forestry licensees the full reduction required will occur at 1 July 2016. For non-forestry licensees in Coles and Short: 8.5% reduction to allocation at 1 July 2016, followed by 8.5% reduction at 1 July 2018 and the remaining reduction to be implemented in two equal steps at 1 July 2020 and 1 July 2022. For forestry licensees in Zone 2A, Coles and Short, reductions to excess water to occur at date of allocation, prior to attaching allocations to forest water licences. Any additional reductions to occur at clearfell. Re-assess level of risk prior to 1 July 2019. If level of risk changes to low or moderate, set the TML at level of allocation at that time and discontinue reductions. If risk continues to be high or very high, continue reductions in Coles and Short. These areas to be given priority for volumetric conversion of existing area-based allocations and allocation of water to forestry, over lower risk management areas.

*determined through the Lower Limestone Risk Assessment described in 4.2.2.

4.2.4 Target Management Levels and the Border Groundwaters Agreement

The Designated Area (commonly referred to as the Border Zone) is a 40 kilometre wide strip centred on the border of South Australia and Victoria and extending for its full length (Figure 2, *Appendix of Figures and Tables*). The area is designated by the *Groundwater (Border Agreement) Act 1985*, and is divided into 22 management zones (11 in each state). Border Zones 1A to 6A and part of Zone 7A lie within the LLC PWA. In each Zone, a Permissible Annual Volume (PAV) as determined by the Border Groundwater Agreement Review Committee under clause 28(2) of the *Groundwater (Border Agreement) Act 1985* establishes the volume of water that is permitted to be extracted from licensed wells (i.e. excluding for stock and domestic purposes). Commercial plantation forests are excluded from this requirement, as they do not extract water via wells.

The Plan sets out principles to ensure volumetric allocations are reduced to the TML in each management area. Despite the reductions to meet TML, the volume of allocations that can potentially be extracted from licensed wells will still exceed the Border Zone PAVs in all Zones located within the LLC PWA: Zones 1A (Myora, Glenburnie, Donovans), 2A, 3A, 4A (Comaum, Joanna, Glenroy, Struan), 6A (Frances, Bangham) and Zone 7A (which includes Western Flat), with the exception of Zone 5A (Table 4.8).

TABLE 4.8 ZONES OF THE DESIGNATED AREA AND PERMISSIBLE ANNUAL VOLUMES

Designated Area Zone	Permissible Annual Volume (ML/year)	Management area(s)
7A	8,803	TATIARA
		WESTERN FLAT
6A	8,758	BANGHAM
		FRANCES
5A	18,943	ZONE 5A
4A	22,102	GLENROY
		COMAUM
		JOANNA
		STRUAN
3A	24,054	ZONE 3A
2A	25,000	ZONE 2A
1A	31,812	DONOVANS
		GLENBURNIE
		MYORA

DEWNR's position is that the Border Groundwaters Agreement does not require the Minister to reduce existing allocations to meet the PAVs; however, the PAVs apply to the granting of new allocations and/or renewal of temporary allocations for extraction from licensed wells. The volumetric conversion of existing allocations is considered to not constitute the granting of a new allocation or the renewal of a temporary allocation. Finally, the allocation of water to existing commercial forests is not subject to the Border Groundwaters Agreement, as commercial forests do not extract water from wells.

South Australia and Victoria have agreed to a review of the Border Groundwaters Agreement in order to modernise the document and incorporate forestry and possibly surface water in its scope. As a precautionary approach while the Agreement is being reviewed, delivery supplements within the Border Zone will be based on the greatest area (in haIE) that was actually flood irrigated in any management area, or spray irrigated in the Donovans management area, during the 2009/10-2011/12 water use years, in order to reduce the level of allocation above the PAV. The delivery supplement is the volume of water in addition to the tradeable component that flood irrigators (and some spray irrigators) are permitted to extract from the aquifer and which is assumed to return to the source aquifer.

4.3 Confined Aquifer

The LLC PWA incorporates the whole of the Zones 1A, 2A, 3A, 4A, 5A, 6A, Taratap Kingston, Lucindale, Kalangadoo and Millicent and parts of Zone 7A, Wirrega and Fairview confined aquifer management areas (Figure 3, *Appendix of Figures and Tables*).

4.3.1 Trends in underground water levels – confined aquifer

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

Prior to 2010, direct leakage of pressure water from the confined aquifer into the overlying unconfined aquifer occurred via a large number of confined aquifer wells in poor condition due to age and construction techniques. During 2001 to 2010, 120 leaking confined aquifer wells in the Kingston-Greenways area were either replaced or back-filled using specialist techniques, as part of the South East Confined Aquifer Well Rehabilitation Scheme. Expenditure on the scheme was estimated to be $5.5 million over nine years, including $1.3 million funding from the Natural Heritage Trust, $1.1 million from State investment and a financial commitment from landowners of up to $3.1 million.

The five year potentiometric level trends in the confined aquifer from March 2007 to March 2012 (Figure 6, *Appendix of Figures and Tables*) indicate a general decline in potentiometric levels in a number of management areas in the LLC PWA. Declines are particularly evident in Zone 2A and other management areas along the Border Zone. Stable to recovering trends over the past five years are evident in many observation wells in Figure 6 (*Appendix of Figures and Tables*), particularly those in the Kingston, Millicent, Kalangadoo and Lucindale management areas.

The ten year potentiometric level trends in the confined aquifer from March 2002 to March 2012 (Figure 7, *Appendix of Figures and Tables*), show a widespread general decline in potentiometric levels across most management areas in the PWA, although the majority of wells in the Kingston management area are stable or recovering.

In the Nangwarry area the confined aquifer is likely to be receiving direct and indirect recharge via preferential flow and downward leakage through the thin aquitard. There is the potential for this process to occur across other faults in the region.

Another response in the confined aquifer potentiometric level could be attributed to hydraulic pressure response where declining or rising water tables in the unconfined aquifer effectively load/unload pressure on the confined aquifer.

4.3.2 Trends in underground water salinity - confined aquifer

There are 44 observation wells in the current salinity monitoring network for the confined aquifer in the LLC PWA. The majority of these wells are situated in the Kingston management area.

In most areas the confined aquifer yields good to excellent quality underground water with quite uniform salinity. Salinity increases to the north and west of the PWA, as shown in Figure 10 (*Appendix of Figures and Tables*). The salinity of the confined aquifer has remained stable over the five years from March 2007 to March 2012, as shown in Figure 10 (*Appendix of Figures and Tables*).

TABLE 4.9: SUMMARY OF LOWER LIMESTONE COAST PRESCRIBED WELLS AREA CONFINED AQUIFER UNDERGROUND WATER ALLOCATIONS AND USAGE FOR IRRIGATION YEARS 2009/10 AND 2010/11

Confined Management Area	No. of Licences	Conversion of area based allocation (halE) to ML	Holding allocations (ML)	Existing volumetric irrigation allocations (ML)	Public Water Supply (ML)	Aquaculture (ML)	Industrial (ML)	Recreational (ML)	Total existing volumetric allocations (E+F+G+H+I) (ML)	Total indicative allocations (C+J) (ML)	Indicative use 2009/10 (ML)	Indicative use 2010/11 (ML)
A	B	C	D	E	F	G	H	I	J	K	L	M
Kalangadoo	11	2,562	0	0	50	0	459	0	509	3071	1945	946
Kingston	47	34,912	0	0	1,110	3,567	0	0	4,677	39589	12022	9721
Lucindale	11	1,407	0	93	900	0	0	0	993	2400	790	515
Millicent	32	5,622	0	0	290	297	598	17	1,202	6824	2282	1574
Taratap	2	23	0	0	0	0	0	0	0	23	0	0
Fairview	0	0	0	0	0	0	0	0	0	0	0	0
Wirrega	1	0	0	0	0	0	225	0	225	225	250	214
Zone 1A	4	611	0	763	210	0	44	0	1,017	1628	690	671
Zone 2A	3	0	0	0	60	0	1,395	0	1,455	1455	45	32
Zone 3A	2	0	0	0	250	0	931	0	1,181	1,181	106	57
Zone 4A	1	81	0	0	0	0	0	0	0	81	23	19
Zone 5A	0	0	0	0	0	0	0	0	0	0	0	0
Zone 6A	0	0	0	0	0	0	0	17	17	17	0	0
Grand Total	**114**	**45,218**	**0**	**856**	**2,990**	**3,864**	**3,652**	**34**	**11,276**	**56,494**	**18,153**	**13,749**

4.3.3 Economic needs – confined aquifer

In terms of providing for future expansion in water use, the Plan provides for new confined aquifer allocations to be allocated from the Crown for limited purposes, including for public water supply, and temporary allocations for mining, geothermal energy, petroleum or carbon dioxide production purposes, subject to a number of conditions. In order to expand, or to set up a totally new water-using enterprise other than for these purposes, an individual or organisation must obtain an allocation through trade or transfer from the same confined aquifer management area, or bring into use their own existing unused allocation, subject to hydrogeological assessment and a number of other conditions. Confined aquifer allocations may not be transferred across management areas.

A number of allocations may only be transferred for the same purpose of use: public water supply, industry, geothermal energy generation, mining, petroleum or carbon dioxide production.

Irrigation

The licensed allocations for the irrigation years 2009/10 and 2010/11 for the LLC PWA confined aquifer management areas are presented in Table 4.9.

Estimated underground water extraction from the confined aquifer was 18,153 ML/year in the 2009/10 irrigation season and 13,749 ML/year in the 2010/11 irrigation season. The majority of allocation for the Kalangadoo, Kingston, Lucindale, Millicent and Zone 1A management areas is for irrigation purposes (Table 4.9). The indicative conversion of haIE allocations to a volumetric basis, is estimated at 45,218 ML/year.

Industry, aquaculture, mining, petroleum and carbon dioxide exploration/production, and geothermal exploration/production

An estimated total volume of 3,652 ML/year and 3,864 ML/year has been allocated from the confined aquifer for use by industry and aquaculture respectively.

Penola Pulp Mill

The Act is subject to the *Penola Pulp Mill Authorisation Act 2007*. In accordance with this Act, an allocation of 2,677.5 ML/year has been made from the Zone 2A, Zone 3A and Kalangadoo management areas for the proposed Penola pulp mill. The site for the proposed mill is expected to be eight kilometres south west of the township of Penola. If established, the mill will supply pulp products to the domestic market and also export them into Asia. The proponents have opted for a total onsite water reuse system for the mill process. The *Penola Pulp Mill Authorisation Act 2007* commenced on 1 November 2007 and expires on 2 November 2013. The Act requires that if the project has not been completed by 1 November 2013, the water licence will be taken to be cancelled and the water allocation endorsed on the licence will be returned to the Minister.

Mining

Action 48 of the Water for Good Plan (Government of South Australia 2010) relates to water used for mining and requires “mining ventures to provide their own water supplies within the sustainable framework of natural resources management planning and regional water demand and supply plans”.

There are a number of extractive mineral mines in the LLC PWA, extracting limestone, sand, and/or gravel. Additionally, a lignite (coal) mine is proposed for an area northeast of Kingston SE. Licensed water use for mining purposes is included in the volumes allocated for industry.

The Plan allows for the allocation of water for the purpose of mining, provided that the majority of the water extracted can be returned to the source aquifer from which the water was originally extracted, with no detrimental change to the quality of water in the source aquifer, and subject to a number of other conditions.

Petroleum and carbon dioxide exploration/production, geothermal energy exploration/generation

The Katnook and Ladbroke Grove gas plants, which are located south of Penola, are involved in the production and processing of petroleum. The Caroline Carbon Dioxide Purification Plant is located southeast of Mount Gambier, and produces liquid carbon dioxide for the soft drink, fire fighting, medical and winemaking industries.

There is currently a Ministerial authorisation under section 128 of the Act for the taking of water in relation to a hydrocarbon exploration well under the *Petroleum Act 2000* (now *Petroleum and Geothermal Energy Act 2000*). A hydrocarbon includes petroleum, natural gas and coal seam gas. Water extracted during the drilling process comes from the unconfined aquifer.

Petroleum and carbon dioxide is sourced from the deeper confined aquifer(s) which may result in co-produced water (water taken as a by-product of petroleum or carbon dioxide extraction), being extracted during the production process.

Users of hydrocarbon production wells may apply for an allocation to account for the co-produced water extracted from the confined aquifer.

The Penola Project (part of the Limestone Coast Geothermal Project, located approximately 40 kilometres north of Mount Gambier) is a hot sedimentary aquifer project, targeting the Pretty Hill Formation in the Penola Trough. The Penola Project is designed to produce water or brine from a known aquifer in the Pretty Hill Formation at depths of between 3,000 to 4,000 metres. The hot (150-200^{0}C) brine is intended to be used in a binary geothermal power plant to generate electricity. The utilised brine will then be re-injected back into reservoirs at higher levels in the same aquifer via a closed loop system. Drilling of the first production well, Salamander 1, near Penola was completed in March 2010 to a depth of 4,025 metres, with the well testing programme completed in July 2010. The project is now on hold pending the securing of adequate funding and a joint venture partner (Panax Geothermal 2011).

The Plan provides for water to be extracted from the confined aquifer for the purpose of geothermal energy, provided that the water extracted is returned to the confined aquifer with no detrimental change to the quality of the water in the source aquifer. Further geothermal exploration may occur in the PWA.

4.3.4 Social needs - confined aquifer

Public Water Supply

Water use by the township of Beachport is stable and SA Water has estimated that customer demand could reach 150 ML/year in 2029/30. However, there is the potential for a reduction in aquifer pressure caused by extractions from up-gradient to the resource to impact on future availability.

Water use by the township of Kalangadoo is stable and SA Water has estimated that customer demand could reach 30 ML/year in 2029/30. This public water resource is directly recharged through active geological faults near the township.

Water use by the township of Kingston is stable and SA Water has estimated that customer demand could reach 340 ML/year in 2029/30. However, there is the potential for a reduction in aquifer pressure caused by extractions up-gradient to the resource to impact on future availability.

Water use by the township of Robe is stable. SA Water's estimates of customer demand indicate that this could reach 455 ML/year in 2029/30. Investigations into the trend of increasing salinity have been undertaken for the Robe public water supply, indicating that higher salinity water from deeper sub-aquifers may be leaking into the aquifers used for the public water supply, as a result of a pressure drop. In an effort to source better quality water, SA Water has drilled and is operating a new well and plans to locate any future wells in a similar manner to avoid the up-gradient influence of other extractions.

Water use by the township of Lucindale is stable and SA Water has estimated that customer demand could reach 70 ML/year in 2029/30. There are no potential issues with future water quality and availability.

Water use by the township of Naracoorte is stable. SA Water has estimated that customer demand could reach 650 ML/year in 2029/30. However an increasing trend in salinity of the water resource may necessitate SA Water to look for options to manage the salinity, including seeking alternative water sources. Investigations may include reviewing water quality and recharge processes for the confined aquifer in the vicinity of the Kanawinka Fault which lies near the town.

Penola public water is supplied from the confined aquifer. This follows the drilling of a second well into this water resource. SA Water has a total allocation from the confined aquifer of 250 ML/year which will cater for the total demand of the township now that the unconfined supply is phased out. SA Water has estimated that customer demand could reach 225 ML/year in the year 2029/30.

Water use by the township of Port MacDonnell is stable and SA Water has estimated that customer demand could reach 85 ML/year in 2029/30. There are no potential issues with the future water quality and availability.

Water use by the township of Tarpeena is stable and SA Water's estimates of customer demand indicate that this could reach 35 ML/year in 2029/30. This public water resource is directly recharged through active geological faults near the township.

Recreational Use

A total of 34 ML/year of underground water has been allocated from the confined aquifer for recreational use. These licences are largely held by sporting clubs for watering sports fields, greens and gardens, and Local Government for the watering of parks and gardens. Future demand for underground water for recreational use is expected to remain steady.

Stock and Domestic Use.

As stock and domestic water use is not required to be licensed, the level of actual use is unknown. Although use is considered to be small, the confined aquifer is an important source of water for stock and domestic use in areas where the salinity of the unconfined aquifer is too high for this purpose. Future usage is not expected to change significantly and is estimated at 1, 210 ML/year.

4.3.5 Environmental needs – confined aquifer

The environmental water requirements have been described in section 2 of the Plan. The future needs of the environment are expected to remain the same as present needs.

4.3.6 Indigenous and cultural needs – confined aquifer

Access to, and use of, water from prescribed water resources by Aboriginal people is exempt from licensing for the purpose of social, cultural or spiritual use, 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 Minister has issued a state-wide authorisation (under section 128 of the Act) to take water for Native Title purposes.

The current and future Aboriginal needs for confined aquifer water have not been identified or quantified at this time. The traditional owners of the land that is now the LLC PWA are the Tanganekald, Meintangk, Bungandiji, Potaruwutj and Marditjali people. Representatives of all traditional owners in the South East region are working closely with the Board through the South East Indigenous Focus Group to identify and quantify these needs.

4.4 Capacity of the resource to meet demand – confined aquifer

In the previous Plans, the PAV for the confined aquifer was defined as the volume of water that can be used on an annual basis without causing significant adverse water pressure level or water quality impacts to that aquifer. The PAV for each management area was developed by DWLBC (now DEWNR) in 2000 (Brown 2000) using a combination of underground water

through-flow calculations and computer flow modelling. The PAVs were determined after a range of annual extraction volumes were modelled to examine the longer term change in aquifer pressure and changes in leakage between the confined and unconfined aquifers.

The former SECWMB set the PAV for each management area at 37% of the underground water through-flow, with the exception of the Kingston management area where the PAV was set at the estimated level of allocation and use of water in this area at the time of assessment (25,000 ML/year). The total estimated underground water through-flow in the Kingston management area is 9,500 ML/year, with 37% of this equal to 3,515 ML/year. This approach, developed in consultation with the community, was adopted to ensure underground water pressure levels do not decline by more than two to four metres over the next 20 years (see Section 4.3.1 for recent trends in confined aquifer conditions).

In 2005, DWLBC undertook a review of the confined aquifer PAVs for the SECWMB (Harrington & Brown unpub). The numerical underground water flow model originally developed by DWLBC in 2000 was updated during this review to reflect current licensed allocations, improved treatment of leaking wells and to allow possible recalculation of PAVs. Following this review, DWLBC recommended no change to PAVs, noting that once a number of years of metered extraction data has been collected, the underground water flow model can be further refined.

4.5 Limestone Coast Groundwater Risk Assessment - confined aquifer

Management areas in which the confined aquifer resource, and therefore the community and industries dependent on the underground water, is considered at risk of degradation from the current level of demand (otherwise known as hotspots) were identified through a risk assessment process (DEWNR in press). The risk assessment was developed using DEWNR's recently adopted risk assessment framework as a basis (DFW, 2012a).

For the confined aquifer, the LLC PWA risk assessment poses the following question for each management area:

"Is there the potential that current levels of allocation and extraction in management areas in the Lower Limestone Coast will lead to (further) declines in water tables and resource quality, which could detrimentally impact the community and industries dependent on the groundwater?"

Sources of risk which could lead to adverse impacts on the confined aquifer resource, and therefore its users (water dependent industries, stock and domestic water users), were identified as: groundwater extraction and interception, climate variability, drought, and climate change. The risk assessment considered the risk of an adverse change occurring in the short term (i.e. during the life of the Plan). Climate change is not considered to be a risk within the next five to ten years[2]. Although climate variability can be considered a risk in the short term, it has been well studied in the South East (Skewes 2006) and the Plan includes policy for its management through a system of carry-over and temporary transfer of allocation. The potential consequences of continued groundwater extraction and interception were therefore evaluated through the risk assessment.

As there are no ecosystems identified as dependent on the confined aquifer, the value of the groundwater resource was determined only for the community (including industry) as water users. This was determined by the extent and level of activity of a variety of water-dependent industries as well as stock and domestic, and public water supply requirements in each management area. The cultural value of the confined aquifer is currently unknown.

[2] The South East Water Science Review (DFW 2010) states that "Existing variability in rainfall patterns is likely to be larger in scale than that caused by human-induced climate change for some time. The region will continue to experience high climate variability, where rainfall and temperature may deviate significantly from the mean for decades at a time".

Resource vulnerability was rated according to background salinity (lower salinity water was given a higher score than higher salinity water) and whether there is evidence that an impact is imminent or already occurring (determined from trends in potentiometric levels and groundwater salinity between 2002-2012 and 2007-2012) (*Figures 6, 7 and 10, Appendix of Figures and Tables*). A consequence level from adverse impacts was then determined by multiplying the value for the community by the resource vulnerability.

The likelihood of each consequence occurring was based on the level of allocation and level of extraction compared to the TML (as shown in Table 5, *Appendix of Figures and Tables*) for each management area. For example, an area which is over-allocated (and therefore has the potential to be over-extracted) with respect to the Permissible Annual Volume developed by DWLBC (now DEWNR) in 2000 (Brown 2000) scored a higher likelihood than areas which are not over-allocated (and therefore should not have the potential to become over-extracted).

Risk was assessed using a consequence and likelihood table, taking into account the level of confidence in the data. Tolerability analysis was used to determine which management areas required treatment in the form of reductions to allocations, according to the level of risk.

The risk assessment showed that the risk to the resource from the current level of allocation and extraction is low in seven management areas, and moderate in six areas (Table 4.10). No management areas were identified as at high or very high risk at the time of adoption of the Plan.

TABLE 4.10 RISK RANKING OF CONFINED AQUIFER MANAGEMENT AREAS IN THE LOWER LIMESTONE COAST

CONFINED MANAGEMENT AREA	RISK RANKING
FAIRVIEW	
KALANGADOO	
KINGSTON	
LUCINDALE	
MILLICENT	
TARATAP	
WIRREGA	
ZONE 1A	
ZONE 2A	
ZONE 3A	
ZONE 4A	
ZONE 5A	
ZONE 6A	

Key to Table 4.10:

COLOUR	RISK RANKING	TOLERABILITY
	Very High	Intolerable
	High	Intolerable
	Moderate	Tolerable subject to being the focus of further investigation where possible
	Low	Broadly acceptable

4.6 Target management levels

In recognition of the fact that the PAV may not be the sustainable limit to extraction in all situations, the Plan incorporates the term “Target Management Level” or TML. TML for the confined aquifer is the maximum annual volume of underground water that can be potentially extracted from each management area. TML includes allocations for irrigation (tradeable components and delivery supplements), industry, public water supply, aquaculture, recreational use, specialised production requirements and unlicensed provisions for stock and domestic requirements. TML does not include allocations for seasonal carryover, or bridging volume. The PAV and TML for each management area are listed in Table 5 (*Appendix of Figures and Tables*). Note that the TML for the confined aquifer is defined differently to that for the unconfined aquifer (see Section 5, *Definitions*).

Volumetric allocations will include not only crop water requirements, but system losses as well. As a result, in the Kingston management area, the allocations following volumetric conversion, plus existing volumetric allocations and the allowance for stock and domestic use, will exceed the PAV of 25,000 ML/year. Resource condition triggers have not been exceeded in the Kingston management area over the last five years and the resource and its users are ranked as at moderate risk from the current level of allocation and demand (i.e. requires no treatment) through the risk assessment run in 2012 and described in section 4.5.

Over the last four years the following metered volumes extracted from the Kingston management area have been recorded: (previously to these four years, use was an estimated theoretical figure):

- 2010/2011 – 9,721 ML (24% of total allocation)
- 2009/2010 – 12,022 ML (30% of total allocation)
- 2008/2009 – 14,862 ML (37% of total allocation)
- 2007/2008 – 12,997 ML (32% total allocation)

The Plan allocates water based on the volumetric conversion model. The Board is proposing to run the numerical confined aquifer underground water flow model within two years of adoption date of the Plan, with varying scenarios of extraction, to determine an appropriate TML for the Kingston management area. If required, the Board will recommend that the Minister amend the Plan in order to incorporate the new TML. In the meantime, if prior to a new TML being determined, extraction from licensed wells plus the allowance for stock and domestic use exceeds 25,000 ML/year and the risk assessment identifies the management area as at high or very high risk from current allocation and demand, reductions to allocations will commence to return allocations to 25,000 ML/year.

4.7 Climate change

Climate change presents a significant challenge to South Australia.

While the water policy decisions included in the 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 knowing the consequences for future water allocation demand is difficult.

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.

Therefore, ongoing monitoring and technical investigations during the life of the Plan will be critical to reviewing the future sustainability of the underground resource.

Projected changes in climatic conditions from modelling indicate an increase in future annual average temperatures, as well as variations in the seasonal temperature and rainfall across

the State. 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 temperature trend and an overall decreasing annual rainfall trend, most significantly in the spring. Annual decreases in rainfall of one to10% are predicted for 2030 and two to 30% by 2070 in the South East NRM region (Suppiah *et al.* 2006).

The close relationship between climate and underground water levels in the unconfined aquifer, will in-turn, continue to have a negative impact on the underground water resources in the LLC PWA.

> The South East Water Science Review (DFW 2010) examined the historical rainfall record for evidence of climate change in the South East. They found that "Over the last 10 years, rainfall has been lower than longer-term averages, with a noticeable decline in groundwater tables compared to the previous three decades. An analysis of the historical rainfall record has shown that each year's rainfall is independent of other years'. Rainfall is random, and there is no suggestion that the current dry period is the result of climate change in the region – it is consistent with the longer-term rainfall distribution pattern.
>
> Highly variable rainfall and the propensity for the region to experience long periods of dry and wet conditions creates a challenge for water managers to devise policies that are adaptable to big changes in available water in this highly variable climate. While the CSIRO has tried to make an assessment of declines in rainfall by downscaling the global climate models, there is still a high degree of uncertainty. Existing variability in rainfall patterns is likely to be larger in scale than that caused by human-induced climate change for some time. The region will continue to experience high climate variability, where rainfall and temperature may deviate significantly from the mean for decades at a time" (DFW 2010).

It is critical that water policy decision makers apply precautionary measures with effective risk and adaptive management and planning. Underground water resource condition triggers for both water level and salinity and the risk assessment process 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 numerical underground water flow models have been developed for the area, enabling informed decisions to be made about how to adjust allocations to meet agreed condition targets.

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 suit the climatic conditions. The requirements will be resistance to disease, heat tolerance and lower water requirements. The intense rainfall events may assist in leaching salt loads from the crop root zones, which will be a benefit to irrigated crops where increasing salt loads from irrigated soils may become an issue.

References and Bibliography

Aquaterra Consulting 2010a, *Modelling forestry effects on groundwater resources in the South East of South Australia*, prepared for the Department of Water, Land and Biodiversity Conservation.

Aquaterra Consulting 2010b, *Modelled hydrological impacts by plantation forest on groundwater resources in the lower South East. A scenarios report*, prepared for the Department for Water.

Brown, K. 2000, *A groundwater flow model of the Tertiary confined sand aquifer in south east South Australia and south west Victoria*, Report Book 2000/00016, Department for Water Resources, Primary Industries and Resources, SA.

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

Benyon, R.G. and Doody, T.M. 2004. 'Water Use by Tree Plantations in South East South Australia.' CSIRO Forestry and Forest Products Technical Report Number 148. CSIRO Mount Gambier SA.

Benyon R, Theiveyanathan T, Doody T 2006, Impacts of Plantations on groundwater in south-eastern Australia. *Australian Journal of Botany* 54, 181-192.

Benyon R.G., Doody T.M., Theiveyanathan S, Koul V 2008, *Plantation Forest Water Use in Southwest Victoria*. CSIRO: Water for a Healthy Country National Research Flagship.

Benyon R., and Doody T. 2009, *Quantifying groundwater recharge under plantations in South East South Australia*. CSIRO: Water for a Healthy Country National Research Flagship.

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

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

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

Department of Environment, Water and Natural Resources,(in press), Risk Assessment for the groundwater resources in the LLC.

Department for Water 2010, *South East Water Science Review*, Lower Limestone Coast Water Allocation Plan Taskforce, Adelaide.

Department for Water 2011, *Water Allocation and Use in the South East 2010-11*, Water Planning and Management South East Division.

Department for Water 2012, *Lower Limestone Coast Water Allocation Plan Policy Principles*, Lower Limestone Coast Water Allocation Plan Taskforce.

Department for Water 2012a, *Risk Management Framework for Water Planning and Management*, Government of South Australia, through Department for Water, Policy and Strategy Division.

Department of Planning and Local Government, 2011. *Limestone Coast Regional Plan; a volume of the South Australian Planning Strategy*. Government of South Australia.

French, R.J. 1987, 'Future productivity on our farmlands', *Proceedings of the Fourth Australian Agronomy Conference*, Latrobe University, Melbourne, Victoria.

Gibbs, M. 2010, 'Rainfall and Recharge' in *South East Water Science Review*, Lower Limestone Coast Water Allocation Plan Taskforce, Adelaide, Department for Water, pp 3-1 – 3-35.

Government of South Australia 2010, *Water for Good: A plan to secure our water future to 2050.*

Harvey, D. 2009, *Accounting for plantation forest groundwater impacts in the lower South East of South Australia.* DWLBC Report 2009/13, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Adelaide.

Harrington, G. and Brown, K. 2005 (unpublished), *South East Confined aquifer Groundwater Resource Assessment: A review of the condition of the resource and estimates of Permissible Annual Volume*, Department of Water, Land and Biodiversity Conservation.

Hybrid Energy Australia (accessed 20 August 2009), *FuturGas Project Overview*, http://www.hybridenergyaustralia.com.au/futurgas.htm).

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, 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 2007/1, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Mount Gambier.

Mustafa, S., Lawson, J., Leaney, F. & Osei-Bonsu, K. 2006, *Land-use impact on water quality and quantity in the Lower South East, South Australia*, DWLBC Report 2006/25, Government of South Australia, through Department of Water, Land and Biodiversity Conservation, Adelaide.

Mustafa S, Slater S and Barnett S, 2012, *Preliminary investigation of seawater intrusion into a freshwater coastal aquifer – Lower South East*, DEWNR Technical Report 2012/01, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide.

Meyer, W. 2010, 'Land use potential for Forestry (Radiata Pine and Blue Gum)' in *South East Water Science Review*, for the Lower Limestone Coast Taskforce**,** ed J. Brookes, Government of South Australia, through the Department for Water, Science, Monitoring and Information Division, pp 6-1-6-24

Panax Geothermal Limited 2009a, *Penola Project – Australia's first conventional geothermal "measured resource"* ASX announcement 23 February 2009

Panax Geothermal Limited 2009b, *Penola Project – Limestone Coast Area South Australia Pre-Feasibility Study*, 8 March 2009

Panax Geothermal Limited 2011, *Annual Report 2011*

Paydar, Z., Chen, Y., Xevi, E. and Buettikofer, H. 2009, *Current understanding of the water cycle in the Limestone Coast Region*. Technical Report 03/09. Cooperative Research Centre for Irrigation Futures.

Primary Industries and Resources SA (PIRSA) 2010, *South East of South Australia Regional Profile October 2010*

Prosser, I.P., and Walker, G. R. 2009, *A review of plantations as a water intercepting land use in South Australia*. CSIRO: Water for a Healthy Country National Research Flagship.

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

Rammers, N. and Stadter, F., 2002, *South East Prescribed Wells Areas groundwater monitoring status report 2002*. South Australia. Department of Water, Land and Biodiversity Conservation. Report DWLBC 2002/10

Skewes, M. 2006, *Climatic Variability and Volumetric Allocations in the South East.* Irrigated Crop Management Service, Rural Solutions, Government of South Australia.

Smerdon, B.D. 2009, *A review of the scientific assessments underpinning the work-in-progress Water Allocation Plan for the Lower Limestone Coast Prescribed Wells Area*. CSIRO: Water for a Healthy Country National Research Flagship.

South Australian-Victorian Border Groundwaters Review Committee 2001, *Five Year management Review 1996-2000.* State of Victoria, Department of Natural Resources and Environment, Melbourne.

South Australian-Victorian Border Groundwaters Review Committee 2006, *Twenty-First Annual Report*. Governments of South Australia and Victoria, Department of Water, Land and Biodiversity Conservation, Adelaide and Department of Natural Resources and Environment,

Victoria.

Suppiah, R., Preston, B., Whetton, P.H., McInnes, K.L., Jones,R.N., Macadam, I., Bathols, J., and Kirono, D. 2006, *Climate change under enhanced greenhouse conditions in South Australia: An updated report on: Assessment of climate change, impacts and risk management strategies relevant to South Australia,* Climate Impacts and Risk Group, CSIRO Marine and Atmospheric Research.

van den Akker, J. and MacKenzie, G. 2004, *South East Groundwater Monitoring status report and assessment of current trends 2003-2004.* . South Australia. Department of Water, Land and Biodiversity Conservation DWLBC Report 2004/26.

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 the Plan that are defined in the Act have the definitions set out in that Act. In addition, for the purposes of the 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 PWA.

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

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

"Allotment" means:

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

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

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

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

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

(f) a separately defined piece of land identified as an allotment for the purposes of the *Real Property Act 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.

"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 artificially drained 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.

"Allowable Annual Volume" means the allowable volume of extraction from licensed wells specified for a particular sub-zone or aquifer within a sub-zone in the Designated Area, as determined by the Border Groundwaters Agreement Review Committee under the *Groundwater (Border Agreement) Act 1985*.

"Annual water use report" means a report produced by a licensee and submitted to the Department of Environment, Water and Natural Resources, Mount Gambier office, by 5 p.m. of 31 July each year, in accordance with section 11 (*Monitoring, Evaluation and Reporting*) of the 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 formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield economical quantities of water to wells and springs.

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

"**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 may transmit appreciable water to or from adjacent aquifers.

"Blue Lake Capture and Buffer Zone" means the area of the Lower Limestone Coast Prescribed Wells Area as shown in Figure 13 (*Appendix of Figures and Tables*).

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

"Bridging Volume" is a temporary allowance which is granted upon application to eligible licensees who can demonstrate that their allocation may be insufficient, to pump in excess of their allocation (subject to licence conditions).

"Cenote" means a deep natural pit or sinkhole, resulting from the collapse of limestone bedrock that exposes underground water underneath.

"Clearfell" or "Clearfelling" means the cutting down or forest harvesting of all of the remaining crop trees from a commercial plantation forest in a given area. The clearfelling of a compartment shall be deemed to have been completed when all of the remaining crop trees within the boundary of the compartment have been harvested or felled. This definition excludes forest thinning.

"Commercial forest" means a forest plantation where the forest vegetation is grown or maintained so that it can be harvested or used for commercial purposes (including through the commercial exploitation of the carbon absorption capacity of the forest vegetation).

"Compartment" means a defined area of crop trees of a commercial forest, usually of the same species and age, surrounded on all sides by a fire break.

"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.

"Confining layer" bears the same meaning as "aquitard".

"Coppice regrowth" means for hardwood plantations, trees which have been regenerated from shoots formed from the stumps of the previous crop of trees, root suckers, or both, i.e., by vegetative means.

"Crop Adjustment Factor (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 16 in Section 6.

"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 the Plan.

"**Date of Declaration**" means the date that the Minister declares a declared forestry area under section 169B of the Act.

"**Declared forestry area**" means a declared forestry area under section 169B of the Act.

"Delivery Supplement" means any or all of the following: "Delivery Supplement for Aquaculture" and/or "Delivery Supplement for Flood Irrigation" and/or "Delivery Supplement for Spray Irrigation".

"Delivery Supplement for Aquaculture" means the volume of water that eligible aquaculture water licensees are allowed to extract from the unconfined aquifer for the purposes of a flow-through aquaculture system, in addition to their tradeable component.

"Delivery Supplement for Flood Irrigation" means the volume of water in addition to the tradeable component that eligible flood irrigators are allowed to extract for the purposes of flood irrigation in conjunction with the corresponding amount of tradeable component (as shown in Table 6, *Appendix of Figures and Tables*), subject to application, from the aquifer and when extracted from the unconfined aquifer, is assumed to return to that aquifer.

"**Delivery Supplement for Spray Irrigation**" means the volume of water in addition to the tradeable component that eligible spray irrigators are allowed to extract for the purposes of spray irrigation in conjunction with the corresponding amount of tradeable component (as shown in Table 6, *Appendix of Figures and Tables*), subject to application, from the aquifer and when extracted from the unconfined aquifer, is assumed to return to that aquifer.

"Designated Area" means the area designated by the *Groundwater (Border Agreement) Act 1985.* This is a 40 kilometre 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 Lower Limestone Coast PWA, the Designated Area encompasses the management areas of Zone 1A (Myora, Donovans, Glenburnie), Zone 2A, Zone 3A, Zone 4A (Struan, Joanna, Glenroy, Comaum), Zone 5A, Zone 6A (Frances, Bangham) and part of Zone 7A (Western Flat).

"Domestic Purpose" in relation to the taking of water does not include –

(a) taking water for the purpose of watering or irrigating land, other than land used solely in connection with a dwelling; or

(ab) without limiting paragraph (a) – taking water for the purpose of watering or irrigating more than 0.4 of a hectare of land; or

(b) taking water to be used in carrying on a business (except for the personal use of persons employed in the business).

"Domestic Water Use" see Domestic Purpose.

"Drawdown" 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" refers to the species existing in an environment and their relationship with one another and the non-living (abiotic) community.

"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.

"Ecosystem function" means the fundamental characteristic of ecosystems related to conditions and processes necessary for maintaining ecosystem integrity, which implies intact abiotic components (e.g. soils and water), biodiversity and reliance on natural successional cycles (e.g. fire, flooding, predation). Ecosystem function will include such processes as decomposition, nutrient cycling and production. It is generally considered that maintenance of biodiversity is integral to ecosystem function. The term is sometimes used interchangeably with ecosystem condition.

"Environmental water requirements" means those water requirements that must be met in order to sustain the ecological values of ecosystems that depend on the water resource, including their process and biodiversity, at a low level of risk.

"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, other than where the sole or predominant use is commercial plantation forest.

"Farm Forestry" means, for the purposes of the Plan, commercial forest where the net planted area does not exceed, or will not exceed 10 per cent of the total area of the land described in a Certificate of Title or Crown Lease, or 20 hectares per Certificate of Title or Crown Lease, whichever is greater and is situated on a farm. For the purposes of the Plan, farm forestry does not include plantings for shade and shelter for stock or crops, natural resources management including soil and water protection, habitat conservation, landscape and amenity values.

"Forest harvesting" means the felling or cutting down of trees; the cutting, snigging, preparing, sorting, loading or carting of plant material from trees which have been cut down or felled or which have fallen.

"Forest thinning" means the selective removal by forest harvesting of a proportion of the trees from a commercial forest, primarily undertaken to improve the growth rate or health of the remaining crop trees in the forest, but does not include clearfelling.

"First rotation" means for the purposes of commercial plantation forest, the first commercial plantation forest established on that land. Where the commercial plantation forest is replanted for any reason prior to the forest reaching 24 months of age, the replanted plantation shall be considered to be a first rotation plantation.

"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.

"Flow-through aquaculture system" means an aquaculture system where water is extracted from a watercourse, a drainage path, an aquifer or from another source and continuously flows through a series of ponds, tanks or dams with no recirculation of water.

"Forest fallow" means the time period between clearfell of the previous commercial plantation forest and the re-establishment of the commercial plantation forest site by means other than through coppice regrowth.

"Forest manager" means in relation to a commercial forest, the person who has effective control of the forest vegetation that makes up the forest, either as the owner or occupier of the land on which the vegetation is growing or as the owner of the forest vegetation under a forest property (vegetation) agreement under the *Forest Property Act 2000*.

"Forest rotation" means the length of time between establishment of the commercial plantation forest by planting, coppice regrowth, or other means, and clearfelling.

"Forest threshold expansion opportunity" means 59,416 hectares, distributed throughout a number of underground water management areas in the lower South East, that was identified for the expansion of forestry and taking into account its recharge impacts. The forest threshold expansion opportunity was managed as two separate pools, one for softwoods and the other for hardwoods, being 28,083 hectares and 31,333 hectares respectively. The forest threshold expansion opportunity makes no allowance for direct extraction by plantation forest established over shallow water tables. Following the adoption of the Plan by the Minister, the forest threshold expansion opportunity shall cease to exist.

"Forest water licence" means a licence granted by the Minister under Chapter 7 Part 5A of the Act.

"Forest water licensee" means a person or entity who holds a forest water licence pursuant to section 169C of the Act.

"Geothermal energy" means thermal energy contained in subsurface rock or other subterranean substances which is extracted or released by a means other than as part of the production of a naturally occurring underground accumulation of a substance.

"Groundwater" see "underground water".

"Hardwood plantations" means all hardwood plantations, represented for the purposes of the Plan as having a nominal forest rotation length of 10 years from establishment of the commercial plantation forest by planting to clearfelling, or a nominal rotation length of eight years from establishment by coppice regrowth to clearfelling.

"Hectare irrigation equivalent (halE)" means the quantity of irrigation water (in addition to rainfall) required to equal the water use from one hectare of a reference crop (usually pasture) grown in the region. Conversion factors have been calculated to allow the growth of different crops based on the same quantity of water. Area-based allocations are expressed in hectare irrigation equivalents.

"Hydraulic gradient" means the rate of change in total hydraulic head per unit distance in a given direction. The direction of gradient is that yielding the maximum rate of decrease in hydraulic head.

"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) that 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.

"Intensive farming" means a method of keeping animals in the course of carrying on the business of primary production in which the animals are usually confined to a small space or area and usually fed by hand or by a mechanical means.

"Invertebrate" means an organism with an external skeleton.

"Irrigation system type" means the specific type of irrigation system used to irrigate. Examples of irrigation system types include flood irrigation, drip irrigation (sub-surface drip; micro-sprinklers; trickle; micro-jet) or spray irrigation (centre pivots – mobile, fixed, lateral move; sprinklers – overhead, under-tree, pop-up, fixed, portable; travellers – cable hose, solid set, wheel lines, tow lines, 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 Recharge" means the process of draining or discharging water directly or indirectly into 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 2 (*Appendix of Figures and Tables*); and
- for the confined aquifer, in that part of the PWA shown in Figure 3 (*Appendix of Figures and Tables*).

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

"Minerals" means

a) any naturally occurring deposit of metal or metalliferous ore, precious stones or any other mineral (including sand, gravel, stone, shell, coal, oil shale, shale and clay); or

b) any metal, metalliferous substance or mineral recoverable from the sea or a natural water supply; or

c) any metal, metalliferous ore or mineral that has been dumped or discarded—

i. in the course of mining operations or operations incidental to mining

operations; or

ii. in other prescribed circumstances;

but does not include—

d) soil; or

e) petroleum or any other substance, the recovery or production of which is governed by the *Petroleum and Geothermal Energy Act 2000*.

"Mining" or "**mining operations"** means—

a) operations carried out in the course of prospecting, exploring or mining for minerals; or

b) without limiting paragraph (a), any operations by which minerals are recovered from any place or situation, including by recovering minerals from the sea or a natural water supply; or

c) on-site operations undertaken to make minerals recovered from the site a commercially viable product, other operations involving such minerals, or other operations involving minerals brought on to the site of a mine for processing; or

d) operations for the rehabilitation of land on account of the impact of any operations under a preceding paragraph; or

e) operations that are directly related to any operations under a preceding paragraph,

but does not include—

f) an investigation or survey under section 15 of the *Mining Act 1971*; or

g) fossicking; or

h) the surface removal of loose rock material disturbed by agricultural operations.

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

"Native underground water" means water occurring naturally below ground level that exists in the relevant aquifer absent of any such water drained or discharged to that aquifer by artificial means.

"Net planted area" as applied to commercial forests, and reported at 30 June each year, means the area of the commercial forest measured from stump to stump, less any unplanted areas, areas under clearfell slash or areas consisting of dead plantation trees, greater than 0.1 hectare. Access tracks less than seven metres wide are part of the net planted area.

"Net productive area" as applied to commercial forests means the area of the commercial forest measured from stump to stump, less any permanently unplanted areas greater than 0.1 hectare. Access tracks less than seven metres wide are part of the net productive area. Areas previously planted during the current rotation, but at the time of assessment are under clear fell slash, or consist of damaged or dead plantation trees, are part of the net productive area.

"Over-allocation" or "Over-allocated" means

a) for the unconfined aquifer, that in a management area the total loss (i.e. the sum of allocations attached to forest water licences, tradeable components, specialised productions requirements, and the allowances for farm forestry and stock and domestic requirements, but not delivery supplements, bridging volumes or carry-overs) exceeds the TML for that management area.

b) for the confined aquifer, that in a management area the total loss (i.e. the sum of the tradeable components, specialised productions requirements, delivery supplements,

and the allowance for stock and domestic requirements, but not bridging volumes or seasonal carry-overs) exceeds the TML for that management area.

"Perched aquifer" or "perched water table" means a region in the unsaturated zone where the soil may be locally saturated because it overlies a low-permeability unit.

"Permissible Annual Volume (PAV)" means:

- for the Designated Area, the maximum volume of underground water that is permitted to be extracted from licensed wells in the unconfined and confined aquifer for each Zone shown in Figure 2 or Figure 3 (*Appendix of Figures and Tables*), as determined by the Border Groundwaters Agreement Review Committee under the *Groundwater (Border Agreement) Act 1985*;
- outside the Designated Area, for the confined aquifer, the volume of water that can be used without causing significant adverse water level or water quality impacts to the confined aquifer, on an annual basis, as defined in the 2001 Water Allocation Plans for the Lacepede Kongorong, Naracoorte Ranges and/or Comaum-Caroline Prescribed Wells Areas.

"Petroleum" means a naturally occurring substance consisting of a hydrocarbon or mixture of hydrocarbons in gaseous, liquid, or solid state. "Petroleum" does not include coal or shale unless occurring in circumstances in which the use of techniques for coal seam methane production or in situ gasification would be appropriate or unless constituting a product of coal gasification (whether produced below or above the ground) for the purposes of the production of synthetic petroleum.

"Phreatophytic vegetation" is vegetation which exists specifically due to the presence of underground water. Underground water sustains deep-rooted phreatophytic plants in an otherwise dry environment. Phreatophytic vegetation is often closely associated with wetlands.

"the Plan" means this Water Allocation Plan for the Lower Limestone Coast Prescribed Wells Area.

"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 depth of water that replenishes underground water via infiltration or percolation of water to an aquifer per year. Recharge rate is usually expressed in mm/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.

"Recirculation aquaculture system" means a closed or semi-closed aquaculture system in which most, or all, of the water is recirculated throughout the system and very little is discharged. Water that would otherwise be discharged as waste is treated and recirculated for re-use within the system.

"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.

"Resilience (ecosystem)" means the capacity of an ecosystem that is adversely affected by a disturbance to recover to its prior condition.

"Resistance (ecosystem)" means the capacity of an ecosystem to resist change, for example by ecophysiological means such as increasing leaf water potentials to overcome the effect of water table drawdown, or reducing canopy area to minimise transpiration rates.

"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 owner" 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.

"Shallow water table" means a median depth of six metres and less to the underground water table as shown in Figure 12 (*Appendix of Figures and Tables*).

"Softwood plantations" means all softwood plantations, represented for the purposes of the Plan as having a nominal forest rotation length of 35 years from establishment of the commercial plantation forest by planting or other means, to clearfelling.

"Specialised Production Requirements (SPRs)" means the water required for crop production in addition to crop water use and delivery volumes as set out in Table 7 (*Appendix of Figures and Tables*). This may include activities such as frost protection for grapevines, drift control for potatoes and maximum 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.

"Stock and domestic use" or **"stock and domestic requirements"** means the aggregate of the volume of water for stock water use and domestic purpose.

"Stromatolite" means layered deposits of calcium carbonate and various other minerals which have been created by the action of living organisms such as microscopic algae, bacteria and other microbes.

"Stygobite" means an organism which exclusively inhabits underground habitats, such as caves and subterranean waters.

"Surface water" means

(a) water flowing over land (except in a watercourse)-

  (i) after having fallen as rain or hail or having precipitated in any other manner; or

  (ii) after rising to the surface naturally from underground;

(b) water of the kind referred to in paragraph (a) that has been collected in a dam or reservoir;

(c) water of the kind referred to in paragraph (a) that is contained in any stormwater infrastructure;

(d) water in a watercourse if the watercourse, or a particular part of the watercourse, is declared by proclamation under section 3(13) to constitute surface water for the purposes of the NRM Act.

"Syncarid" means a small (approximately 3mm long) aquatic invertebrate belonging to an ancient order of crustaceans, Syncaridae. Their form has changed little over millions of years, and they are sometimes referred to as living fossils. They are usually found in underground environments and are generally rare.

"Target Management Level (TML)" means:

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

b) for the confined aquifer, the maximum annual volume of underground water that can be potentially extracted from each management area. 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 excludes allocations for seasonal carryover or bridging volume. The TML for each confined aquifer management area is listed in Table 5 (*Appendix of Figures and Tables*).

"Total Available Recharge (TAR)" means the volume of mean annual vertical recharge in a particular management area, less a nominal 10% set aside for environmental water requirements, 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 sequence of rocks occurring above the aquitard on top of the Dilwyn Formation or the Mepunga Formation in the Otway Basin, or the Renmark Group in the Murray Basin, whether occurring within the Gambier Limestone of the Otway Basin, the Murray Group Limestone of the Murray Basin, or some other younger geological unit.

"Underground water" means –

(a) water occurring naturally below ground level;

(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 metres 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" bears the same meaning as "ecosystem dependent on underground water".

"Unplanted land" means land that has not previously supported commercial plantation forestry.

"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 Act as amended. A reference to a water (holding) allocation in the 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 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.

"the Act" *Natural Resources Management Act 2004*

"CSIRO" Commonwealth Scientific and Industrial Research Organisation

"DE equation" dependent ecosystems equation (described in Section 2.3.1)

"DEWNR" Department of Environment, Water and Natural Resources

"DFW" Department for Water (previously part of DWLBC and now part of DEWNR)

"**DWLBC**" Department of Water, Land and Biodiversity Conservation (now part of DEWNR)

"EPBC" Environment Protection and Biodiversity Conservation

"LLC" Lower Limestone Coast

"the Minister" the Minister for Sustainability, Environment and Conservation

"NRM" natural resources management

"NRM Plan" Natural Resources Management Plan

'PIRSA" Department of Primary Industries and Regions South Australia

"the Plan" Water Allocation Plan for the Lower Limestone Coast Prescribed Wells Area

"PWA" Prescribed Wells Area

"REM" Resource and Environmental Management

"SAWID" South Australian Wetlands Inventory Database

"SECWMB" South East Catchment Water Management Board

"SEWPaC" Department of Sustainability, Environment, Water, Population and Communities

"TML" Target Management Level

"WAP" Water Allocation Plan

Measurements

halE	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
μScm^{-1}	micro Seimens per centimetre. Seawater has conductivity ofapproximately 54,000 μScm^{-1}, and fresh drinking water has conductivity of approximately 100 μScm^{-1}.

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

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

i) To provide for the management of commercial forests as a water affecting activity, following the Lower Limestone Coast PWA becoming a declared forestry area.

6.2 Principles

Limit to total allocation

1. No new water shall be allocated from the unconfined aquifer for the life of the Plan, except for the following purposes:

    a) to give effect to the volumetric conversion of existing area-based allocations in accordance with principles 8-11 (*Conversion of allocations expressed in haIE to volumetric allocation*);

    b) to allow for water to be allocated for the purposes of bridging volumes in accordance with principles 34-36 (*Bridging Volumes*);

    c) to give effect to the recalculation of volumetric allocations in existence at date of adoption in accordance with principles 37-41 (*Recalculation of volumetric allocations granted prior to date of adoption*);

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

    e) to allow for the allocation of a water taking allocation or an allocation attached to a forest water licence from the unconfined aquifer, following the surrender of an allocation from the confined aquifer in accordance with principle 42 (*Allocation on surrender of a confined aquifer water allocation);*

    f) to allow for the allocation of water for the purpose of pulp and paper mill operations in accordance with principle 44 (*Allocation for existing pulp and paper mill operations*);

    g) to allow for the allocation of water for the purposes of public water supply in accordance with principle 45 (*Allocation for public water supply*);

h) to allow for the allocation of water for the purpose of mining, in accordance with principle 46 (*Allocations for the purpose of mining*);

i) to allow for the allocation of water as carry-over in accordance with principles 47-51 (*Seasonal variability – carry-over and temporary trade volumes*);

j) to allow for a water (taking) allocation to be taken from another management area in accordance with principles 74-77 (*Rotational crops*);

k) to give effect to the allocation of water drained or discharged into a well in accordance with principles 78-82 (*Basis of allocation of water drained or discharged into a well*);

l) to temporarily or permanently transfer an allocation in accordance with section 7 of the Plan (*Transfer Criteria – Unconfined Aquifer*);

m) to give effect to delivery supplements issued in accordance with principle 144 (*Transfers of allocations*) and principles 149-150 (*Temporary transfers to manage seasonal variability*);

n) to allow for the allocation of water in accordance with principle 83 (*Limit to total allocation following the declaration of a declared forestry area*);

o) to allow for the allocation of water to existing commercial forests as a water allocation attached to a forest water licence, in accordance with principles 90-94 (*Allocation for existing commercial forests*);

p) to give effect to 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.

q) to allow for the allocation of a water taking allocation or an allocation attached to a forest water licence, following the reduction of an allocation in a high or very high risk management area in accordance with principle 43 (*Allocation in another management area following reduction of an allocation).*

Protection of ecosystems dependent on underground water – extraction from licensed wells

2. Water shall not be allocated pursuant to subprinciples d), e), h), j), l) or q) of principle 1 if to do so will, or is likely to, create or contribute to a significant adverse effect on ecosystems dependent on underground water.

3. For the purposes of principle 2, in assessing the likelihood of a significant adverse effect upon an ecosystem dependent on underground water, consideration shall be given to:

a) if the ecosystem dependent on underground water is a wetland listed in Table 10 (*Appendix of Figures and Tables*) and whether any part of the wetland as mapped in the DEWNR SAWID for the South East of South Australia, falls within a 16 km^2 circle centred on the proposed point of taking of the allocation; or

b) if, at the date of application, the ecosystem dependent on underground water is a wetland listed on SAWID 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

c) whether the wetland identified in subprinciple b) of principle 3 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 metres/year (measured over the preceding five years) in a representative observation well within the 16 km^2 circle specified in subprinciple a) of principle 3 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

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

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

f) any other relevant environmental matter.

4. For any underground water dependent ecosystem identified for protection under principle 3 above, the set-back distance for any new wells shall be calculated using the DE equation described in Section 2.3.1 (*Setback distance for unconfined aquifer wells)*.

5. Notwithstanding principle 4, the Minister may, on written request by a licensee, approve a different methodology of determining the set-back distance to that determined in principle 4, where the licensee can demonstrate to the Minister's satisfaction that the underground water dependent ecosystem(s) identified in principle 3 will not be detrimentally affected by the proposed extraction from the well(s).

Basis of allocation

6. Water shall be allocated by volume.

Volume of allocation

7. Where an allocation is granted for purposes other than irrigation, the allocation shall not exceed the amount reasonably required (applying current industry best practice standards, as determined by the Minister) for the purpose proposed.

Conversion of allocations expressed in haIE to volumetric allocation

8. Allocations presently expressed in hectare irrigation equivalents (haIE) shall be converted to a volume, in accordance with principles 9-33.

9. The allocation of water for irrigation purposes shall not exceed a volume determined pursuant to principles 10-33.

10. For the purposes of converting haIE allocations to a volume, each licence shall be assigned to the corresponding volumetric conversion zone shown in Figure 11 (*Appendix of Figures and Tables*) based upon the management area stated on the licence at the date of adoption.

11. For the purposes of principle 10, 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 subprinciple b) of principle 11, based on the location of the point of extraction;

b) if the licensee makes a written request to the Minister, a proportion of the area-based allocation may be assigned to each volumetric conversion zone, calculated according to the average area in hectares irrigated in each area in the 2009/10, 2010/11 and 2011/12 water use years;

c) the Minister will not consider any request under subprinciple b) of principle 11 received by DEWNR after 5 p.m. on the nearest business day following six months after date of adoption.

Tradeable component

12. The tradeable component is the component of a water allocation which may be permissibly traded.

13. 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 19-28);

        ii. any specialised production requirements (see principles 29-33);

        iii. any bridging volume (see principles 34-36); and

        iv. any carry-overs (see principle 47).

14. The tradeable component of a water (taking) allocation for irrigation purposes shall be calculated according to the values contained in Column B of Table 6 (*Appendix of Figures and Tables*) for the corresponding volumetric conversion zone.

15. Where a water (holding) allocation is expressed as an area (haIE) at date of adoption, the tradeable component of a water (holding) allocation shall be that as shown in Column B of Table 6 (*Appendix of Figures and Tables*) for the corresponding volumetric conversion zone.

16. Licensees that have grown an eligible crop in an eligible volumetric conversion zone, as listed in Table 8 (*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.

17. For the purposes of principle 16, the crop adjustment volume shall be calculated by multiplying the average area in hectares of the eligible crop grown in the 2006/07, 2007/08, 2008/09, 2009/10, 2010/11 and 2011/12 water use years with the exception of any water use years in which the eligible crop was not grown, by the crop adjustment factor for the corresponding volumetric conversion zone, in accordance with Table 8 (*Appendix of Figures and Tables*), and this volume shall be added to and become part of the tradeable component specified in principle 14.

18. The tradeable component of a water (taking) allocation granted for plant nurseries, including allocations expressed as an area at date of adoption, and including nurseries used to produce planting stock for commercial forests or farm forestry, shall be:

    a) that as shown in Column B of Table 6 (*Appendix of Figures and Tables*) for the corresponding management area; or

    b) where the licensee can demonstrate to the Minister's satisfaction that the resulting volumetric allocation is insufficient, it shall be re-calculated based on best industry practice/standards as determined by the Minister.

Delivery Supplement

19. If a licensee makes a written request to the Minister for an additional volume known as a delivery supplement for flood irrigation, the Minister may grant such a request if satisfied that:

    a) the licensee has used their allocation for flood irrigation prior to the date of adoption; and

    b) the allocation has been converted to a volume in accordance with principles 8-11 (*Conversion of allocations expressed in haIE to volumetric allocation*).

20. If a licensee makes a written request to the Minister for an additional volume known as a delivery supplement for spray irrigation, the Minister may grant such a request if satisfied that:

    a) the licensee has used their allocation for spray irrigation in the Benara, Donovans, Kongorong, MacDonnell or Moorak management areas prior to the date of adoption, but not for the purpose of plant nurseries; and

    b) the allocation has been converted to a volume in accordance with principles 8-11 (*Conversion of allocations expressed in haIE to volumetric allocation*).

21. In management areas outside the Designated Area (Figure 2, *Appendix of Figures and Tables*), the delivery supplement shall be calculated according to the values contained in Columns C and D of Table 6 (*Appendix of Figures and Tables*) for the corresponding volumetric conversion zone and irrigation system type.

22. In management areas located within the Designated Area (Figure 2, *Appendix of Figures and Tables*), where Annual Water Use Reports have been received by DEWNR for any of the 2006/07, 2007/08, 2008/09, 2009/10, 2010/11 or 2011/12 water use years by 31 July 2012, the maximum delivery supplement shall correspond to the greatest area (in haIE) actually flood irrigated in any management area within the Designated Area, or spray irrigated within the Donovans management area, according to those reports.

23. Notwithstanding principles 21 and 22, if the licensee has had a crop adjustment volume added to their tradeable component pursuant to principle 16, an additional delivery volume shall be calculated and added to the delivery supplement.

24. For the purposes of principle 23, 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.

25. If any part of a tradeable component associated with a delivery supplement is transferred, any delivery supplement for any allocation not transferred shall be proportionately reduced by the Minister.

26. 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 2011/12 water use year; or

    b) in the absence of an Annual Water Use Report for the 2011/12 water use year, on the proportional split of irrigation systems in place reported in the licensee's Annual Water Use Report for the 2010/11 water use year; and

    c) issued for the proportion of tradeable component associated with each eligible irrigation system type identified in any Annual Water Use Reports for the 2010/11 and/or 2011/12 water use years received by DEWNR by 31 July 2012, as the maximum proportional split via irrigation system type at 30 June 2011 or 30 June 2012, whichever is the greater.

27. For the purposes of principle 26, 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 26 as the year with the maximum area under an eligible irrigation system type, 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 the system type by the total net irrigation requirement for the licence; or

d) where the licensee has reported nil use of one or more irrigation system types, the proportional split of irrigation system types shall be calculated based on the capacity of each irrigation system type.

28. The Minister will not consider:

a) any request under principles 19 or 20 received by DEWNR after 5 p.m. on Thursday 24 December 2015; and

b) for the purposes of principles 26 and 27:

i. any request received by DEWNR after 5 p.m. on Thursday 24 December 2015; and

ii. where no Annual Water Use Report for any of the 2010/11 or 2011/12 water use years was received by DFW (now DEWNR) by 31 July 2012;

instead the licensee will be considered to have carried out no flood or spray irrigation during the 2010/11 and 2011/12 water use years.

Specialised Production Requirements

29. If a licensee makes a written request to the Minister for an additional volume known as specialised production requirements, the Minister 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 8-11 (*Conversion of allocations expressed in haIE to volumetric allocation*);

b) the application is for an eligible crop(s) listed in Table 7 (*Appendix of Figures and Tables*) and for the maximum area(s) of the crop(s) referenced in the Annual Water Use Reports for the 2006/07, 2007/08, 2008/09, 2009/10, 2010/11 or 2011/12 water use years, whichever is the greater;

c) the additional volume of water sought does not exceed the amount specified in Table 7 (*Appendix of Figures and Tables*) for the relevant crop;

d) the licensee grew the eligible crop during at least one of the 2006/07, 2007/08, 2008/09, 2009/10, 2010/11 or 2011/12 water use years (according to the Annual Water Use Reports received by DWLBC/DFW (now DEWNR) prior to 31 July 2012); and

i. for grapevines: that prior to 1 July 2012, the licensee had installed (or made a significant financial commitment for the installation of) an overhead spray system for frost control, and where separate frost control infrastructure was installed, a separate meter was installed to measure this allocation by the date of application;

ii. for fruit trees: that prior to 1 July 2012, 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 a salinity of ≥ 1,350 mg/L TDS.

30. When endorsing conditions on a water licence, it is suggested that the Minister give consideration to endorsing the condition that a specialised production requirements allocation may not be used for any other purpose than the purpose for which it was issued.

31. The Minister will not consider any request under principle 29 received by DEWNR after 5 p.m. on Thursday 24 December 2015.

32. Specialised production requirements used for grapevine frost control shall be allocated for a water use year as follows:

    a) on date of adoption the allocation shall be the value set out in Table 7 (*Appendix of Figures and Tables*) for the purpose of grapevine frost control;

    b) in the second water use year from date of adoption, the allocation shall be the value set out in Table 7 (*Appendix of Figures and Tables*) minus any volume extracted in the first year;

    c) in all subsequent years from date of adoption, the allocation shall be calculated as the value set out in Table 7 (*Appendix of Figures and Tables*) minus the volumes extracted in the previous two years.

33. 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.

Bridging Volumes

34. If a licensee makes a written request to the Minister for an additional volume known as a bridging volume, the Minister 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 8-11 (*Conversion of allocations expressed in haIE to volumetric allocation*) and the licensee has a demonstrated need for a bridging volume, based on indicative volumes taken in the 2006/07, 2007/08, 2008/09, 2009/10 and 2010/11 and 2011/12 water use years as described in Annual Water Use Reports held by DEWNR at 31 July 2012;

    b) the additional volume of water sought does not exceed the amount specified in columns E, F or G in Table 6 (*Appendix of Figures and Tables*) for the corresponding volumetric conversion zone and irrigation system type;

    c) the management area is not in the Designated Area;

    d) the management area has not been identified at the date of adoption as being at high or very high risk of degradation through the risk assessment process, these management areas being: Frances, Hynam East, Myora, Zone 2A, Zone 3A, Zone 5A, Coles and Short.

35. A bridging volume shall be allocated on a temporary basis and expire on 30 June 2016, regardless of the date of allocation.

36. The Minister will not consider any request made under principle 34:

    a) received by DEWNR after 5 p.m. on the nearest business day following six months after the date of adoption; or

    b) if a minimum of one Annual Water Use report was not received by DEWNR for any of the 2006/07, 2007/08, 2008/09, 2009/10 and 2010/11 and 2011/12 water use years.

Recalculation of volumetric allocations granted prior to date of adoption

37. Existing licences at the date of adoption endorsed with a volumetric allocation and not resulting from the conversion of a water (holding) allocation to a water (taking) allocation, will only be recalculated in the following circumstances:

    a) licences granted for irrigation purposes that were originally granted as a volume based on net irrigation requirement for the reference crop and/or delivery losses, at rates less than those listed in Table 6 (*Appendix of Figures and Tables);*

    b) licences granted for recreational purposes that were originally granted as a volume based on net irrigation requirement for the reference crop and/or delivery losses, at rates less than those listed in Table 6 (*Appendix of Figures and Tables);*

    c) licences granted for the purpose of aquaculture which are not expressed as a total volume which may be taken and used on an annual basis; or

    d) licences granted for plant nurseries, including nurseries used to produce planting stock for commercial forests or farm forestry, where the licensee can demonstrate to the satisfaction of the Minister that the allocation is insufficient.

38. Allocations described in subprinciples a) and b) of principle 37 shall be recalculated according to principle 8, except that:

    a) licensees with allocations made in accordance with subprinciple a) of principle 37 will not be eligible for specialised production requirements or bridging volumes, according to principles 29-33 and 34-36, respectively.

    b) licensees with allocations made in accordance with subprinciple b) of principle 37 will not be eligible for delivery supplements, specialised production requirements or bridging volumes, according to principles 19-28, 29-33 and 34-36, respectively.

39. Notwithstanding principle 38, allocations that were granted for irrigated recreational purposes under principle 6.2.2-6.2.3 (*Unlicensed pre-existing water use*) of the 2001 Comaum-Caroline or Lacepede Kongorong or Naracoorte Ranges Water Allocation Plans, shall not exceed 10 ML/year.

40. Licensees with allocations described under subprinciple c) of principle 37 (*Recalculation of volumetric allocations granted prior to date of adoption)* shall not be eligible for specialised production requirements or bridging volumes, according to principles 29-33 and 34-36, respectively, and shall be recalculated in the following manner:

    a) water for aquaculture in dam(s) or tank(s), with no flow through or recirculation, shall be calculated based on twice the volume required to fill the dam(s) or tank(s) in place at 30 June 2012, plus the estimated average annual evaporation from the dam(s) or tank(s), expressed as a water (taking) allocation;

    b) where the water is used in a flow-through aquaculture system or a recirculation aquaculture system and the allocation was not originally calculated as the total volume that may be taken and used on an annual basis, the allocation shall consist of the following components:

        i. a tradeable component, calculated as the volume required to fill the ponds or tanks in place at 30 June 2012 twice per year, plus average annual evaporation from the ponds or tanks; plus

        ii. a delivery supplement for aquaculture, calculated according to the following formula: the average volume pumped during 2006/07, 2007/08, 2008/09, 2009/10, 2010/11 and 2011/12 water use years with the exception of any water use year(s) in which no water was pumped for the purpose of aquaculture, less the volume calculated as the tradeable component;

    c) where the allocation used for aquaculture is expressed, prior to date of adoption, as a total volume which may be taken and used on an annual basis, the allocation shall remain expressed in this manner and of the same volume.

41. Licensees with allocations described in subprinciple d) of principle 37:

a) will not be eligible for delivery supplements, specialised production requirements or bridging volume according to principles 19-28, 29-33 and 34-36, respectively; and

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

Allocation on surrender of a confined aquifer water allocation

42. If a licensee has an allocation which may be taken from the confined aquifer, the licensee may surrender the allocation to the Minister and the Minister may grant an allocation of the same volume in an unconfined aquifer management area, provided that:

a) in the case of an application for a water (taking) allocation, principles 2-5 (*Protection of ecosystems dependent on underground water – extraction from licensed wells*); and principles 58-65 (*Hydrogeological effects and assessment*)*;* or

b) in the case of an application for an allocation to be attached to a forest water licence, principles 124 and 125 (*Hydrogeological assessment for commercial forests*) and principles 84-89 (*Protection of ecosystems dependent on underground water – setback distance for commercial forests)* and the commercial forest development having been authorised by the relevant authority under the *Development Act 1993;* and

c) the management area shall not be in the Designated Area;

d) an equivalent volume of unallocated water is available in the unconfined aquifer management area, at the date of application.

Allocation in another management area, following reduction of an allocation

43. If a licensee has had their allocation reduced according to principles 127-135 *(Addressing over-allocation in management areas considered to be at high or very high risk of degradation, identified through the risk assessment process)*, the Minister may grant a water (taking) allocation or an allocation to be attached to a forest water licence in another management area, provided that:

a) the maximum volume of allocation is equivalent to or less than the volume of reduction to the tradeable component, to that point in time; and

b) the management area shall not be in the Designated Area;

c) an equivalent volume of unallocated water is available for allocation in the unconfined aquifer management area, at the date of application; and

d) in the case of an application for a water (taking) allocation, principles 2-5 (*Protection of ecosystems dependent on underground water – extraction from licensed wells*); and principles 58-65 (*Hydrogeological effects and assessment*) are complied with*;* or

e) in the case of an application for an allocation to be attached to a forest water licence, principles 124 and 125 (*Hydrogeological assessment for commercial forests*) and principles 84-89 (*Protection of ecosystems dependent on underground water – setback distance for commercial forests)* have been complied with and the commercial forest development has been authorised by the relevant authority under the *Development Act 1993.*

Allocation for existing pulp and paper mill operations

44. Water shall be available for allocation for the purposes of pulp and paper mill operations from the Hindmarsh and/or Mayurra management areas, subject to:

a) the applicant having established prior to date of adoption, a development, project or undertaking that was actively using water within three years preceding the date of adoption, from the unconfined aquifer for the purpose of pulp and paper mill operations; and

b) the allocation shall be exempt from principles 65 (*Hydrogeological assessment for the purposes of industry, energy generation, mining, or public water supply*) and subprinciples b) and c) of principle 70 (*Divided allotments and allotments held in adjacent management areas*); and

c) the allocation shall not cause either the Hindmarsh or Mayurra management areas to become over-allocated.

Allocation for public water supply

45. A maximum of 221 ML may be allocated by the Minister for the purposes of public water supply from the Mount Benson management area, provided that:

a) the applicant has been taking water pursuant to authorisations published in the Gazette by the Minister under section 128 of the Act dated 23 August 2008 and 31 October 2011;

b) the applicant has made a significant financial commitment prior to date of adoption to a development, project or undertaking that will use water from the unconfined aquifer for the purpose of public water supply; and

c) the allocation shall be exempt from principle 65 (*Hydrogeological assessment for the purposes of industry, energy generation, mining, or public water supply*).

Allocations for the purpose of mining

46. Water may be allocated for the purpose of mining, subject to the following:

a) principles 2-5 (*Protection of ecosystems dependent on underground water*);
b) principle 65 (*Hydrogeological assessment for the purposes of industry, energy generation, mining, or public water supply*);
c) principle 68 (*Piping of water for a distance at least 2.25 kilometres*);
d) water may be allocated above the TML for the relevant management area at the time of application;
e) where water is to be allocated above the TML, that:
   i. the licensee has been granted a permit to drain or discharge water into a well pursuant to section 127(3)(c) of the Act; and
   ii. the equivalent volume of that granted in excess of the TML, is returned to the source aquifer from which the water was originally extracted, pursuant to the permit, with no detrimental change to the quality of water in the source aquifer;
f) allocations shall expire on the 30 June following the cessation of the activity authorised under the *Mining Act 1971.*

Seasonal variability – carry-over and temporary trade volumes

47. Where:

a) a licence is endorsed with a volumetric water (taking) allocation; and

b) DEWNR has received an Annual Water User 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, which will be equivalent to the unused volume of allocation at the end of the preceding water use year, or 25% of the licensee's annual allocation for the preceding year, whichever is the lesser.

48. Where a licence is endorsed with a volumetric water (taking) allocation, 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 149 (*Temporary transfers to manage seasonal variability*).

49. No allocation granted in accordance with principles 47 and 48 shall result in the total volume available for use in any one water use year exceeding 140% of the licensee's annual allocation.

50. For the purpose subprinciple c) of principle 47, 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;

    d) bridging volume.

51. For the purposes of principles 47-50, annual allocation comprises the sum of:

    a) the tradeable component;

    b) any delivery supplement; and

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

    but does not comprise bridging volumes, carry-overs or additional water transferred in temporarily under principle 149 (*Temporary transfers to manage seasonal variability)*.

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 58-65 (*Hydrogeological effects and assessment*); and

        ii. principles 2-5 (*Protection of ecosystems dependent on underground water – extraction from licensed wells);* and

    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 58-65 (*Hydrogeological effects and assessment*);

        ii. principles 2-5 (*Protection of ecosystems dependent on underground water – extraction from licensed wells);*

        iii. an equivalent volume of unallocated water being available in the receiving management area, at the date of application*;* and

        iv. the transfer principles set out in Section 7.

    c) any conversion in management areas in the Designated Area may not cause the sum of water (taking) allocations to exceed the corresponding Permissible Annual Volume.

53. Notwithstanding subprinciple b) of principle 52, the conversion of a water (holding) allocation from one management area to a tradeable component of a water (taking) allocation in another management area, may only occur:

    a) following the completion of the conversion of area-based water licences to a volumetric basis; and

    b) if all or a part of the LLC is declared a declared forestry area, the allocation of water allocations attached to forest water licences has been completed; or

    c) commencing 1 July 2016;

    whichever is the sooner.

54. An area-based (haIE) water (holding) allocation must first be converted to a volumetric water (holding) allocation according to principle 15, prior to conversion to a tradeable component of a water (taking) allocation.

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

Returned water

56. Where all or part of a water allocation endorsed on a licence is surrendered or otherwise forfeited to the Minister, water will not then be available for allocation except where the area is or becomes under-allocated with respect to the limits to allocation set out in Table 1 (*Appendix of Figures and Tables*), in which case the following principles apply:

    a) principle 42 (*Allocation on surrender of a confined aquifer water allocation*);

    b) principle 43 (*Allocation in another management area, following reduction of an allocation)*; or

    c) principle 46 (*Allocations for the purpose of mining*); or

    d) principles 52-55 (*Conversion of a water (holding) allocation to a water (taking) allocation*) or

    e) principle 140 (*Transfers of allocations*); or

    f) principle 123 (*Returned water – allocations attached to forest water licences*).

57. For the purposes of principle 56, with respect to the TMLs set out in Table 1 *(Appendix of Figures and Tables*):

    a) where a tradeable component or allocation for 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 bridging volume or 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, mining, and public water supply shall comply with the 16 km^2 circle test as defined in principles 62 and 63.

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

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

i. a continuing mean (arithmetic) increase in salinity of the underground water resource of greater than 2% per year (measured over the preceding five 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 continuing mean (arithmetic) decrease in underground water levels of greater than 0.1 metres per year (measured over the preceding five 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 a representative 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 2-5 (*Protection of ecosystems dependent on underground water – extraction from licensed wells*).

60. Notwithstanding principle 59, in the case of applications for variations of a water licence for the purpose of irrigating a rotational crop, and where one or more of the following resource condition triggers have been exceeded:

a) a mean (arithmetic) increase in salinity of the underground water resource of greater than 2% per year (measured over the preceding five 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

b) a mean (arithmetic) decrease in underground water levels of greater than 0.1 metres per year (measured over the preceding five 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 a representative well or wells as determined by the Minister;

the variation may still be approved if 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 the approval would not cause the triggers at the destination to exceed those existing at the origin prior to the transfer.

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

61. The granting of a water allocation pursuant to principles 149 and 150 (*Temporary transfers to manage seasonal variability)* is exempt from principles 58-60 (*Hydrogeological effects and assessment*).

The 16 km^2 circle test

62. 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, within the 16km^2 circle.

63. For the purposes of principle 62:

a) the 16 km^2 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 a 100 metre radius of the centremost point of the nominated allotment);

b) the total volume of water which may be granted includes the sum of the tradeable component, and any specialised production requirements and, if the management area is within a declared forestry area, any water allocations attached to forest water licences, but does not include delivery supplements, carry-overs or additional water transferred in temporarily under principles 149 and 150 (*Temporary transfers to manage seasonal variability)*.

c) the annual average vertical recharge for a management area shall be calculated using the adopted recharge rate set out in Table 1 (*Appendix of Figures and Tables)* for the management area, multiplied by the area within the 16 km^2 circle (less the area occupied by bodies of water and/or native vegetation and/or farm forestry).

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

64. Notwithstanding principles 58-63, 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 aggregate of:

a) the total volume of underground water (minus any delivery supplements) extracted within the 16km^2 circle during the water use year prior to the application; and

b) if the management area is within a declared forestry area, water allocations attached to forest water licences within the 16km^2 circle; and

c) the volume of allocation proposed to be granted;

to exceed 1.25 times the amount of annual average vertical recharge for that management area, within the 16km^2 circle. The annual average vertical recharge for a management area shall be calculated in accordance with subprinciple c) of principle 63.

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

65. The allocation of water for industry, energy generation, mining, 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 a mean (arithmetic) increase in salinity of the underground water resource of greater than 2% per year (measured over the preceding five years) at the point of taking and the nearest representative observation well(s) as determined by the Minister;

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 metres/year after three years from the start of taking; or

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

Restrictions on use

66. Water shall not be allocated from the unconfined aquifer for a purpose that produces tail water 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;

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;

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 that purpose have no significant hydraulic connection with either aquifer.

67. For the purpose of principle 66, tail water is water that flows out of a system once it has flowed through any ponds, tanks, vessels or other places, including places for the keeping of farmed aquatic species.

Piping of water for a distance at least 2.25 kilometres

68. Where water from the unconfined 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) with the exception of public water supply:

i. the taking and use of water shall comply with principles 58-65 (*Hydrogeological effects and assessment*);

ii. notwithstanding subprinciple b)(i) of principle 68, the 16 km^2 circle test shall apply only at the point of taking.

Use of imported water

69. 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 10.7 (*Importation of Water*) of the Plan.

Divided allotments and allotments held in adjacent management areas

70. 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 PWAs, 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 58-65 (*Hydrogeological effects and assessment*) and principles 2-5 (Protection of e*cosystems dependent on underground water – extraction from licensed wells*);

c) the point of extraction and/or use is not moved more than two 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); and

e) an allocation from another management area is not taken or used in the Padthaway PWA.

71. An allocation that has been taken and used in an adjoining management area or PWA pursuant to principle 70 will not be available for further transfer within the receiving management area or PWA, except where principle 140 (*Transfers of allocations*) applies.

Endorsement of Certificates of Title on licences

72. 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 legal access to the land and has made an application to the Minister for such a variation, accompanied by a written statement made by the registered proprietor of the land consenting to the variation.

73. For the purposes of principle 72, where the licensee is not the registered proprietor of the land, the relevant Certificate(s) of Title will only be endorsed on the licence for

a) a maximum of five years unless otherwise specified in the written statement, where the subject land is in the same management area as the one the licence is referenced to;

b) a maximum of five years, if the subject land is in a different management area than the one the licence is referenced to.

Rotational crops

74. The Minister may vary a water licence for the purposes of irrigating a rotational crop, subject to principles 58-65 (*Hydrogeological effects and assessment*) and principles 2-5 (*Protection of ecosystems dependent on underground water – extraction from licensed wells*).

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

76. Notwithstanding principle 75, water may not be taken from another management area to irrigate a rotational crop, where the proposed point of taking lies within:

a) the Designated Area, unless the management area specified on the licence to be varied is within the Designated Area and the variation does not cause the sum of water (taking) allocations in the corresponding Zone or sub-zone of the Designated Area to exceed or further exceed the relevant Permissible Annual Volume or Allowable Annual Volume; or

b) the Padthaway PWA.

77. Where the proposed point of taking lies within a management area that is fully allocated on the date of application, or the granting of the variation under principle 74 will cause the management area to become fully or over-allocated, the Minister may grant a variation for a maximum of 12 months, provided that the aggregate of:

a) the volume of water extracted in the form of tradeable components and specialised production requirements (but not delivery supplements or bridging volumes); and

b) any allocations attached to forest water licences; and

c) the allowance for stock and domestic use and farm forestry;

in the preceding water use year (at the date of application) in the management area did not exceed 90% of the TML as set out in Table 1 (*Appendix of Figures and Tables*) for that management area.

Basis of allocation of water drained or discharged into a well

78. Water that is drained or discharged into a well will not be available for allocation where the Minister considers that it would have contributed to the natural vertical recharge of the unconfined or confined aquifer systems.

79. 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:

a) the water has been imported pursuant to a permit issued under section 127(5)(i) and/or (k) of the Act, for the purposes of drainage and discharge into a well and has been taken and used under a licence issued under the provisions of the Act; or

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

80. Any application for an allocation pursuant to principle 79, must be made within three years calculated from 1 July in the year in which the water was drained or discharged into the relevant well.

81. Water drained or discharged into a well shall only be taken from the original well into which water was drained or discharged, or from a well within a radius of 500 metres of the original well.

82. Subject to principles 78-81:

a) if the water drained or discharged into a well is a product of a desalination process, a maximum of 100% of the volume drained or discharged may be allocated on licence to the permit holder for extraction;

b) if the water drained or discharged into a well is not the product of a desalination process, a maximum of 80% of the volume drained or discharged may be allocated on licence to the permit holder for extraction.

FOREST WATER LICENCES

Except as provided below, pursuant to section 76(9)(b) of the Act, all commercial forests within the LLC PWA are designated as commercial forests that, on account of assessments undertaken by the Board, have been identified as being appropriate to bring within the ambit of Part 5A Division 2 of Chapter 7 of the Act on account of their impacts on the prescribed water resource and taking into account the requirements of that Part.

Pursuant to section 76(10)(c) of the Act, forests that fall within the definition of farm forestry in the Plan are excluded from the designation under section 76(9)(b) (so as to exclude them from the operation of Part 5A Division 2 of Chapter 7).

Principles 83-126 are subject to the Minister declaring the LLC PWA (or a portion of that area) to be a "declared forestry area" pursuant to section 169B(1) of the Act.

Limit to total allocation following the declaration of a declared forestry area

83. Water from the unconfined aquifer may be allocated during the life of the Plan for the following purposes:

    a) to convert a water (taking) allocation to a water allocation attached to a forest water licence;

    b) to convert a water (holding) allocation to a water allocation attached to a forest water licence;

    c) to convert a water allocation attached to a forest water licence to a water (taking) allocation;

    d) DELETED – by s89(2) amendment.

    e) to allow for the allocation of water in accordance with principle 97 (*Farm forestry*);

    f) to temporarily or permanently transfer an allocation attached to a forest water licence in accordance with section 7 of the Plan (*Transfer Criteria – Unconfined Aquifer*).

Protection of ecosystems dependent on underground water - set-back distance for commercial forests

84. Water shall not be allocated for commercial forests pursuant to subprinciple a) or b) or f) of principle 83 if to do so will, or is likely to, create or contribute to a significant adverse effect on ecosystems dependent on underground water.

85. For the purposes of principle 84, in assessing the likelihood of a significant adverse effect upon an ecosystem dependent on underground water, consideration shall be given to:

    a) if the ecosystem dependent on underground water is a wetland listed in Table 10 (*Appendix of Figures and Tables*); or

    b) if, at the date of application, the ecosystem dependent on underground water is a wetland listed on SAWID as a wetland of high or very high conservation value and 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 metres/year (measured over the preceding five years) in the nearest representative observation well or wells to the ecosystem, 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 its proximity to any ecosystems dependent on underground water; and

    e) any other relevant environmental matter.

86. If the ecosystem dependent on underground water is a wetland listed in Table 10 *(Appendix of Figures and Tables),* water shall not be allocated for commercial forests unless the forest is situated:

    a) the minimum distance from the wetland (as determined by the Minister) required to prevent a significant adverse effect on the ecosystem, including but not limited

to, a decrease in underground water levels of greater than 0.05 metres in the vicinity of the wetland at the end of the forest rotation; or

b) if the Minister is unable to determine a set-back distance in accordance with subprinciple a) of principle 86, the minimum setback distance from the wetland as listed in Table 10 (*Appendix of Figures and Tables*).

87. Notwithstanding principle 86, the setback distance from a wetland listed in Table 10 shall be at least 20 metres.

88. If the ecosystem dependent on underground water is a wetland listed on SAWID as a wetland of high or very high conservation value and meets the criteria set out in subprinciple b) of principle 85, water shall not be allocated for commercial forests unless the forest is situated:

a) the minimum distance from the wetland (as determined by the Minister) required to prevent a significant adverse effect on the ecosystem, including but not limited to a decrease in underground water levels of greater than 0.05 metres in the vicinity of the wetland at the end of the forest rotation; or
b) if the Minister is unable to determine a set-back distance in accordance with subprinciple a) of principle 88, the set-back distance shall be at least 20 metres from the wetland.

89. Notwithstanding principles 86-88, the Minister may, on written request by a forest water licensee, approve a different methodology of determining the set-back distance to that determined in principles 86-88, where the licensee can demonstrate to the Minister's satisfaction that the underground water dependent ecosystem(s) identified in principle 85 will not be detrimentally affected by the proposed commercial forest to be planted.

Allocation for existing commercial forests

90. For the purpose of section 169I(1) of the Act, an application for a forest water licence for a commercial forest within the relevant declared forestry area (as the forest exists on the day from which a forest water licence is required under Part 5A Division 2 of Chapter 7 of the Act) is to be made by 5 p.m., on the nearest business day following 6 months after the declaration of a declared forestry area. The volume of the allocation to be attached to the forest water licence shall be issued in accordance with principles 100-103 (*Volume of allocation for existing commercial forest*).

91. Where commercial forest land is partially or wholly clearfelled at the date of declaration and has been under clearfell for no more than three years and eight months prior to the date of declaration, the applicant for an allocation under principle 90 shall be granted a forest water licence in accordance with principle 90, but for the purposes of that allocation:

a) the net productive area of the compartment will be taken to be the net productive area of the previous forest rotation; and

b) the commercial forest species will be taken to be the commercial forest species clearfelled or in the process of being clearfelled.

92. If, at the date of declaration, a water (holding) allocation is being used to offset:

a) the interception of vertical recharge to underground water by a commercial forest; or

b) direct underground water extraction by a commercial forest;

(known as an off-set allocation), the off-set allocation shall be converted to an allocation attached to a forest water licence, expressed as a volume equivalent to the off-set allocation volume, converted from haIE if necessary, pursuant to principles 8-11 (C*onversion of allocations expressed in haIE to volumetric allocation).*

93. Where a resulting allocation under principle 92 is less than that determined in accordance with principles 100-103 (*Volume of allocation for existing commercial*

forest), the additional allocation required shall be granted as an allocation attached to a forest water licence. The additional allocation to be granted shall be calculated as follows: the volume determined in accordance with principles 100-103 (*Volume of allocation for existing commercial forest*), less any volume equivalent to the off-set allocation volume, following the conversion from haIE if necessary.

94. When endorsing conditions on a licence it is suggested that the Minister give consideration to endorsing a condition that, following the clearfelling of the forest, the replacement forest (if any) shall be located at least 20 metres from a wetland listed in Table 10 (*Appendix of Figures and Tables*), or a wetland of high or very high conservation value which meets the criteria set out in subprinciple b) of principle 85.

Allocation for proposed commercial forests (not yet planted)

95. Where:

    a) land is unplanted; and

    b) development authorisation under the *Development Act 1993* has been granted for land use change to a commercial forest prior to or on the date of declaration; and

    c) the development authorisation under the *Development Act 1993* has not expired; and

    d) the land does not have an existing off-set allocation, as defined in principle 92;

    the applicant for an allocation under principle 90 may receive an allocation in accordance with principles 90-94 (*Allocation for existing commercial forests*).

96. A forest water licence issued in accordance with principle 95 shall be cancelled and the allocation returned to the Crown, where the development authorisation under the *Development Act 1993* for land use change to a commercial forest has expired after the date of declaration and the commercial forest was not planted.

Farm forestry

97. Where land described in a Certificate of Title or Crown Lease with farm forestry established prior to date of adoption is subject to a change of land use to commercial forest, or, where the area of forest is increased after the date of declaration on land described in a Certificate of Title or Crown Lease that is part of a farm forest, such that the existing plantation established prior to the date of adoption no longer meets the definition of farm forestry, the original plantation area that met the definition of farm forestry shall be considered to be commercial forest and may be granted a forest water licence from the Crown under section 169C of the Act. The volume of the allocation to be attached to the forest water licence shall be determined in accordance with principles 100-103 (*Volume of allocation for existing commercial forest*). The additional forest area established in excess of the original farm forestry area will require a forest water licence.

98. Where land described in a Certificate of Title or Crown Lease with farm forestry established after the date of adoption is subject to a change of land use to commercial forest, or, where the area of forestry is increased on land described in a Certificate of Title or Crown Lease that is part of a farm after the date of declaration, such that the existing plantation established after the date of adoption no longer meets the definition of farm forestry, the original plantation area that met the definition of farm forestry shall be considered to be commercial forest and shall require a forest water licence.

99. Where land described in a Certificate of Title or Crown Lease will be subdivided on a farm for purposes other than commercial forest, such that the net planted area of farm forestry established on the land described in a Certificate of Title or Crown Lease created by the subdivision will now exceed 10% of the land described in the Certificate of Title or Crown Lease or 20 hectares, whichever is greater, the owner at the time of replanting shall not replant after clearfelling the area of farm forestry in

excess of 10% of the area of land described in the Certificate of Title or Crown Lease or 20 hectares, whichever is greater, unless the entire area to be replanted has a forest water licence.

Volume of allocation for existing commercial forests

100. The volume of water allocated in accordance with principle 90 (*Allocation for existing commercial forests)* shall be equivalent to an amount reflecting the commercial forests':

a) deemed recharge interception at the time of canopy closure, for the relevant management area as shown in Table 2 (*Appendix of Figures and Tables*); and

b) deemed direct underground water extraction impacts based on the direct underground water extraction by plantations established by any means other than coppice regrowth, for the relevant management area, as shown in Table 3 (*Appendix of Figures and Tables*), for that portion of the commercial forest which overlies the median six metres and less depth to the underground water table as shown in Figure 12 (*Appendix of Figures and Tables)*.

101. For the purposes of subprinciple a) of principle 100, the recharge interception at the time of canopy closure by commercial forest is calculated as follows for the life of the Plan for a forest rotation: the net productive area of the plantation (hectares), multiplied by the ML/net productive hectare/year value shown in Table 2 (*Appendix of Figures and Tables*) for the corresponding management area.

102. For the purposes subprinciple b) of principle 100, the deemed direct underground water extraction from shallow water tables by plantations established by any means other than coppice regrowth, is calculated as follows for the life of the Plan for a forest rotation:

a) for hardwood plantations, that portion of the net productive area of the plantation (hectares) which overlies the median six metres and less depth to the underground water table as shown in Figure 12 (*Appendix of Figures and Tables*) multiplied by 1.82 ML/hectare/year; or

b) for softwood plantations, that portion of the net productive area of the plantation (hectares) which overlies the median six metres and less depth to the underground water table as shown in Figure 12 (*Appendix of Figures and Tables*), multiplied by 1.66 ML/hectare/year.

103. For the Frances, Hynam East, Myora, Zone 2A, Zone 3A, Zone 5A, Coles and Short management areas, the volume of water allocated in accordance with principle 100 shall be:

a) the volume calculated in accordance with principles– 100-102 minus a volume equivalent to the reductions required to allocations calculated in accordance with principle 127 (*High and very high risk management areas: Myora and Zone 2A*), principle 128 (*High and very high risk management areas: Frances, Zone 3A and Zone 5A*) and principle 129 (*High and very high risk management areas: Hynam East, Coles and Short*); or
b) the volume calculated in accordance with subprinciples a) and b) of principle 105 (*Volume of allocation – minimum required for commercial forests*);

whichever is the greater.

Volume of allocation – coppicing after date of declaration

104. Where the second or subsequent forest rotation of short rotation hardwood plantations is to be established after the date of declaration from the coppice regrowth from the existing stumps following clearfell, the licensee shall be required to obtain an additional 0.68 ML per hectare per year for that portion of the net planted area of the plantation which overlies the median six metres and less depth to the

underground water table as shown in Figure 12 (*Appendix of Figures and Tables)*, by 30 June of the following year if the plantation is clearfelled between 1 July and 31 December, or by 31 December of the same year if the plantation is clearfelled between 1 January and 30 June.

Volume of allocation – minimum required for commercial forests

105. The minimum volume of water allocation attached to a forest water licence required to fully account for the impacts of that commercial forest on underground water resources, shall be equivalent to:

a) the deemed recharge interception of underground water by a commercial forest, for the relevant management area (as shown in Table 3 (*Appendix of Figures and Tables*)); plus

b) where a part or all of the commercial forest overlies or will overlie the median six metres and less depth to the underground water table as shown in Figure 12 (*Appendix of Figures and Tables*), the deemed direct underground water extraction impacts based on the direct underground water extraction by plantations established by any means other than coppice regrowth as shown in column C for hardwoods and column E for softwoods of Table 3 (*Appendix of Figures and Tables*) for the relevant management area, for that portion of the commercial forest which overlies the median six metres and less depth to the underground water table as shown in Figure 12 (*Appendix of Figures and Tables*); or

c) where a part or all of the commercial forest overlies or will overlie the median six metres and less depth to the underground water table as shown in Figure 12 (*Appendix of Figures and Tables*), and consists of hardwood which is to be established by coppice regrowth after the date of declaration, the deemed direct underground water extraction impacts based on coppice regrowth as shown in column D of Table 3 (*Appendix of Figures and Tables*) for the relevant management area, for that portion of the commercial forest which overlies the median six metres and less depth to the underground water table as shown in Figure 12 (*Appendix of Figures and Tables*).

106. For the purposes of subprinciple a) of principle 105, the deemed recharge interception of underground water by commercial forest is calculated as follows:

a) for hardwood plantations, the net planted area of the plantation (hectares), multiplied by the ML/hectare/year value shown in Column A of Table 3 (*Appendix of Figures and Tables*) for the corresponding management area; or

b) for softwood plantations, the net planted area of the plantation (hectares) multiplied by the ML/hectare/year value shown in Column B of Table 3 (*Appendix of Figures and Tables*) for the corresponding management area.

107. Notwithstanding principles 105 and 106, in determining the minimum volume of water required to account for the recharge interception of underground water by a commercial forest, a revised deemed rate or rates may be calculated on written request by a forest water licensee, where:

a) more than one year of forest fallow occurs prior to the start of the forest rotation;

b) no forest fallow year occurs prior to the start of the forest rotation, and the forest is not a hardwood plantation established after the date of declaration through coppice regrowth;

c) a softwood plantation undergoes five or more forest thinning operations;

d) a softwood plantation undergoes three or less forest thinning operations.

108. For the purposes of principle 107, the deemed recharge interception of underground water by commercial forest is calculated as follows:

a) the net planted area of the plantation (hectares), multiplied by the ML/hectare/year value as calculated in Table 4 (*Appendix of Figures and Tables*) for the corresponding management area and forest type.

Seasonal variability – carry-over and temporary trade volumes

Principles 109 – 114 deleted by section 89(2) amendment

Allocation in another management area, following reduction of an allocation attached to a forest water licence

115. If a forest water licensee has had their allocation reduced according to principles 127-135 *(Addressing over-allocation in management areas considered to be at high or very high risk of degradation, identified through the risk assessment process)*, the Minister may grant a water (taking) allocation or an allocation to be attached to a forest water licence in another management area, provided that:

    a) the maximum volume of allocation is equal to or less than the volume of reduction to the tradeable component to that point in time, plus the difference between the rates specified in principle 100 (*Volume of allocation for existing commercial forests*) and the volume initially allocated in accordance with principle 103 (*Volume of allocation for existing commercial forests*); and

    b) the management area shall not be in the Designated Area;

    c) an equivalent volume of unallocated water is available for allocation in the unconfined aquifer management area, at the date of application; and

    d) in the case of an application for a water (taking) allocation, principles 2-5 (*Protection of ecosystems dependent on underground water – extraction from licensed wells*); and principles 58-65 (*Hydrogeological effects and assessment*) are complied with*;* or

    e) in the case of an application for an allocation to be attached to a forest water licence, principles 124 and 125 (*Hydrogeological assessment for commercial forests*) and principles 84-89 (*Protection of ecosystems dependent on underground water – setback distance for commercial forests)* have been complied with and the commercial forest development has been authorised by the relevant authority under the *Development Act 1993.*

Conversion of a water (holding) allocation or a water (taking) allocation to a water allocation attached to a forest water licence

116. A water (taking) allocation or a water (holding) allocation may be converted to a water allocation attached to a forest water licence, subject to the following:

    a) the volume corresponding to the tradeable component of the water (taking) allocation or to the whole of the water (holding) allocation will be endorsed as the water allocation attached to the forest water licence. Any specialised production requirements, bridging volumes or delivery supplements shall be cancelled;

    b) where the conversion is from a water (holding) allocation or a water (taking) allocation to a water allocation attached to a forest water licence and where the proposed point of taking is located in the same management area, the conversion will be subject to:

        i. principles 84-89 (*Protection of ecosystems dependent on underground water – set-back distance for commercial forests);*

        ii. principles 124 and 125 (*Hydrogeological assessment for commercial forests*);

        iii. the commercial forest development having been authorised by the relevant authority under the *Development Act 1993;*

        iv. principles 167 and 168 *(Transfers in management areas subject to reductions);* and

c) where the conversion is from a water (holding) allocation or a water (taking) allocation from one management area to a water allocation attached to a forest water licence in another management area, the conversion will be subject to:

i. there being an equivalent volume of unallocated water in the receiving management area;

ii. principles 84-89 (*Protection of ecosystems dependent on underground water – set-back distance for commercial forests);*

iii. principles 124 and 125 (*Hydrogeological assessment for commercial forests*);

iv. the transfer principles set out in Section 7; and

v. the commercial forest development having been authorised by the relevant authority under the *Development Act 1993.*

117. Notwithstanding subprinciple c) of principle 116, the conversion of a water (holding) allocation or a water (taking) allocation from one management area to a water allocation attached to a forest water licence in another management area, may only occur:

a) following the completion of the conversion of area-based water licences to a volumetric basis; and

b) following the completion of the allocation of water allocations attached to forest water licences; or

c) commencing 1 July 2016;

whichever is the sooner.

Conversion of a water allocation attached to a forest water licence to a water (taking) allocation

118. All or part of a water allocation attached to a forest water licence may be converted to a tradeable component of a water (taking) allocation of the same volume, under the following circumstances:

a) all (or a part) of the commercial forest has been clearfelled, and any coppice regrowth of hardwood forests has been killed to the satisfaction of the Minister; and

b) subject to principles 119-122.

119. A water allocation attached to a forest water licence may be converted to a tradeable component of a water (taking) allocation of the same volume, subject to the following:

a) where the proposed point of taking is located in the same management area, the conversion will be subject to:

i. principles 2-5 (*Protection of ecosystems dependent on underground water – extraction from licensed wells);*

ii. principles 58-65 (*Hydrogeological effects and assessment*);

iii. principles 147 and 148 (*Transfers in management areas subject to reductions).*

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

i. there being an equivalent volume of unallocated water in the receiving management area;

ii. principles 2-5 (*Protection of ecosystems dependent on underground water);*

iii. principles 58-65 (*Hydrogeological effects and assessment*);

iv. the transfer principles set out in Section 7.

c) any conversion in management areas in the Designated Area may not cause the sum of water (taking) allocations to exceed the corresponding PAV.

120. Notwithstanding subprinciple b) of principle 119, the conversion of a water allocation attached to a forest water licence from one management area to a water (taking) allocation in another management area, may only occur:

a) following the completion of the conversion of area-based water licences to a volumetric basis; and

b) following the completion of the allocation of water allocations attached to forest water licences; or

c) commencing 1 July 2016;

whichever is the sooner.

121. Where a water allocation attached to a forest water licence has been converted to a water (taking) allocation, the licensee is not eligible to be granted a delivery supplement, specialised production requirements or a bridging volume.

122. Notwithstanding principles 119-121, where a water allocation attached to a forest water licence is being converted to a tradeable component of a water (taking) allocation on the same allotment following the clearfell of the forest, a hydrogeological assessment (as described in principles 58-65 (*Hydrogeological effects and assessment*)) is only required if additional water is to be extracted from that allotment in excess of that previously associated with the commercial forest.

Returned water – allocations attached to forest water licences

123. Where all or part of a water allocation attached to a forest water licence is surrendered or otherwise forfeited to the Minister, water will not be then available for allocation except where the area is or becomes under-allocated with respect to the TML set out in Table 1 (*Appendix of Figures and Tables*), in which case the following principles apply:

a) subprinciple b) of principle 119 (*Conversion of a water allocation attached to a forest water licence to a water (taking) allocation*) applies; or

b) principle 116 (*Conversion of a water (holding) allocation or a water (taking) allocation to a water allocation attached to a forest water licence);* or

c) principle 160 (*Transfer of a water allocation attached to a forest water licence*); or

d) principles 56 and 57 (*Returned water*).

Hydrogeological assessment for commercial forests

124. The allocation of water for the purpose of commercial forests shall comply with the 16km^2 circle test as defined in principles 62 and 63. The 16km^2 circle shall be centred on the geometric centre of the proposed forest.

125. No allocation shall be made for the purpose of commercial forests 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 continuing mean (arithmetic) increase in salinity of the underground water resource of greater than 2% per year (measured over the preceding five years) in a representative observation well within a 16 km^2 circle centred over the geometrical centre of the proposed forest, 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 continuing mean (arithmetic) decrease in underground water levels of greater than 0.1 metres per year (measured over the preceding five years) in a representative observation well within a 16 km^2 circle centred over the geometrical centre of the proposed forest, or in the absence of any representative wells within the 16 km^2 circle, in a representative 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 84 - 89 (*Protection of ecosystems dependent on underground water – set-back distance for commercial forests*).

Variation of a water allocation attached to a forest water licence

126. An allocation attached to a forest water licence may be varied in accordance with principle 96 (*Allocation for proposed commercial forest (not yet planted)*) or principles 127-136 *(Addressing over-allocation in management areas considered to be at high or very high risk of degradation, identified through the risk assessment process)*.

ADDRESSING OVER-ALLOCATION IN MANAGEMENT AREAS CONSIDERED TO BE AT HIGH OR VERY HIGH RISK OF DEGRADATION, IDENTIFIED THROUGH THE RISK ASSESSMENT PROCESS (section 4.2.2)

High and very high risk management areas: Myora and Zone 2A

127. In the management areas of Myora and Zone 2A, water (holding) allocations and all components of water (taking) allocations and water allocations attached to forest water licences, should be reduced by the Minister, in the following manner:

a) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations and allocations attached to forest water licences in the management area, may be reduced proportionately so that the aggregate of:

i. tradeable components

ii. specialised production requirements of water (taking) allocations;

iii. allocations attached to forest water licences in accordance with principle 100-102 (*Volume of allocation for existing commercial forests*);

iv. allowances for stock and domestic use; and

v. allowances for farm forestry;

does not exceed the TML for that management area, as listed in Table 1 (*Appendix of Figures and Tables*);

b) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations, may be reduced by 100% of the required reduction by 1 July 2016;

c) any associated delivery supplement should be proportionately reduced by the Minister at the same rate as the tradeable component;

d) all allocations attached to forest water licences should be reduced in accordance with principle 131 (*Reductions to water allocations attached to forest water licences*).

High and very high risk management areas: Frances, Zone 3A and Zone 5A

128. In the management areas of Frances, Zone 3A and Zone 5A, water (holding) allocations and all components of water (taking) allocations and water allocations attached to forest water licences, should be reduced by the Minister, in the following manner:

    a) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations and allocations attached to forest water licences in the management area, may be reduced proportionately so that the aggregate of:

        i. tradeable components

        ii. specialised production requirements of water (taking) allocations;

        iii. allocations attached to forest water licences in accordance with principle 100-102 (*Volume of allocation for existing commercial forests*);

        iv. allowances for stock and domestic use; and

        v. allowances for farm forestry;

        does not exceed the TML for that management area, as listed in Table 1 (*Appendix of Figures and Tables*);

    b) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations, may be reduced by:

        i. 25% of the required reduction on 1 July 2016;

        ii. a further 25% of the required reduction on 1 July of every second water use year following the first reduction, until 100% of the required reduction has been completed;

    c) any associated delivery supplement should be proportionately reduced by the Minister at the same rate as the tradeable component;

    d) all allocations attached to forest water licences should be reduced in accordance with principle 131 (*Reductions to water allocations attached to forest water licences*).

High and very high risk management areas: Hynam East, Coles and Short

129. In the management areas of Hynam East, Coles and Short, water (holding) allocations and all components of water (taking) allocations and water allocations attached to forest water licences, should be reduced by the Minister, in the following manner:

    a) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations and allocations attached to forest water licences in the management area, may be reduced proportionately so that the aggregate of:

        i. tradeable components

        ii. specialised production requirements of water (taking) allocations;

        iii. allocations attached to forest water licences in accordance with principle 100-102 (*Volume of allocation for existing commercial forests*);

        iv. allowances for stock and domestic use; and

        v. allowances for farm forestry;

        does not exceed the TML for that management area, as listed in Table 1 (*Appendix of Figures and Tables*);

b) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations, may be reduced by:

   i. 8.5% on 1 July 2016;

   ii. a further 8.5% on 1 July 2018;

   iii. half of the remaining reduction required on 1 July 2020 and 1 July 2022, respectively;

c) any associated delivery supplement should be proportionately reduced by the Minister at the same rate as the tradeable component;

d) all allocations attached to forest water licences should be reduced in accordance with principle 131 (*Reductions to water allocations attached to forest water licences*).

Moderate to low risk management areas: Bangham, Beeamma, Benara, Blanche Central, Bool, Bowaka, Bray, Comaum, Compton, Conmurra, Donovans, Duffield, Fox, Glenburnie, Glenroy, Grey, Hacks, Hindmarsh, Hynam West, Joanna, Joyce, Kennion, Killanoola, Kongorong, Lacepede, Lake George, Landseer, Lochaber, MacDonnell, Marcollat, Mayurra, Minecrow, Monbulla, Moorak, Mount Benson, Mount Muirhead, Moyhall, Murrabinna, Ormerod, Peacock, Riddoch, Rivoli Bay, Ross, Smith, Spence, Stewarts, Struan, Symon, Townsend, Waterhouse, Western Flat, Woolumbool and Young.

130. Management areas assessed at date of adoption as being at low or moderate risk of degradation through the risk assessment process described in section 4.2.2 (Bangham, Beeamma, Benara, Blanche Central, Bool, Bowaka, Bray, Comaum, Compton, Conmurra, Donovans, Duffield, Fox, Glenburnie, Glenroy, Grey, Hacks, Hindmarsh, Hynam West, Joanna, Joyce, Kennion, Killanoola, Kongorong, Lacepede, Lake George, Landseer, Lochaber, MacDonnell, Marcollat, Mayurra, Minecrow, Monbulla, Moorak, Mount Benson, Mount Muirhead, Moyhall, Murrabinna, Ormerod, Peacock, Riddoch, Rivoli Bay, Ross, Smith, Spence, Stewarts, Struan, Symon, Townsend, Waterhouse, Western Flat, Woolumbool and Young), may not be subject to reductions unless identified as being at high or very high risk through principle 132 (*Adaptive management principles/ongoing risk assessment*).

Reductions to water allocations attached to forest water licences

131. A water allocation attached to a forest water licence should be varied, so as to provide for a reduction in the water allocation, within the prescribed period of a part (or all) of the forest being clearfelled; in the following manner:

   a) as part or all of compartments are clearfelled, the volume of allocation equivalent to the clearfelled area should be reduced from the forest water licence, until such time as the total volume of reductions to allocations attached to forest water licences for that management area is achieved; or

   b) in accordance with a scheme approved by the Minister under section 169E of the Act.

Adaptive management principles / ongoing risk assessment

132. Notwithstanding principles 127-131, if a risk assessment process which is re-run prior to 1 July 2019, determines that the Killanoola management area has been elevated to a high or very high risk of degradation, water (holding) allocations and all components of water (taking) allocations and water allocations attached to forest water licences, should be reduced by the Minister, in the following manner:

   a) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations and allocations attached to forest water licences in the management area, may be reduced proportionately so that the aggregate of:

i. tradeable components;

ii. specialised production requirements of water (taking) allocations;

iii. allocations attached to forest water licences in accordance with principle 100-102 (*Volume of allocation for existing commercial forests*);

iv. allowances for stock and domestic use; and

v. farm forestry;

does not exceed the Total Available Recharge for that management area, as listed in Table 1 (*Appendix of Figures and Tables*);

b) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations, may be reduced by 100% of the required reduction by 1 July 2020;

c) any associated delivery supplement should be proportionately reduced by the Minister at the same rate as the tradeable component;

d) all allocations attached to forest water licences should be reduced in accordance with principle 131 (*Reductions to water allocations attached to forest water licences*).

133. Notwithstanding principles 127-131, if a risk assessment process which is re-run prior to 1 July 2019, determines that the Bangham, Comaum, Fox, Glenroy and/or Joanna management areas have been elevated to a high or very high risk of degradation, water (holding) allocations and all components of water (taking) allocations and water allocations attached to forest water licences, should be reduced by the Minister, in the following manner:

a) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations and allocations attached to forest water licences in the management area, may be reduced proportionately so that the aggregate of:

i. tradeable components;

ii. specialised production requirements of water (taking) allocations;

iii. allocations attached to forest water licences in accordance with principle 100-102 (*Volume of allocation for existing commercial forests*);

iv. allowances for stock and domestic use; and

v. allowances for farm forestry;

does not exceed the Total Available Recharge for that management area, as listed in Table 1 (*Appendix of Figures and Tables*);

b) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations, may be reduced by:

i. 25% of the required reduction on 1 July 2020;

ii. a further 25% of the required reduction on 1 July of every second water use year following the first reduction, until 100% of the required reduction has been completed;

c) any associated delivery supplement should be proportionately reduced by the Minister at the same rate as the tradeable component;

d) all allocations attached to forest water licences should be reduced in accordance with principle 131 (*Reductions to water allocations attached to forest water licences*).

134. Notwithstanding principles 127-131, if a risk assessment process which is re-run prior to 1 July 2019, determines that the Beeamma, Stewarts and/or Western Flat management areas have been elevated to a high or very high risk of degradation, water (holding) allocations and all components of water (taking) allocations and water allocations attached to forest water licences, should be reduced by the Minister, in the following manner:

    a) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations and allocations attached to forest water licences in the management area, may be reduced proportionately so that the aggregate of:

        i. tradeable components;

        ii. specialised production requirements of water (taking) allocations;

        iii. allocations attached to forest water licences in accordance with principle 100-102 (*Volume of allocation for existing commercial forests*);

        iv. allowances for stock and domestic use; and

        v. allowances for farm forestry;

        does not exceed the Total Available Recharge for that management area, as listed in Table 1 (*Appendix of Figures and Tables*);

    b) water (holding) allocations and the tradeable components and specialised production requirements of water (taking) allocations, may be reduced by:

        i. 8.5% on 1 July 2020;

        ii. a further 8.5% on 1 July 2022;

        iii. half of the remaining reduction required on 1 July 2024 and 1 July 2026, respectively.

    c) any associated delivery supplement should be proportionately reduced by the Minister at the same rate as the tradeable component;

    d) all allocations attached to forest water licences should be reduced in accordance with principle 131 (*Reductions to water allocations attached to forest water licences*).

135. Notwithstanding principles 127-131, if a risk assessment process which is re-run prior to 1 July 2019, determines that the Coles, Short, Frances, Hynam East, Zone 2A, Zone 3A and/or Zone 5A management areas are identified as a low to moderate risk of degradation, reductions may be discontinued and the TML set at the volume of water (holding) allocations and the tradeable components and/or specialised production requirements of water (taking) allocations, and allocations attached to forest water licences, plus the allowance for stock and domestic use and farm forestry, calculated at 30 June 2020.

136. Notwithstanding principles 127-135, where the Minister identifies that the sustainable level of allocation in a management area that has undergone reductions to allocations is greater than the specified allocation limit, water (holding) allocations, water allocations attached to forest water licences and the tradeable components of water (taking) allocations, should be increased proportionately so that the level of allocation plus the allowance for stock and domestic use and farm forestry, equals the sustainable level identified by the Minister. Any associated delivery supplement or specialised production requirements allocation should be proportionately increased by the Minister at the same rate as the tradeable component. For the purposes of this principle, where a licensee has applied for an allocation according to principles 43 or 115, increases to allocations will be adjusted by subtracting the volume allocated according to principles 43 or 115.

Exemption from reductions

137. Notwithstanding principles 127-136, allocations for the purposes of public water supply, industry, intensive farming and recreation in existence at date of adoption are exempt from reductions.

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 resource such as soils or 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 ensure that allocations resulting from transfers remain within the sustainable limits of the unconfined aquifer in the relevant management area.

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

7.2 Principles

Transfers of allocations

138. 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.

139. The whole or part of an allocation from the unconfined aquifer endorsed on a licence may be transferred within the same management area temporarily or permanently.

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

    a) transferred temporarily for a maximum of five years into an under-allocated management area within or outside of the LLC PWA; or

    b) transferred permanently into an under-allocated management area within the LLC PWA;

    where there is an equivalent volume of unallocated water in the receiving management area.

141. Notwithstanding principle 140, the transfer of an allocation into another management area may only occur:

    a) following the completion of the conversion of area-based water licences to a volumetric basis; and

    b) following the completion of the allocation of water allocations attached to forest water licences; or

c) commencing 1 July 2016;

whichever is the sooner.

142. Notwithstanding principle 141, no allocations may be transferred to be taken:

a) from the Padthaway PWA;

b) from any management area in the Designated Area unless:

i. the allocation to be transferred originated from the Designated Area; and

ii. the transfer does not cause the sum of water (taking) allocations in the corresponding Zone or sub-zone of the Designated Area to exceed or further exceed the relevant Permissible Annual Volume or Allowable Annual Volume;

c) from the Hindmarsh or Mayurra management areas until such time as water is allocated for the purpose of existing pulp and paper mill operations according to principle 44 (A*llocation for existing pulp and paper mill operations*), unless the allocation to be transferred originated from the Hindmarsh or Mayurra management areas and is to be transferred within the same management area;

d) where the total allocation in the receiving management area exceeds the TML for that management area, at the time of application.

143. Where water is temporarily transferred into another management area pursuant to principle 140:

a) the allocation continues to be accounted for in both the originating and receiving management areas; and

b) the corresponding endorsement of land parcel or allotment in the receiving management area must be removed from the licence upon the expiry of the transfer period.

144. 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 to the transferee if the Minister is satisfied that the tradeable component will continue to be used for the purpose of delivery supplement;

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 139 or sub-principle a) of principle 140, shall be forfeited by the transferee at the end of the temporary transfer and re-issued to the transferor;

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

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

ii. with the exception of specialised productions requirements allocated for rotational crops, the Minister is satisfied that the water is to be taken and used on the same allotment(s) and for the same purpose;

iii. where the specialised production requirements were allocated for the purpose of irrigating rotational crops, the Minister is satisfied that the water is to be taken and used for the same purpose.

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

Applications to transfer water (taking) allocations – purpose of mining

146. A water (taking) allocation for the purpose of mining may only be transferred and used for the purpose of mining.

Transfers in management areas subject to reductions

147. In management areas subject to reductions in allocations, if a licensee applies in writing to the Minister, the Minister may transfer in an allocation from the same management area exempt from principles 58-65 (*Hydrogeological effects and assessment*) and principles 2-5 (*Protection of ecosystems dependent on underground water – extraction from licensed wells*).

148. Notwithstanding principle 147, 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 principles 58-65 (*Hydrogeological effects and assessment*) and principles 2-5 (*Protection of ecosystems dependent on underground water – extraction from licensed wells*). The maximum total allocation that can be transferred by a licensee under this principle from the date of adoption shall not exceed 75% of the reduction implemented at the date of application to transfer.

Temporary transfers to manage seasonal variability

149. If a licensee who holds an unconfined aquifer water (taking) allocation applies in writing to the Minister, the Minister may transfer in additional water for the purpose of managing seasonal variability, subject to the following:

a) a licensee may 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, any specialised production requirements with the exception of water for frost control for vines, but does not include delivery supplement, bridging volume, 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 is made; and

e) the transfer is exempt from principles 58-65 (*Hydrogeological effects and assessment*) and principles 2-5 (*Protection of ecosystems dependent on underground water - extraction from licensed wells*).

150. Where a transfer occurs pursuant to principle 149:

a) any delivery supplement associated with a 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 purpose and irrigation system type;

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 is made.

Piping of water for a distance at least 2.25 kilometres

151. 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 58-65 (*Hydrogeological effects and assessment*);

ii. nowithstanding subprinciple b)(i) of principle 151, the 16 km^2 circle test shall apply only at the point of taking.

152. Notwithstanding principle 151, 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 58-65 (*Hydrogeological effects and assessment)* at both the extraction and discharge sites without further assessment.

Endorsement of Certificates of Title on licences

153. 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

154. An allocation to take water drained and discharged into the unconfined aquifer according to principles 78-82 (*Basis of allocation of water drained or discharged into a well*) may only be transferred if the Minister is satisfied that the allocation will be taken from:

a) the same point of extraction; or

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

Hydrogeological effects and assessment

155. An unconfined aquifer transfer application shall be deemed to have complied with the 16 km^2 circle test (as defined in principles 62 and 63 (*The 16 km^2 circle test*)) without further assessment, if:

a) the application is to transfer a licence endorsed with a 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; or

b) the application is for a further 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 100 metres of the original well);

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

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

156. Notwithstanding principle 155, the further temporary transfer of an allocation which has been in place for five years or greater, is subject to principles 58-65 (*Hydrogeological effects and assessment*).

157. Notwithstanding principles 155 and 156, if one or more of the following resource condition triggers for the unconfined aquifer have been exceeded:

a) a mean (arithmetic) increase in salinity of the underground water resource of greater than 2% per year (measured over the preceding five 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

b) a mean (arithmetic) decrease in underground water levels of greater than 0.1 metres per year (measured over the preceding five 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 a representative well or wells as determined by the Minister;

the transfer application may still be approved if 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 the approval would not cause the triggers at the destination to exceed those existing at the origin prior to the transfer.

TRANSFER OF A WATER ALLOCATION ATTACHED TO A FOREST WATER LICENCE

Principles 158-174 are subject to the Minister declaring the LLC PWA (or a portion of that area) to be a “declared forestry area” pursuant to section 169B(1) of the Act.

158. All transfers of water allocations attached to a forest water licence are subject to the allocation principles set out in section 6 of the Plan.

159. Following the adoption of the Plan, the whole or part of an allocation attached to a forest water licence may be transferred within the same management area temporarily or permanently.

160. The whole or a part of an allocation attached to a forest water licence may be:

a) transferred temporarily for a maximum of five years into an under-allocated management area within or outside of the LLC PWA; or

b) transferred permanently into an under-allocated management area within the LLC PWA;

where there is an equivalent volume of unallocated water in the receiving management area.

161. Notwithstanding principle 160, the transfer of an allocation into another management area may only occur:

a) following the completion of the conversion of area-based water licences to a volumetric basis; and

b) following the completion of the allocation of water allocations attached to forest water licences; or

c) commencing 1 July 2016;

whichever is the sooner.

162. Notwithstanding principle 160, an allocation attached to a forest water licence may not be transferred to be taken:

a) from the Padthaway PWA; or

b) from the Designated Area unless the allocation to be transferred originated from the Designated Area; or

c) from the Hindmarsh or Mayurra management areas until such time as water is allocated for the purpose of existing pulp and paper mill operations according to principle 44 (A*llocation for existing pulp and paper mill operations*), unless the allocation to be transferred originated from the Hindmarsh or Mayurra management areas and is to be transferred within the same management area;

d) where the total allocation in the receiving management area exceeds the TML for that management area, at the time of application.

163. Where water is temporarily transferred into another management area pursuant to principle 160:

a) the allocation must continue to be accounted for in both the originating and receiving management areas; and

b) the corresponding endorsement of the land parcel or allotment in the receiving management area must be removed from the licence upon the expiry of the transfer period.

164. All or part of a water allocation attached to a forest water licence may be transferred, under the following circumstances:

a) where the licence and its associated allocation is transferred to a new owner but the site of the commercial forest to which the licence and allocation relates remains the same; or

b) where all (or a part) of the commercial forest has been clearfelled, and any coppice regrowth of hardwood forests has been killed to the satisfaction of the Minister.

165. Notwithstanding principles 159-160, a water allocation attached to a forest water licence, issued in accordance with principle 95 *(Allocation for proposed commercial forests (not yet planted)),* may only be transferred in the period between allocation of the water and the planting of the commercial forest, where the licence and its associated allocation is transferred to a new owner but the site of the proposed commercial forest to which the licence and allocation relates remains the same.

166. A water (holding) allocation or a water (taking) allocation may be transferred for the purposes of conversion to a water allocation attached to a forest water licence, in accordance with principles 158-165 (*Transfer of a water allocation attached to a forest water licence)* and principles 116 and 117 (*Conversion of a water (holding) allocation or a water (taking) allocation to a water allocation attached to a forest water licence)*.

Transfers in management areas subject to reductions

167. In management areas subject to reductions in allocations, a forest water licensee may transfer an allocation from within the same management area. A transfer under this principle is exempt from principles 124 and 125 (*Hydrogeological assessment for commercial forests*) and principles 84-89 (*Protection of ecosystems dependent on underground water – set-back distance for commercial forests*).

168. Notwithstanding principle 167, only transfers below or equal to 75% of the extent of the reduction to the forest water licensee's allocation are exempt from principles 124 and 125 (*Hydrogeological assessment for commercial forests*) and principles 84-89 (*Protection of ecosystems dependent on underground water – set-back distance for commercial forests*). The maximum total allocation that can be transferred by a forest water licensee under this principle from the date of declaration shall not exceed 75% of the reduction implemented at the date of application to transfer.

Temporary transfers exempt from hydrogeological assessment

169. If a licensee who holds a water allocation attached to a forest water licence applies to the Minister, the Minister may transfer in additional water, 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 of the tradeable component or an allocation attached to a forest water licence, which is 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 volume of the allocation attached to the forest water licence but does not include additional water transferred in temporarily);

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

    e) the transfer is exempt from principles 124 and 125 (*Hydrogeological assessment for commercial forests*) and 84-89 (*Protection of ecosystems dependent on underground water - set back distance for commercial forests*).

170. Where a transfer occurs pursuant to principle 169, 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 transferor at the expiry of the temporary transfer, if the Minister is satisfied that it will continue to be used for the same purpose and through the same irrigation system type.

Endorsement of Certificates of Title on licences

171. 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

172. A transfer application shall be deemed to have complied with principles 124 and 125 (*Hydrogeological assessment for commercial forests*), without further assessment, if:

    a) the application is to transfer an allocation attached to a forest water licence, where the transferred water is to be used on the same allotment(s); or

b) the application is for a further temporary transfer of an allocation attached to a forest water licence (of the same quantity) where the transferred water is to be used on the same allotment(s) as the previous temporary transfer.

173. Notwithstanding principle 172, the renewal of any temporary transfer of an allocation which has been in place for five years or greater, is subject to principles 124 and 125 (*Hydrogeological assessment for commercial forests*).

174. Notwithstanding principles 172 and 173, if one or more of the following resource condition triggers for the unconfined aquifer have been exceeded:

a) a mean (arithmetic) increase in salinity of the underground water resource of greater than 2% per year (measured over the preceding five 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

b) a mean (arithmetic) decrease in underground water levels of greater than 0.1 metres per year (measured over the preceding five 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 a representative well or wells as determined by the Minister;

the transfer application may still be approved if 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 the approval would not cause the triggers at the destination to exceed those existing at the origin prior to the 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 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 throughout the entire PWA.

c) To provide felixibility and equity in access to the underground water resource of the confined aquifer.

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 and other water resources.

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

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

8.2 Principles

Limit to total allocation

175. No new water shall be allocated from the confined aquifer for the life of the Plan, except for the following purposes:

a) to give effect to the volumetric conversion of existing area-based allocations in accordance with principles 177-180 (*Conversion of allocations expressed in haIE to volumetric allocation*);

b) to allow for water to be allocated for the purposes of bridging volumes in accordance with principles 200-202 (*Bridging Volumes*);

c) to give effect to delivery supplements issued in accordance with principle 237 (*Transfer of water allocations*) and principles 239 and 240 (*Temporary transfers to manage seasonal variability*);

d) to allow for the allocation of water as carry-over in accordance with principles 207 – 211 (*Seasonal variability – carry-over and temporary trade volumes*);

e) to allow for the allocation of water for the purpose of public water supply in accordance with principle 212 (*Allocations for public water supply*);

f) to allow for the allocation of water in accordance with principle 213 (*Allocations for geothermal energy*) for the purpose of geothermal energy generation;

g) to give effect to the allocation of water in accordance with principle 214 (*Allocations for the purpose of mining*);

h) to allow for the allocation of water in accordance with principles 215–217 (*Allocations for the purpose of petroleum and carbon dioxide production*);

i) to temporarily or permanently transfer an allocation in accordance with section 9 of the Plan (*Transfer Criteria - Confined Aquifer*);

j) to give effect to 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; and

k) to give effect to the recalculation of volumetric allocations in existence at date of adoption in accordance with principles 203–206 (*Recalculation of volumetric allocations from the confined aquifer granted prior to date of adoption*).

Basis of allocation

176. Water shall be allocated by volume.

Conversion of allocations expressed in haIE to volumetric allocation

177. Allocations presently expressed in hectare irrigation equivalents shall be converted to a volume, in accordance with principles 178-199.

178. The allocation of water for irrigation purposes shall not exceed a volume determined pursuant to principles 179-199.

179. For the purposes of converting haIE allocations to a volume, each licence shall be assigned to the corresponding volumetric conversion zone shown in Figure 11 (*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 conversion zone shall be based on the location of the point of extraction.

180. For the purposes of principle 179, 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 subprinciple b) of principle 180, based on the location of the point of extraction;

    b) if the licensee makes a written request to the Minister, a proportion of the area-based allocation may be assigned to each volumetric conversion zone, calculated according to the average area in hectares irrigated in each area in the 2009/10, 2010/11 and 2011/12 water use years;

    c) the Minister will not consider any request under subprinciple b) of principle 180 received by DEWNR after 5 p.m. on the nearest business day following six months after date of adoption.

Tradeable component

181. The tradeable component is the component of a water allocation which may be permissibly traded.

182. The tradeable component of a water (taking) allocation is the volume allocated on the licence, minus:

    a) any delivery supplement (see principles 186-194);

    b) any specialised production requirements (see principles 195-199);

    c) any bridging volume (see principles 200-202); and

    d) any carry-overs (see principles 207-211).

183. The tradeable component of a water (taking) allocation for irrigation purposes shall be calculated according to the values contained in Column B of Table 6 (*Appendix of Figures and Tables*) for the corresponding volumetric conversion zone.

184. Licensees that have grown an eligible crop in an eligible volumetric conversion zone, as listed in Table 8 (*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.

185. For the purposes of principle 184, the crop adjustment volume shall be calculated by multiplying the average area in hectares of the eligible crop grown in the 2006/07, 2007/08, 2008/09, 2009/10, 2010/11 and 2011/12 water use years with the exception of any water use years in which the eligible crop was not grown, by the crop adjustment factor for the corresponding volumetric conversion zone in accordance with Table 8 (*Appendix of Figures and Tables*), and this volume shall be added to and become part of the tradeable component specified in principle 183.

Delivery Supplement

186. If a licensee makes a written request to the Minister for an additional volume known as a delivery supplement for flood irrigation, the Minister may grant such a request if satisfied that:

    a) the licensee has used their allocation for flood irrigation prior to the date of adoption; and

    b) the allocation has been converted to a volume in accordance with principles 177-180 (*Conversion of allocations expressed in haIE to volumetric allocation).*

187. If a licensee makes a written request to the Minister for an additional volume known as a delivery supplement for spray irrigation, the Minister may grant such a request if satisfied that:

    a) the licensee has used their allocation for spray irrigation in the Benara, Donovans, Kongorong, MacDonnell or Moorak volumetric conversion zones prior to the date of adoption; and

    b) the allocation has been converted to a volume in accordance with principles 177-180 (*Conversion of allocations expressed in haIE to volumetric allocation).*

188. The delivery supplement shall be calculated according to the values contained in Columns C and D of Table 6 (*Appendix of Figures and Tables*) for the corresponding volumetric conversion zone and irrigation system type.

189. Notwithstanding principle 188, if the licensee has had a crop adjustment volume added to their tradeable component pursuant to principle 184, an additional delivery volume shall be calculated and added to the delivery supplement.

190. For the purposes of principle 189, 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.

191. If any part of a tradeable component associated with a delivery supplement is transferred, any delivery supplement for any allocation not transferred shall be proportionately reduced by the Minister.

192. 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 2011/12 water use year; or

    b) in the absence of an Annual Water Use Report for the 2011/12 water use year, on the proportional split of irrigation systems in place reported in the licensee's Annual Water Use Report for the 2010/11 water use year; and

    c) issued for the proportion of tradeable component associated with each eligible irrigation system type identified in any Annual Water Use Reports for 2010/11 and/or 2011/12 received by DEWNR by 31 July 2012, as the maximum proportional split via irrigation system type at 30 June 2011 or 30 June 2012, whichever is the greater.

193. For the purposes of principle 192, 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 192 as the year with the maximum area under an eligible 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 the system type by the total net irrigation requirement for the licence; or

d) where the licensee has reported nil use of one or more irrigation system types, the proportional split of irrigation system types shall be calculated based on the capacity of each irrigation system type

194. The Minister will not consider:

a) any request under principle 186 or 187 received by DEWNR after 5 p.m. on Thursday 24 December 2015; and

b) for the purposes of principles 192 and 193:

i. any request received by DEWNR after 5 p.m. on Thursday 24 December 2015; and

ii. where no Annual Water Use Report for any of the 2010/11 or 2011/12 water use years was received by DFW (now DEWNR) by 31 July 2012;

instead the licensee will be considered to have carried out no flood or spray irrigation during the 2010/11 and 2011/12 water use years.

Specialised Production Requirements

195. If a licensee makes a written request to the Minister for an additional volume known as specialised production requirements, the Minister 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 177-180 (*Conversion of allocations expressed in haIE to volumetric allocation*);

b) the application is for an eligible crop(s) listed in Table 7 (*Appendix of Figures and Tables*) and for the maximum area(s) of the crop(s) referenced in the Annual Water Use Reports for the 2006/07, 2007/08, 2008/09, 2009/10, 2010/11 or 2011/12 water use years, whichever is greater;

c) the additional volume of water sought does not exceed the amount specified in Table 7 for the relevant crop (*Appendix of Figures and Tables*);

d) the licensee grew the eligible crop during at least one of the 2006/07, 2007/08, 2008/09, 2009/10, 2010/11 or 2011/12 water use years (according to at least one Annual Water Use Report received by DWLBC/DFW (now DEWNR) prior to 31 July 2012); and

i. for grapevines: that prior to 1 July 2012, the licensee had installed (or made a significant financial commitment for the installation of) an overhead spray system for frost control, and where separate frost control infrastructure was installed, a separate meter was installed to measure this allocation by the date of application;

ii. for fruit trees: that prior to 1 July 2012, 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 a salinity of ≥ 1,350 mg/L TDS.

196. When endorsing conditions on a water licence, it is suggested that the Minister give consideration to endorsing the condition that a specialised production requirements allocation may not be used for any other purpose than the purpose for which it was issued.

197. The Minister will not consider any request under principle 195 received by DEWNR after 5 p.m. on Thursday 24 December 2015.

198. Specialised production requirements used for grapevine frost control shall be allocated for a water use year as follows:

a) on date of adoption the allocation shall be the value set out in Table 7 (*Appendix of Figures and Tables*) for the purpose of grapevine frost control;

b) in the second water use year from date of adoption, the allocation shall be the value set out in Table 7 (*Appendix of Figures and Tables*) minus any volume extracted in the first year;

c) in all subsequent years from date of adoption, the allocation shall be calculated as the value set out in Table 7 (*Appendix of Figures and Tables*) minus the volumes extracted in the previous two years.

199. 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.

Bridging Volumes

200. If a licensee makes a written request to the Minister for an additional volume known as a bridging volume, the Minister may grant such a request if satisfied that:

a) the management area is not the Kingston management area;

b) the original allocation to which the request relates has been converted to a volume in accordance with principles 177-180 (*Conversion of allocations expressed in haIE to volumetric allocation*);

c) the licensee has a demonstrated need for a bridging volume, based on indicative volumes taken in the 2006/07, 2007/08, 2008/09, 2009/10, 2010/11 or 2011/12 water use years as described in Annual Water Use Reports held by DEWNR at 31 July 2012;

d) the additional volume of water sought does not exceed the amount specified in columns E, F or G of Table 6 (*Appendix of Figures and Tables*) for the corresponding volumetric conversion zone and irrigation system type.

201. A bridging volume shall be allocated on a temporary basis and expire on 30 June 2016, regardless of the date of allocation.

202. The Minister will not consider any request made under principle 200:

a) received by DEWNR after 5 p.m. on the nearest business day following six months after the date of adoption; or

b) if a minimum of one Annual Water Use report was not received by DEWNR for any of the 2006/07, 2007/08, 2008/09, 2009/10, 2010/11 or 2011/12 water use years.

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

203. Existing licences at the date of adoption endorsed with a volumetric allocation will only be recalculated 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 less than those listed in Table 6 (*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 less than those listed in Table 6 (*Appendix of Figures and Tables*);

    c) licences granted for the purpose of aquaculture which are not expressed as a total volume which may be taken and used on an annual basis.

204. Allocations described in subprinciples a) and b) of principle 203 shall be recalculated according to principle 178, except that:

    a) licensees with allocations made in accordance with subprinciple a) of principle 203 will not be eligible for specialised production requirements or bridging volumes, according to principles 195-199 or 200-202, respectively.

    b) licensees with allocations made in accordance with subprinciple b) of principle 203 will not be eligible for delivery supplements, specialised production requirements or bridging volumes, according to principles 186-194, 195-199 and 200-202, respectively.

205. Notwithstanding principle 203, allocations that were granted for irrigated recreational purposes under principles 8.2.2-8.2.3 (*Unlicensed pre-existing water use*) in the 2001 Comaum-Caroline or Lacepede Kongorong or Naracoorte Ranges WAPs, shall not exceed 10 ML.

206. Licensees with allocations described in accordance with subprinciple c) of principle 203 shall not be eligible for specialised production requirements or bridging volumes, according to principles 195-199 or 200-202, respectively, and shall be recalculated in the following manner:

    a) water for aquaculture in dam(s) or tank(s), with no flow through or recirculation, shall be calculated based on twice the volume required to fill the dam(s) or tank(s) in place at 30 June 2012, plus the estimated average annual evaporation from the dam(s) or tank(s), expressed as a water (taking) allocation;

    b) where the water is used in a flow-through aquaculture system or a recirculation aquaculture system and the allocation was not originally calculated as the total volume that may be taken and used on an annual basis, the allocation shall consist of the following components:

        i. a tradeable component, calculated as the volume required to fill the ponds or tanks in place at 30 June 2012 twice per year, plus average annual evaporation from the ponds or tanks; plus

        ii. a delivery supplement for aquaculture, calculated according to the following formula: the average volume pumped during the 2006/07, 2007/08, 2008/09, 2009/10, 2010/11 or 2011/12 water use years with the exception of any water use year(s) in which no water was pumped for the purpose of aquaculture, less the volume calculated as the tradeable component;

    c) where the allocation used for aquaculture is expressed, prior to date of adoption, as a total volume which may be taken and used on an annual basis, the allocation shall remain expressed in this manner and of the same volume.

Seasonal variability –carry over and temporary trade volumes

207. Where:

a) a licence is endorsed with a volumetric water (taking) allocation; and

b) DEWNR has received an Annual Water User 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, which will be equivalent to the unused volume of allocation at the end of the preceding water use year, or 25% of the licensee's annual allocation for the preceding year, whichever is the lesser.

208. Where a licence is endorsed with a volumetric water (taking) allocation, 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 239 and 240 (*Temporary transfers to manage seasonal variability*).

209. No allocation granted in accordance with principles 207 and 208 shall result in the total volume available for use in any one water use year exceeding 140% of the licensee's annual allocation.

210. For the purpose of subprinciple c) of principle 207, 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;

d) bridging volume.

211. For the purposes of principles 207-210, annual allocation comprises the sum of:

a) the tradeable component;

b) any delivery supplement; and

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

but does not comprise bridging volumes, carry-overs or additional water transferred in temporarily under principles 239 and 240 (*Temporary transfers to manage seasonal variability)*.

Allocations for public water supply

212. Water from the confined aquifer may be allocated for the purpose of public water supply subject to principles 220 – 222 (*Hydrogeological effects and assessment*), and subject to the following:

a) no water will be allocated above the TML for the relevant management area at the time of application;

b) allocations, if granted, will be granted in order of receipt of applications.

Allocations for geothermal energy

213. Water from the confined aquifer may be allocated for the purpose of producing geothermal energy, subject to the following:

a) water may be allocated above the TML for the relevant management area at the time of application;

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

c) at least 99 percent of the water extracted is returned to the same source aquifer from which the water was originally taken pursuant to a permit in accordance with section 10.5 (*Managed Aquifer Recharge: Draining or discharging of water into a well*) of the Plan, following the generation of geothermal energy, with no detrimental change to the quality of water in the source aquifer;

d) water allocated under this principle is exempt from principles 220-222 (*Hydrogeological effects and assessment)*, principle 230 (*Piping of water for a distance at least 2.25 kilometres),* and principles 218 and 219 (*Returned water*)*;*

e) allocations shall expire on the 30 June following the cessation of the activity authorised under the *Petroleum and Geothermal Energy Act 2000*.

Allocations for the purpose of mining

214. Water from the confined aquifer may be allocated upon application in writing to the Minister, for the purpose of mining, subject to the following:

a) water may be allocated above the TML for the relevant management area at the time of application;

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

c) all water extracted is returned to the same source aquifer from which water was originally taken pursuant to a permit in accordance with section 10.5 (*Managed Aquifer Recharge: Draining or discharging of water into a well*) of the Plan, with no detrimental change to the quality of water in the source aquifer;

d) no weakening or fracture of the confining layer between the unconfined and confined aquifers;

e) water allocated under this principle is exempt from principles 220-222 (*Hydrogeological effects and assessment)* and principle 230 (*Piping of water for a distance at least 2.25 kilometres);*

f) allocations shall expire on the 30 June following the cessation of the activity authorised under the *Mining Act 1971.*

Allocation for the purpose of petroleum or carbon dioxide production

215. Water from the confined aquifer may be allocated above the TML for the purpose of water taken as a by-product of petroleum or carbon dioxide production (known as co-produced water), including allocation to water users producing co-produced water as a by-product of petroleum or carbon dioxide production in existence at the date of adoption.

216. When endorsing conditions on a licence it is suggested that the Minister give consideration to endorsing a condition that the operation of licensed wells for the purpose of petroleum or carbon dioxide production shall be consistent with the provisions of the appropriate statement of environmental objective, required under the *Petroleum and Geothermal Energy Act 2000*.

217. Allocations made in accordance with principle 215 shall be exempt from principles 220-222 (*Hydrogeological effects and assessment)* and shall expire on the 30 June following the cessation of the activity authorised under the *Petroleum and Geothermal Energy Act 2000*.

Returned water

218. Where all or part of a water allocation endorsed on a licence is surrendered or otherwise forfeited to the Minister, the water surrendered or forfeited will only be available for further allocation where the area is or becomes under-allocated with respect to the corresponding TML set out in Table 5 (*Appendix of Figures and Tables*), in which case the following principles apply:

    a) principle 212 (*Allocations for public water supply*);

    b) principle 213 (*Allocations for geothermal energy*);

    c) principle 214 (*Allocations for the purpose of mining*);

    d) principles 215 – 217 (*Allocations for the purpose of petroleum or carbon dioxide production*) .

219. For the purposes of principle 218, with respect to the TMLs set out in Table 5 (*Appendix of Figures and Tables*):

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

    b) where a bridging volume 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

220. 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 significant 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:

        i. within the vicinity of the point of taking (including neighbouring properties and the nearest potentiometric level monitoring wells),

        ii. within the relevant confined aquifer management area;

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

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

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

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

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

221. In areas where the existing confined aquifer potentiometric level is greater than the unconfined aquifer potentiometric level, the allocation 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.

222. The allocation 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 two kilometre radius from the point(s) of taking of greater than two 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.

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

223. The granting of a water allocation resulting from principles 239 and 240 (*Temporary transfers to manage seasonal variability*) is exempt from principles -220-222 (*Hydrogeological effects and assessment*).

Volume of allocation

224. 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.

Restrictions on use

225. Water shall not be allocated from the confined aquifer for the purposes of wild flooding.

226. Water shall not be allocated from the confined aquifer for a purpose that produces tail water 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 that purpose have no significant hydraulic connection with either aquifer.

227. For the purpose of principle 226, tail water is water that flows out of a system once it has flowed through any ponds, tanks, vessels or other places, including places for the keeping of farmed aquatic species.

Endorsement of Certificates of Title on licences

228. 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 legal access to the land and made an application to the Minister for such a variation, accompanied by a written statement made by the registered proprietor of the land consenting to the variation.

229. For the purposes of principle 228, where the licensee is not the registered proprietor of the land, the relevant Certificate(s) of Title will only be endorsed on the licence for a maximum of five years unless otherwise specified in the written statement.

Piping of water for a distance at least 2.25 kilometres

230. 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 220-222 (*Hydrogeological effects and assessment*); and

c) the use of water shall comply with subprinciples (a)(c)(d)(e) and (f) of principle 220.

Use of imported water

231. 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, use of the water must comply with section 10.7 (*Importation of Water*) of the Plan.

Addressing over-allocation in the Kingston management area

232. If in the Kingston management area the sum of metered extraction plus the allowance for stock and domestic use minus any volumes returned to the source aquifer by geothermal energy or mining activities, exceeds 25,000 ML/year in any water use year and the area is identified as at high or very high risk of degradation through a risk assessment, all components of water (taking) allocations in the management area should be reduced in the following manner:

a) each licensed allocation component may be reduced so that the aggregate of the tradeable components, delivery supplements and/or specialised production requirements of water (taking) allocations in the management area, plus the allowance for stock and domestic use, does not exceed 25,000 ML/year; and

b) 25% of the required reduction shall take place on 1 July of the next water use year following the sum of metered extraction, plus the allowance for stock and domestic use in the Kingston management area exceeding 25,000 ML/year and the management area being identified as high or very risk;

c) a further 25% of the required reduction shall take place on 1 July, every second water use year following the first reduction, until 100% of the required reduction has been completed.

233. Notwithstanding principle 232, if a risk assessment process, which is re-run prior to 1 July 2019, determines that the Kingston management area is at low to moderate risk of degradation at the time of the assessment, reductions may be discontinued and the TML set at the level of allocation, plus the allowance for stock and domestic use.

234. Notwithstanding principles 232 and 233, allocations for the purposes of public water supply, industry, intensive farming and recreation, are exempt from reductions.

9. Transfer Criteria – Confined Aquifer

9.1 Objectives

The objectives of the confined aquifer transfer criteria are:

a) 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.

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, or other water resources.

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

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

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

9.2 Principles

Transfer of water allocations

235. All transfers of confined aquifer water (taking) allocations are subject to the allocation principles set out in section 8 of the Plan.

236. The whole or part of an allocation from the confined aquifer endorsed on a licence may be transferred within the same management area temporarily or permanently.

237. Where a water allocation from the confined aquifer is transferred:

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

    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 subprinciple a) of principle 237 shall be forfeited by the transferee at the end of the temporary transfer and re-issued to the transferor;

    c) no specialised production requirements and/or seasonal carry-over and/or bridging volumes will be transferred unless:

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

        ii. with the exception of specialised productions requirements allocated for rotational crops, the Minister is satisfied that the water is to be taken and used on the same allotment(s) and for the same purpose; or

        iii. where the specialised production requirements were allocated for the purpose of irrigating rotational crops, the Minister is satisfied that the water is to be taken and used for the same purpose.

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

Temporary transfers to manage seasonal variability

239. If a licensee who holds a confined aquifer water (taking) allocation for any purpose applies in writing to the Minister, the Minister may transfer in 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 grapevines, but does not include delivery supplement, bridging volumes, 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 is made;

    e) the transfer is exempt from principles 220-222 (*Hydrogeological effects and assessment*).

240. Where a transfer occurs pursuant to principle 239:

    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 same purpose and irrigation system type;

    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 is made.

Endorsement of Certificates of Title on licences

241. 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 (taking) allocations – purpose of use

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

243. A water (taking) allocation from the confined aquifer for the purpose of geothermal energy generation may only be transferred and used for the purpose of geothermal energy generation.

244. A water (taking) allocation from the confined aquifer for the purpose of mining may only be transferred and used for the purpose of mining.

245. A water (taking) allocation from the confined aquifer for the purpose of petroleum or carbon dioxide production may only be transferred and used for the purpose of petroleum or carbon dioxide production.

Applications to transfer water (taking) allocations – hydrogeological effects and assessment

246. A confined aquifer transfer application shall be deemed to have complied with principles 220-222 (*Hydrogeological effects and assessment*) 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 100 metres of the original well.

b) the application is for a further 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 metres of the original well);

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

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

247. Notwithstanding principle 246, the further temporary transfer of an allocation which has been in place for five years or greater, is subject to principles 220-222 (*Hydrogeological effects and assessment*).

248. Notwithstanding principles 246 and 247, if the following resource condition trigger for the confined aquifer has been exceeded:

a) a mean (arithmetic) decrease in the potentiometric level of the confined aquifer:

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

ii. within the relevant confined aquifer management area;

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

the transfer application may still be approved if the resource condition trigger for potentiometric level at the destination is exceeded at a lesser rate than at the point of origin, and the approval would not cause the trigger at the destination to exceed that existing at the origin prior to transfer.

Piping of water for a distance at least 2.25 kilometres

249. 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 water must be transported by pipe or other enclosed vessel; and

b) with the exception of public water supply, the taking of water shall comply with principles 220-222 (*Hydrogeological effects and assessment*);

250. Notwithstanding principle 249, 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 220-222 (*Hydrogeological effects and assessment*) at both the extraction and discharge sites without further assessment.

Transfers in management areas subject to allocation reductions

251. In management areas subject to reductions in allocations, if a licensee applies in writing to the Minister, the Minister may transfer in an allocation from the same management area. In this circumstance, principles 220-222 (*Hydrogeological effects and assessment*) would not apply.

252. Notwithstanding principle 251, 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 principles 220-222 (*Hydrogeological effects and assessment*).

253. For the purposes of principles 251-252, the maximum total allocation that can be transferred by a licensee under these principles from date of adoption shall not exceed 75% of the total reduction implemented at the date of application to transfer.

10. Permits

The provisions outlined in this section should be considered as in addition to, and do not derogate from, the requirements outlined in section 8.2 of the Water Allocation Plan for the Morambro Creek and Nyroca Channel Prescribed Watercourses including Cockatoo Lake and the Prescribed Surface Water Area January 2006.

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;
- 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. The relevant authority at date of adoption of the Plan is listed in the table below.

Water Affecting Activity	**Example Activities**	**Relevant Authority (at date of adoption)**
Drilling, plugging, backfilling or sealing of a well in accordance with section 127(3)(a) of the Act.	- well construction -underground water access trenches -an excavation which intercepts underground water	Minister
Repairing, replacing, or altering the casing, lining or screen of a well in accordance with section 127(3)(b) of the Act.	-well maintenance -well replacement	Minister
Draining or discharging water directly or indirectly into a well in accordance with section 127(3)(c) of the Act.	-managed aquifer recharge -aquifer storage and recovery	Minister
Using water in the course of carrying on a business in an NRM Region at a rate that exceeds the rate prescribed by an NRM Plan if the water has been brought into the region by means of a pipe or other channel, in accordance with section 127(5)(i) of the Act.	-importation of water	Minister

10.1 Permit objectives

The following objectives apply to all water affecting activities as described in section 127 of the Act, within the boundaries of the LLC 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:

   i. sustain the existing uses of the water; and

   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:

a) wells of any diameter with a depth equal to or greater than 2.5 metres;

b) underground water access trenches exceeding a depth of 2.5 metres;

c) excavations of any depth with a diameter of less than one metre which do intercept or will intercept underground water as measured at its autumn low.

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, underground water resources and water dependent ecosystems.

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

d) To ensure the integrity of public water supply from wells is maintained, by minimising well interference effects on public water supply wells.

e) To ensure the integrity of the head works of wells is maintained.

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

10.2.2 Principles

254. Where the well to be drilled is for the purposes of re-siting of the point of take (e.g. a replacement well), the new well must be sited no more than 100 metres from the existing well, and no closer to the nearest neighbouring existing well than the well that is being re-sited (and there is no change to the total volume of water to be extracted or to the conditions on the original permit). For the purposes of this principle, a neighbouring existing well is defined as a well that has supplied water for irrigation, stock, domestic or commercial use in the last 10 years and is owned by another party.

255. The siting of stock (non-intensive) or domestic wells must have no detrimental effect on any other operational well.

256. The relevant authority shall not grant a permit for the construction of a new or replacement well (excluding wells exclusively for stock and domestic use) that may create or may contribute to a significant adverse effect on ecosystems that depend on underground water.

257. For the purposes of principle 256, in assessing the likelihood of significant adverse effects, consideration shall be given to:

    a) if the ecosystem that depends on underground water is one or more of the 13 priority wetland complexes dependent on underground water listed in Table 10 (*Appendix of Figures and Tables*); or

    b) if at the date of application, the ecosystem that depends on underground water is listed on the DEWNR SAWID for the South East of South Australia, as a wetland of high or very high conservation value (see Table 9, *Appendix of Figures and Tables*) – 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

    c) whether the wetland identified in subprinciple b) of principle 257 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 metres/year (measured over the preceding five years) in a representative observation well within the 16 km^2 circle specified in subprinciple b) of principle 257 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

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

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

    f) any other relevant matter.

258. For any underground water dependent ecosystem identified for protection under principle 257 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 water dependent ecosystems*).

259. Notwithstanding principles 256-258, 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 and subject to principle 254.

260. When endorsing conditions on a permit, it is suggested that the Minister give consideration to endorsing the following conditions:

    a) 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, underground water resources and water dependent ecosystems.

    b) 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 underground water dependent ecosystems. Drilling equipment shall be disinfected after use to prevent the spread of iron bacteria.

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

    d) 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.

    e) 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 the 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.

261. Any underground water access trench exceeding a depth of 2.5 metres shall be governed by the principles under 10.2.

262. When endorsing conditions on a permit for an underground water access trench, it is suggested that the Minister give consideration to endorsing the following conditions:

    a) 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.

    b) An underground water access trench must be, and must remain:

        i. fenced sufficiently to prevent stock access;

        ii. bunded or surrounded by an earthen levee at least 500 mm high;

        iii. maintained so as to prevent contamination of the water resources.

    c) Completion of an underground water access trench must be reported within 30 days to the relevant authority, for inspection to ensure compliance with the permit conditions.

10.4 An excavation which intercepts underground water

Note: The principles under section 10.4 have no force or effect unless a regulation provides that wells of this class require a permit.

263. The principles in section 10.4 apply to any excavation of any depth with a diameter of greater than or equal to one metre which does or will intercept underground water as measured at the autumn low of the underground water table, and is not an underground water access trench or 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*.

264. The principles in section 10.2 (*Well siting, construction and maintenance*) apply to any excavation of any depth with a diameter of less than one metre which does or will intercept underground water as measured at the autumn low of the underground water table.

265. When endorsing conditions on a permit for an excavation which intercepts under ground water, it is suggested that the Minister give consideration to endorsing the following conditions:

    a) Excavation works must be undertaken in a manner as recommended by the relevant authority, so as to prevent contamination of the water resource.

    b) An excavation must be, and must remain, until remediation works are completed:

        i. fenced sufficiently to prevent stock access;

        ii. maintained so as to prevent contamination of the water resource.

    c) Remediation of the excavation shall be completed within 12 months of the granting of a permit under this section, unless otherwise agreed to in writing by the relevant authority. For the purposes of this principle “remediation” means the back-filling of the excavation to above the underground water surface as measured at its autumn low or as specified by the relevant authority, preferably with the soil and/or rock initially removed during the excavation process, such that the underground water is no longer exposed.

d) Completion of the remediation works of the excavation must be reported within 30 days to the relevant authority, for inspection to ensure compliance with the permit conditions.

10.5. Managed Aquifer Recharge: 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") (section 127(3)(c) of the Act). These objectives are additional to those expressed for all water affecting activities.

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*.

Water drained or discharged into a well must comply with the *Environment Protection Act 1993* and any associated policy.

10.5.1 Objectives

a) To protect the underground water resource from waste or pollutants (as defined in the *Environment Protection (Water Quality) Policy 2009* under the *Environment Protection Act 1993*) 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.

10.5.2 Principles

266. The relevant authority will not grant a permit if the salinity of the drained or discharged water exceeds:

   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.

267. 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.

268. This risk assessment must be consistent with the *National Water Quality Management Strategy – Australian Guidelines for Water Recycling: Managing Health & Environmental Risks, Phase 1 2006,* and 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.

269. Water that is drained or discharged into a well by means of gravity is exempt from subprinciple a) of principle 268.

270. Roof runoff (surface water) drained or discharged into a well via a closed system of capture and transport is exempt from subprinciples a), c) and d) of principle 268, provided that the system is equipped with a mechanism to divert first flush water.

271. 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 subprinciples a), c) and d) of principle 268, provided reasonable and practicable measures have been applied to protect water quality.

272. Further to subprinciple b) of principle 268, 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.

273. Roof runoff captured in a closed system and then drained or discharged into a well is exempt from principle 272.

274. For the purposes of principle 268, 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 asnear as possible to the proposed point of injection.

275. For the purposes of principle 274, “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.

276. For the purposes of principle 272 and principle 274, 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.

277. When endorsing conditions on a permit, it is suggested that the Minister give consideration to endorsing the following conditions:

a) 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.

b) The head-works for the draining or discharge of water shall be constructed so that extraction and draining and discharge operations can be metered without interference.

c) The head-works for the draining or discharge of water shall be constructed so that water cannot leak if the well becomes clogged.

d) For the purposes of subprinciples b) and c) of principle 277, the term “head-works” means any assembly on top of a well located between the well casing and the water delivery system.

e) 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.

10.6 Managed Aquifer Recharge: Aquifer Storage and Recovery

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.

278. Managed aquifer recharge, including activities comprising aquifer storage and recovery developments is subject to principles 266-277 (*Managed Aquifer Recharge: Draining or discharging of water into a well*).

10.7 Importation of Water

The following objective 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.

10.7.1 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, downstream areas, water dependent ecosystems or the productive capacity of the land.

10.7.2 Principles

279. The relevant authority will not grant a permit for the use of imported water if to do so would:

    a) 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) have the potential to adversely affect the quality of the prescribed underground water resource;

    c) adversely affect the productive capacity of the land by causing salinity, water-logging, perched water tables or other impacts.

280. For the purposes of principle 279, the 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 the Plan, the reference points relate to the effectiveness of the policies and health of the underground water resource.

Therefore, there is a need to monitor and evaluate the effectiveness of the Plan's policies and the health and sustainability of the underground water resource.

Reporting and monitoring of underground water extraction by individual licensees is required to ensure that licensees do not use water in excess of the volume allocated on their water licences or forest water licence(s), or use water in contravention of the conditions of their licence(s). Under section 115 of the Act, penalties are payable in relation to the unauthorised or unlawful taking or use of water.

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 environmental water provisions.

11.1 Objectives

The monitoring strategy set out in the 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;

d) that water is used in accordance with the conditions on the water licences or forest water licences; and

e) the adequate protection of underground water dependent ecosystems.

11.2 Monitoring the capacity of the underground water resource

Existing monitoring network

DEWNR and its predecessors have undertaken regular water level and confined aquifer pressure monitoring in the LLC PWA since the late 1960s to early 1970s. Salinity monitoring has been less comprehensive.

Unconfined Aquifer

The unconfined aquifer water level monitoring network in the LLC PWA has been in operation for over 30 years, and is monitored by DEWNR. 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 2009/10, the unconfined aquifer water level monitoring network in the LLC PWA consisted of 472 wells. These wells are located in areas of highest risk to the underground water resource, such as around the Blue Lake, areas of intense underground water use for industry near Millicent, and some commercial forest areas where considerable water level declines are being observed (DFW 2011).

The unconfined aquifer salinity monitoring network in the LLC PWA consisted of 228 wells in 2009/10 (DFW 2011).

Monitoring is generally undertaken quarterly for both salinity and water level. Data collected is used to:

- determine trends in the condition of the unconfined aquifer;
- determine whether any resource condition triggers established for the Plan (Section 4.1.1 and Section 4.1.2) have been exceeded; and
- inform the implementation of the policy set out in the Plan, including an assessment of the risk to the resource from allocation and demand for water (Section 4.2.2) prior to 1 July 2019.

Table 11.1 summarises the number of monitoring wells and frequency of data collection for the unconfined aquifer.

Long term monitoring is also necessary to determine whether seawater intrusion is actively occurring in the Eight Mile Creek area and the areas where the interface between freshwater and seawater has been intersected.

TABLE 11.1 SUMMARYOF EXISTING UNCONFINED AQUIFER UNDERGROUND WATER MONITORING WELLS NETWORK AND MONITORING REQUIREMENTS AT A REGIONAL LEVEL

Property measured	Number of Observation Wells in the LLC PWA	Frequency	Responsible
Underground water level in the unconfined aquifer	472	Quarterly	Minister through DEWNR
Underground water salinity in the unconfined aquifer	228	Quarterly	Minister through DEWNR

Confined Aquifer

As at 2009/10, 94 water level/pressure confined aquifer monitoring wells were situated within the PWA, with most concentrated around and to the south east of Kingston SE, either side of the Princes Highway. This reflects the artesian nature of the aquifer in this area (DFW 2011).

The salinity monitoring network consisted of 33 wells at 2009/10, historically concentrated in the artesian area in the vicinity of and south east of Kingston SE. Monitoring is undertaken twice a year for both salinity and water level/pressure (DFW 2011).

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 LLC PWA	Frequency	Responsible
Underground water level in the confined aquifer	94	6 monthly	Minister through DEWNR
Underground water salinity in the confined aquifer	33	6 monthly	Minister through DEWNR

11.3 Monitoring the taking and use of underground water at the property level

Annual Water Use Report for non-forestry licensees

When endorsing conditions on a water licence, it is suggested that the Minister give consideration to endorsing the following conditions:

281. An Annual Water Use Report must be prepared by each non-forestry licensee and submitted to the Department of Environment, Water and Natural Resources, Mount Gambier office, by 5 p.m. of 31 July each year.

282. 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 (i.e. opening and closing meter readings);

c) the period of water use (i.e. 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 aquifer storage and recovery in the water use year (where applicable); and

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

i. the irrigation system type;

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 (e.g. neutron probes, external irrigation scheduling service, tensiometer etc.)

Annual Water Use Report for licensees with forest water licences

When endorsing conditions on a forest water licence, it is suggested that the Minister give consideration to endorsing the following conditions:

283. An Annual Water Use Report must be prepared by each forest water licensee and submitted to the Department of Environment, Water and Natural Resources, Mount Gambier office, by 5 p.m. of 31 July each year.

284. Each licensee must provide the following information in the Annual Water Use Report:

    a) the volume of water allocated on each forest water licence for recharge interception and direct underground water extraction;

    b) the purpose for which water has been taken;

    c) for each compartment on the forest water licence, and during the water use year:

        i. the location (GPS coordinates) and compartment numbers or identifiers;

        ii. species description and, for hardwood plantations, a description of whether coppiced or not;

        iii. area clearfelled in hectares and month and year when the clearfell was completed;

        iv. net planted area established in hectares and month and year established;

        v. net planted area in hectares for each compartment for recharge interception;

        vi. net planted area in hectares for each compartment for direct underground water extraction;

        vii. whether any area established is first rotation, or a second or a subsequent rotation plantation;

        viii. the deemed volume of water used by the licensee for recharge interception and, where applicable, direct underground water extraction, calculated in accordance with principles 105 – 108 (*Volume of allocation – minimum required for commercial forests*).

Evaluation of the demands on the resource and the capacity of the resource to meet demands

285. Once each year DEWNR should prepare a summary of the patterns in use of underground water.

286. Prior to 1 July 2019, the Board will undertake a review of the condition of the underground water resources (including both the confined and unconfined aquifers) in the LLC PWA, including:

    a) trends in underground water level salinity;

    b) trends in underground water table levels;

    c) trends in potentiometric pressure; and

    d) levels of underground water extraction.

The data collected will be used in a risk assessment process to determine whether any changes are required to the allocations of underground water.

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 LLC PWA should be consistent with the *National Natural Resource Management Monitoring and Evaluation Framework, Resource Condition Indicators (Inland Aquatic Ecosystem Integrity) (*NRM Ministerial Council 2002).

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 DEWNR 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.

The majority 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.

DEWNR 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 is also available. DEWNR 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 DEWNR and the Board.

DEWNR 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, the 13 priority underground water dependent ecosystem complexes identified in Table 10 (*Appendix of Figures and Tables*), and where possible, additional ecosystems identified in the SAWID as having high or very high ecological value within the PWA, should be included.

The purpose of the monitoring is to assess the success with which the environmental protection policy (principles 2-5 and 84-89) 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) species composition and abundance (flora and fauna);

e) species recruitment of both flora and fauna;

f) specific terrestrial and aquatic vegetation health; and

g) ecosystem water use.

Underground water monitoring wells and surface water level gauge boards were constructed by DEWNR in 2009 at each of the 13 priority wetland complexes listed in Table 10 (*Appendix of Figures and Tables*). Preliminary conceptual models of groundwater and surface water interactions at each of the priority wetland complexes have been developed (SKM 2010) and continue to be monitored and refined.

DEWNR established ecological monitoring protocols for high value underground water dependent wetlands of the South East NRM Region, including these wetland complexes (Ecological Associates 2010). Ecological Associates (2010) proposed a methodology to investigate gradual changes in vegetation communities from dryland areas to wetland areas. Transect surveys were proposed to investigate changes in the structure of vegetation

communities via monitoring the distribution of indicator species along a transect over time. Quadrat surveys were proposed to investigate changes in species composition (% cover) and richness over time.

Following this, the former Department of Environment and Natural Resources engaged Beacon Ecological (2010) to implement, test (collect baseline data) and refine a broad-range vegetation monitoring protocol at seven sites within five of the 13 priority wetland complexes:

- Trail Waterhole (Topperwein and Trail Waterhole Complex);
- Topperwein (Topperwein and Trail Waterhole Complex);
- Honan Scrub (Honan and Kangaroo Flat Complex);
- Middlepoint Swamp (Lower South East Rising Springs West Complex);
- Butchers Gap (Hog Lake Complex);
- Lake Robe (Robe to Beachport Coastal Lakes Complex); and
- Big Dip (Robe to Beachport Coastal Lakes Complex).

A field survey to implement, test (collect baseline data) and refine a broad-range vegetation monitoring protocol at the above sites was undertaken by two qualified botanists in April 2010.

11.5 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 commercial forests;
    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 for individual ecosystems dependent on underground water is required to better inform the determination of environmental protection policy. Environmental response functions describe the relationship between ecosystem function and water regimes in which the ecosystems

exist (e.g. 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 (for example 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 underground water dependent ecosystem to provide representative data);

b) proximity of the pumping wells 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.

11.6 Evaluation

The evaluation of monitoring data will need to focus on assessing the effectiveness of the policies of the Plan in maintaining the ecological function of ecosystems dependent on underground water as entered on the SAWID 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.

Evaluation and reporting of monitoring data for the 13 wetland complexes identified in Table 10 (*Appendix of Figures and Tables*) and for all high ecological value underground water dependent ecosystems identified for protection through the Plan, 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 and Bibliography

Beacon Ecological 2010, *Groundwater dependent ecosystem monitoring program: vegetation monitoring*, prepared for the Department for Environment and Heritage, June 2010.

Department for Water 2011, *Lower Limestone Coast PWA Groundwater Level and Salinity Status Report 2009-10*

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.

Ecological Associates 2010, *Monitoring the Ecological Response of High Value Wetlands to Changes in Groundwater*. Ecological Associates report CC017-2-B prepared for the Department of Environment and Heritage, South Australia.

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.

Natural Resource Management Ministerial Council 2002, *National Natural Resource Management Monitoring and Evaluation Framework,* 3 May 2002 meeting, last revised 8 April 2003.

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.

SKM (2010). *Conceptual Diagrams of Wetland Groundwater Dependent Ecosystems – GDE Monitoring Project South East, SA.* Report to Department for Water.

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.

12. Consistency with other Plans and Legislation

In preparing the 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,* the *Natural Resources Management (Commercial Forests) Amendment Act 2011,* 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 South East Natural Resources Management Board Regional Natural Resources Management Plan 2010;

f) the State Natural Resources Management Plan 2012;

g) Intergovernmental Agreement on a National Water Initiative 2004;

h) South Australia's Strategic Plan 2011;

i) Water For Good. A plan to ensure our water future to 2050.

Appendix of Figures and Tables

TABLE 1: SUMMARY OF THE WATER ACCOUNT FOR THE LOWER LIMESTONE COAST UNCONFINED AQUIFER (DRAFT)

Unconfined Management Area	Adopted Recharge Rate (mm/year)	Target Management Limit (TML) (ML/yr)	Total Available Recharge (if different to TML) (ML/yr)	Indicative Allocation Conversion of IEs (ML/yr) March 2012 + SPRs at June 2012					Existing Volumetric Allocations (ML/yr)	Holding Allocations (ML/yr)	Holding Forestry (ML)/yr	Indicative Allocation Non-Forestry (ML/yr)	Forestry Recharge Interception at June 2012 (ML/yr)	Forestry Direct Groundwater Extraction at June 2012 (ML/yr)	Farm Forestry RI & DGE (ML/yr)	Stock & Domestic (ML/yr)	Total losses ((total alloc + farm forestry + S&D)- DS)	Total Account (ML/yr) (total losses + DS)	Water Account Surplus/Deficit (ML/yr)
				Tradeable (ML/yr)	Forestry (ML/yr)	Delivery Supplement (ML/yr)	SPRs 2012 (ML/yr)	Total (ML/yr)											
BANGHAM	20	6,395	5,408	5,376	0	155	98	5,629	35	0	0	5,664	0	0	166	720	6,395	6,550	**0**
BEEAMMA	20	8,763	4,123	7,945	0	0	178	8,122	0	0	0	8,122	0	0	72	569	8,763	8,763	**0**
BENARA	170	37,749		7,059	0	510	209	7,778	3,739	2,586	0	14,103	6,569	1,478	47	1,192	22,879	23,388	**14,870**
BLANCHE CENTRAL	175	12,140		2,871	0	0	70	2,941	43	0	0	2,984	4,321	2	40	340	7,687	7,687	**4,453**
BOOL	105	4,417		1,382	0	0	0	1,382	268	498	0	2,148	0	0	9	215	2,371	2,371	**2,046**
BOWAKA	85	16,107		8,427	0	4,171	0	12,597	0	1,588	0	14,185	68	120	44	771	11,017	15,188	**5,089**
BRAY	90	17,118		1,745	0	492	0	2,237	2,091	3,738	0	8,066	576	151	3	988	9,292	9,784	**7,826**
COLES	120	25,228		5,316	386	897	0	6,599	683	1,015	911	8,297	16,764	24,492	217	479	50,264	51,161	**-25,036**
COMAUM	60	4,640	3,388	2,785	0	0	44	2,829	45	0	0	2,874	1,363	157	9	237	4,640	4,640	**0**
COMPTON	175	5,921		232	0	0	0	232	411	348	0	992	1,228	32	0	222	2,473	2,473	**3,448**
CONMURRA	95	29,764		10,231	0	3,461	0	13,692	3,832	5,844	0	23,368	1,174	909	894	1,184	24,068	27,529	**5,696**
DONOVANS	175	34,394		16,931	0	1,296	1,143	19,370	497	0	0	19,867	6,437	0	140	1,043	26,190	27,486	**8,203**
DUFFIELD	50	9,225		0	0	0	0	0	0	634	0	634	0	0	4	522	1,160	1,160	**8,064**
FOX	100	22,027	20,370	5,959	0	1,090	153	7,203	3,113	6,357	0	16,673	1,915	3,105	435	989	22,027	23,117	**0**
FRANCES	30	4,393		5,520	0	9	16	5,546	86	0	0	5,632	0	0	0	611	6,234	6,243	**-1,840**
GLENBURNIE	150	36,789		14,308	41	0	761	15,110	5,461	0	0	20,571	12,688	0	275	1,072	34,606	34,606	**2,183**
GLENROY	100	8,866	7,357	7,440	0	145	986	8,571	13	0		8,584	0	0	0	427	8,866	9,011	**0**
GREY	150	25,044		21,366	0	3,445	459	25,270	568	0	132	25,838	642	657	157	1,043	25,024	28,469	**20**
HACKS	125	5,229		4,756	0	1,640	0	6,396	0	0	0	6,396	0	0	0	214	4,970	6,610	**259**
HINDMARSH	150	31,276		7,488	0	0	475	7,962	629	437	0	9,028	15,888	3,606	287	735	29,544	29,544	**1,732**
HYNAM EAST	25	3,576		6,826	0	0	136	6,962	0	0	0	6,962	0	0	10	597	7,568	7,568	**-3,992**
HYNAM WEST	80	5,725		5,051	0	4,219	0	9,269	0	0	0	9,269	0	0	0	327	5,377	9,596	**348**
JOANNA	50	15,442	12,855	13,014	0	21	106	13,140	151	0	0	13,291	813	339	47	973	15,442	15,463	**0**
JOYCE	120	38,180		8,683	0	1,344	68	10,095	2,689	3,443	0	16,227	3,041	4,598	635	1,165	24,322	25,666	**13,857**
KENNION	120	25,271		3,324	0	903	54	4,280	1,117	9,981	745	15,378	2,923	2,703	262	1,004	22,113	23,016	**3,158**
KILLANOOLA	145	23,557	22,340	9,953	840	1,927	554	13,274	1,314	1,402	277	15,990	3,592	4,505	405	716	23,557	25,484	**0**
KONGORONG	170	32,676		11,438	0	828	778	13,044	496	0	0	13,540	9,571	466	427	908	24,083	24,911	**8,593**
LACEPEDE	100	18,014		833	0	0	1	833	559	4,506	0	5,898	0	0	0	739	6,637	6,637	**11,377**
LAKE GEORGE	75	7,975		1,104	0	0	43	1,147	300	2,616	0	4,063	0	0	156	586	4,805	4,805	**3,169**
LANDSEER	45	7,626		940	0	907	0	1,847	0	1,016	0	2,864	0	0	0	484	2,441	3,348	**5,185**
LOCHABER	90	18,916		2,533	0	0	0	2,533	2,457	3,220	0	8,210	0	0	68	851	9,130	9,130	**9,786**
MACDONNELL	150	24,410		19,730	0	1,498	1,226	22,453	538	0	0	22,991	10	0	10	1,043	22,557	24,055	**1,853**
MARCOLLAT	75	13,262		443	0	679	0	1,122	0	1,319	0	2,441	0	0	74	501	2,337	3,016	**10,924**
MAYURRA	110	19,430		1,452	0	0	0	1,452	2,620	4,484	0	8,556	0	0	39	1,126	9,721	9,721	**9,708**
MINECROW	75	18,387		2,750	0	1,988	0	4,738	230	4,033	0	9,001	0	0	232	977	8,222	10,210	**10,165**
MONBULLA	180	26,692		9,010	0	1,756	215	10,980	905	2,509	0	14,394	4,007	3,905	378	699	21,627	23,383	**5,064**
MOORAK	175	11,164		3,009	0	217	0	3,226	46	124	0	3,396	146	0	67	436	3,828	4,045	**7,336**
MOUNT BENSON	60	12,940		3,655	0	97	177	3,928	616	3,607	0	8,151	3,069	211	1	699	12,034	12,130	**906**
MOUNT MUIRHEAD	110	25,066		1,464	0	502	0	1,966	3,091	10,373	0	15,430	2,217	1,700	206	1,324	20,374	20,876	**4,692**
MOYHALL	105	5,565		1,170	0	978	0	2,148	25	1,039	0	3,211	0	0	6	256	2,496	3,473	**3,069**
MURRABINNA	90	13,919		86	0	83	0	168	1,388	3,057	0	4,614	0	0	0	642	5,173	5,256	**8,746**
MYORA	160	20,655		4,004	0	0	209	4,212	75	749	0	5,037	12,456	3,397	77	412	21,378	21,378	**-723**
ORMEROD	120	8,901		528	0	77	0	604	0	0	0	604	0	0	0	337	865	941	**8,037**
PEACOCK	70	19,666		0	0	0	0	0	0	2,581	0	2,581	0	0	8	766	3,355	3,355	**16,312**
RIDDOCH	130	28,633		9,947	0	2,499	114	12,560	814	1,364	0	14,738	9,153	1,040	140	1,003	23,575	26,074	**5,057**
RIVOLI BAY	100	14,029		196	0	0	33	229	415	5,214	0	5,858	206	103	26	895	7,088	7,088	**6,941**
ROSS	110	20,538		2,663	0	2,327	0	4,990	1	5,515	0	10,506	0	0	0	764	8,943	11,269	**11,595**
SHORT	150	30,597		8,266	3,945	5,763	36	18,011	14	313	147	18,338	17,926	21,421	845	531	53,444	59,207	**-22,846**
SMITH	100	17,154		1,942	0	1,022	0	2,964	0	9,004	0	11,968	617	909	10	895	13,377	14,400	**3,777**
SPENCE	115	32,643		2,817	0	1,708	0	4,525	1,186	5,218	819	10,929	4,004	5,736	210	1,010	21,000	22,708	**11,643**
STEWARTS	145	18,330	12,128	17,476	0	24,589	0	42,065	382	0	0	42,447	0	0	102	370	18,330	42,919	**0**
STRUAN	95	6,147		5,248	0	417	144	5,809	0	0	0	5,809	0	0	0	301	5,693	6,109	**454**
SYMON	110	22,498		2,416	0	0	0	2,416	1,355	6,575	0	10,346	1,471	557	1,107	1,005	14,487	14,487	**8,011**
TOWNSEND	85	20,970		5,221	0	2,892	3	8,117	1,401	3,298	0	12,816	0	0	128	988	11,040	13,932	**9,930**
WATERHOUSE	80	16,102		6,142	0	415	506	7,063	1,713	2,198	0	10,974	341	10	12	1,054	11,975	12,391	**4,127**
WESTERN FLAT	20	1,548	1,154	1,331	0	0	0	1,331	12	0	0	1,343	0	0	5	201	1,548	1,548	**0**
WOOLUMBOOL	90	25,182		1,793	0	1,733	0	3,526	20	5,763	0	9,309	0	0	456	1,105	9,137	10,870	**16,045**
YOUNG	200	30,273		2,361	0	29	98	2,487	848	2,291	337	5,626	8,509	3,123	313	734	18,612	18,641	**11,660**
ZONE 2A	140	66,015		24,358	101	216	1,043	25,718	1,389	324	0	27,431	29,340	8,610	848	1,754	67,767	67,982	**-1,752**
ZONE 3A	120	54,158		29,687	172	1,846	2,221	33,926	936	0	0	34,862	14,223	12,528	1,281	1,775	62,823	64,670	**-8,665**
ZONE 5A	40	18,780		23,902	0	173	695	24,770	618	0	0	25,388	0	0	66	1,832	27,113	27,286	**-8,332**
TOTAL		**1,186,097**		**393,899**	**5,486**	**80,959**	**13,052**	**493,395**	**51,235**	**130,183**	**3,368**	**674,813**	**197,266**	**110,568**	**11,454**	**47,355**	**963,865**	**1,044,825**	

Key to Table 1:

Red shaded = very high risk management areas
Orange shaded = high risk management areas

Adopted recharge rate and Total Available Recharge values from Latcham *et al.* (2007)

Forestry recharge interception values are calculated based on 100% recharge interception. The actual volume allocated to existing commercial forests in high and very high risk management areas will be calculated based on 100% recharge interception less a volume equivalent to the reductions required to allocations for that management area, or the deemed rates of recharge interception (78% for hardwoods, 83% for softwoods), whichever is the greater.

TABLE 2: RECHARGE INTERCEPTION ALLOCATIONS FOR EXISTING COMMERCIAL FORESTS

Unconfined aquifer management area	Recharge Interception allocation (ML/net productive hectare of commercial forest/year)*
BANGHAM	0.20
BEEAMMA	0.20
BENARA	1.70
BLANCHE CENTRAL	1.75
BOOL	1.05
BOWAKA	0.85
BRAY	0.90
COLES	1.20
COMAUM	0.60
COMPTON	1.75
CONMURRA	0.95
DONOVANS	1.75
DUFFIELD	0.50
FOX	1.00
FRANCES	0.30
GLENBURNIE	1.50
GLENROY	1.00
GREY	1.50
HACKS	1.25
HINDMARSH	1.50
HYNAM EAST	0.25
HYNAM WEST	0.80
JOANNA	0.50
JOYCE	1.20
KENNION	1.20
KILLANOOLA	1.45
KONGORONG	1.70
LACEPEDE	1.00
LAKE GEORGE	0.75
LANDSEER	0.45
LOCHABER	0.90
MACDONNELL	1.50
MARCOLLAT	0.75
MAYURRA	1.10
MINECROW	0.75
MONBULLA	1.80
MOORAK	1.75
MOUNT BENSON	0.60
MOUNT MUIRHEAD	1.10
MOYHALL	1.05
MURRABINNA	0.90

TABLE 2: RECHARGE INTERCEPTION ALLOCATIONS FOR EXISTING COMMERCIAL FORESTS

Unconfined aquifer management area	Recharge Interception allocation (ML/net productive hectare of commercial forest/year)*
MYORA	1.60
ORMEROD	1.20
PEACOCK	0.70
RIDDOCH	1.30
RIVOLI BAY	1.00
ROSS	1.10
SHORT	1.50
SMITH	1.00
SPENCE	1.15
STEWARTS	1.45
STRUAN	0.95
SYMON	1.10
TOWNSEND	0.85
WATERHOUSE	0.80
WESTERN FLAT	0.20
WOOLUMBOOL	0.90
YOUNG	2.00
ZONE 2A	1.40
ZONE 3A	1.20
ZONE 5A	0.40

*****Recharge interception allocation volume based on 100% recharge interception at canopy closure.

TABLE 3: MINIMUM VOLUME OF ALLOCATION REQUIRED FOR COMMERCIAL FORESTS

	Deemed Recharge Interception		Deemed Direct Underground Water Extraction		
	A	B	C	D	E
Unconfined aquifer management area	**Minimum volume hardwood (ML/net planted hectare of forest/year)**	**Minimum volume softwood (ML/net planted hectare of forest/year)**	**Minimum volume hardwood (ML/net planted hectare of forest/year)**	**Minimum volume hardwood when coppiced after date of declaration (ML/net planted hectare of forest/year)**	**Minimum volume softwood (ML/net planted hectare of forest/year)**
BANGHAM	0.16	0.17	1.82	2.50	1.66
BEEAMMA	0.16	0.17	1.82	2.50	1.66
BENARA	1.33	1.41	1.82	2.50	1.66
BLANCHE CENTRAL	1.37	1.45	1.82	2.50	1.66
BOOL	0.82	0.87	1.82	2.50	1.66
BOWAKA	0.66	0.71	1.82	2.50	1.66
BRAY	0.70	0.75	1.82	2.50	1.66
COLES	0.94	1.00	1.82	2.50	1.66
COMAUM	0.47	0.50	1.82	2.50	1.66
COMPTON	1.37	1.45	1.82	2.50	1.66
CONMURRA	0.74	0.79	1.82	2.50	1.66
DONOVANS	1.37	1.45	1.82	2.50	1.66
DUFFIELD	0.39	0.42	1.82	2.50	1.66
FOX	0.78	0.83	1.82	2.50	1.66
FRANCES	0.23	0.25	1.82	2.50	1.66
GLENBURNIE	1.17	1.25	1.82	2.50	1.66
GLENROY	0.78	0.83	1.82	2.50	1.66
GREY	1.17	1.25	1.82	2.50	1.66
HACKS	0.98	1.04	1.82	2.50	1.66
HINDMARSH	1.17	1.25	1.82	2.50	1.66
HYNAM EAST	0.20	0.21	1.82	2.50	1.66
HYNAM WEST	0.62	0.66	1.82	2.50	1.66
JOANNA	0.39	0.42	1.82	2.50	1.66
JOYCE	0.94	1.00	1.82	2.50	1.66
KENNION	0.94	1.00	1.82	2.50	1.66
KILLANOOLA	1.13	1.20	1.82	2.50	1.66
KONGORONG	1.33	1.41	1.82	2.50	1.66
LACEPEDE	0.78	0.83	1.82	2.50	1.66
LAKE GEORGE	0.59	0.62	1.82	2.50	1.66
LANDSEER	0.35	0.37	1.82	2.50	1.66
LOCHABER	0.70	0.75	1.82	2.50	1.66
MACDONNELL	1.17	1.25	1.82	2.50	1.66

TABLE 3: MINIMUM VOLUME OF ALLOCATION REQUIRED FOR COMMERCIAL FORESTS

	Deemed Recharge Interception		Deemed Direct Underground Water Extraction		
	A	B	C	D	E
Unconfined aquifer management area	**Minimum volume hardwood (ML/net planted hectare of forest/year)**	**Minimum volume softwood (ML/net planted hectare of forest/year)**	**Minimum volume hardwood (ML/net planted hectare of forest/year)**	**Minimum volume hardwood when coppiced after date of declaration (ML/net planted hectare of forest/year)**	**Minimum volume softwood (ML/net planted hectare of forest/year)**
MARCOLLAT	0.59	0.62	1.82	2.50	1.66
MAYURRA	0.86	0.91	1.82	2.50	1.66
MINECROW	0.59	0.62	1.82	2.50	1.66
MONBULLA	1.40	1.49	1.82	2.50	1.66
MOORAK	1.37	1.45	1.82	2.50	1.66
MOUNT BENSON	0.47	0.50	1.82	2.50	1.66
MOUNT MUIRHEAD	0.86	0.91	1.82	2.50	1.66
MOYHALL	0.82	0.87	1.82	2.50	1.66
MURRABINNA	0.70	0.75	1.82	2.50	1.66
MYORA	1.25	1.33	1.82	2.50	1.66
ORMEROD	0.94	1.00	1.82	2.50	1.66
PEACOCK	0.55	0.58	1.82	2.50	1.66
RIDDOCH	1.01	1.08	1.82	2.50	1.66
RIVOLI BAY	0.78	0.83	1.82	2.50	1.66
ROSS	0.86	0.91	1.82	2.50	1.66
SHORT	1.17	1.25	1.82	2.50	1.66
SMITH	0.78	0.83	1.82	2.50	1.66
SPENCE	0.90	0.95	1.82	2.50	1.66
STEWARTS	1.13	1.20	1.82	2.50	1.66
STRUAN	0.74	0.79	1.82	2.50	1.66
SYMON	0.86	0.91	1.82	2.50	1.66
TOWNSEND	0.66	0.71	1.82	2.50	1.66
WATERHOUSE	0.62	0.66	1.82	2.50	1.66
WESTERN FLAT	0.16	0.17	1.82	2.50	1.66
WOOLUMBOOL	0.70	0.75	1.82	2.50	1.66
YOUNG	1.56	1.66	1.82	2.50	1.66
ZONE 2A	1.09	1.16	1.82	2.50	1.66
ZONE 3A	0.94	1.00	1.82	2.50	1.66
ZONE 5A	0.31	0.33	1.82	2.50	1.66

TABLE 4: CALCULATION OF THE ADDITIONAL DEEMED RATES OF RECHARGE INTERCEPTION (ML/NET PLANTED HECTARE OF FOREST/YEAR)

Forest Type	Calculation of the Additional Deemed Rates of Recharge Interception (ML/net planted hectare of forest/year)
Hardwood	= [(100% - x)/100%] * [adopted recharge rate (in mm/year)/100] where x = [(120% x no. of additional years of forest fallow) + 120% + 80% + 40%] / (10 + no. of years of forest fallow); adopted recharge rate is as listed in Table 1 (*Appendix of Figures and Tables*), for the relevant management area.
Softwood	= [(100% -x)/100%] * [adopted recharge rate (in mm/year)/100] where x = [(120% x no. of additional years of forest fallow) + 120% + 100% + 80% + 60% + 40% + 20% + (50% x no. of forest thinnings)] / (35 + no. of years of forest fallow); adopted recharge rate is as listed in Table 1 (*Appendix of Figures and Tables*), for the relevant management area.

Note to Table 4:
The percentages in the calculation of x are the assumed recharge rates as a percentage of average annual vertical recharge for a given management area, as listed in Table 4.2 (*Assessment of the capacity of the resource to meet demand*).

TABLE 5: CONFINED AQUIFER - SUMMARY OF THE WATER ACCOUNT FOR THE LOWER LIMESTONE COAST PWA

A	B	C	D	E	F	G	H
Confined Aquifer Management Area	**PAV (ML/year)**	**TML (ML/year)**	**Stock and domestic requirements (ML/year)**	**Indicative allocation conversion of IE's (ML/year)**	**Total existing volumetric allocations (ML/year)**	**Total demand for water (ML/year) (D+E+F)**	**Water account (surplus/deficit) (ML/year) (C-G)**
Kalangadoo	3,900	3,900	78	2,562	509	3,149	751
Kingston	25,000	40,089	500	34,912	4,677	40,089	0
Lucindale	3,600	3,600	72	1,407	993	2,472	1,128
Millicent	10,800	10,800	216	5,622	1,202	7,040	3,760
Taratap	330	330	7	23	0	30	300
Fairview	290	290	6	0	0	6	284
Wirrega	960	960	19	0	225	244	716
Zone 1A	9,200	9,200	184	611	1,017	1,812	7,388
Zone 2A	2,900	2,900	58	0	1,455	1,513	1,387
Zone 3A	1,900	1,900	38	0	1,181	1,219	681
Zone 4A	710	710	14	81	0	95	615
Zone 5A	540	540	11	0	0	11	529
Zone 6A	360	360	7	0	17	24	336
Grand Total	**60,490**	**75,579**	**1,210**	**45,218**	**11,276**	**57,704**	**N/A**

Notes to Table 5:

1. Total Indicative Allocation Conversion of IE's is based on conversion to a volumetric system for all individual licences, with the tradeable component based on crop water requirements + 16% additional volume. Column E includes delivery supplements.
2. The above table does not include bridging volumes or specialised production requirements allocations that some licensees may choose to apply for under the terms of this Plan.

TABLE 6. VOLUMETRIC CONVERSION

A	B	C	D	E	F	G
VOLUMETRIC CONVERSION ZONE	**Tradeable component drip/spray/flood (ML/halE)****	**Delivery supplement (flood) (ML/halE)*****	**Delivery supplement (spray) (ML/halE)*****	**Drip Bridging Volume (ML/halE)**	**Flood Bridging Volume (ML/halE)**	**Spray Bridging Volume (ML/halE)**
BANGHAM	7.77	2.37	0.00	0.74	9.11	2.08
BEEAMMA	7.77	5.52	0.00	0.74	9.11	2.08
BENARA	5.68	1.74	0.43	0.54	2.65	1.91
BLANCHE CENTRAL	5.68	1.74	0.00	0.54	2.65	2.16
BOOL	7.13	6.34	0.00	0.68	9.59	1.66
BOWAKA	7.13	6.89	0.00	0.68	8.92	1.35
BRAY	6.37	6.15	0.00	0.60	7.96	2.75
COLES	6.77	6.55	0.00	N/A	N/A	N/A
COMAUM	6.77	2.07	0.00	0.64	9.11	1.58
COMPTON	5.68	1.74	0.00	0.54	2.65	2.16
CONMURRA	6.77	6.55	0.00	0.64	8.47	1.28
DONOVANS	5.68	1.73	0.43	0.54	2.65	1.91
DUFFIELD	7.77	7.50	0.00	0.74	9.72	3.35
FOX	6.77	6.55	0.00	0.64	8.47	1.28
FRANCES	7.42	2.27	0.00	N/A	N/A	N/A
GLENBURNIE	5.68	1.73	0.00	0.54	2.65	2.16
GLENROY	6.77	2.07	0.00	0.64	9.11	1.58
GREY	5.89	5.71	0.00	0.56	5.28	1.17
HACKS	7.13	6.34	0.00	0.68	9.59	1.66
HINDMARSH	5.68	1.74	0.00	0.54	2.65	2.16
HYNAM EAST	7.42	11.40	0.00	N/A	N/A	N/A
HYNAM WEST	7.42	11.40	0.00	0.70	7.30	1.22
JOANNA	6.77	2.07	0.00	0.64	3.15	2.22
JOYCE	7.13	6.89	0.00	0.68	6.40	1.41
KENNION	6.37	6.15	0.00	0.60	7.96	2.75
KILLANOOLA	6.77	6.55	0.00	0.64	6.07	1.34
KONGORONG	5.68	1.74	0.43	0.54	2.65	1.91
LACEPEDE	7.13	6.89	0.00	0.68	8.92	3.08
LAKE GEORGE	6.37	6.15	0.00	0.60	7.96	2.75
LANDSEER	7.77	7.50	0.00	0.74	9.72	1.47
LOCHABER	7.42	11.40	0.00	0.70	7.30	1.22
MACDONNELL	5.68	1.74	0.43	0.54	2.65	1.91
MARCOLLAT	7.77	11.91	0.00	0.74	7.64	1.27
MAYURRA	5.89	5.71	0.00	0.56	7.37	2.54
MINECROW	7.13	6.89	0.00	0.68	8.92	1.35
MONBULLA	6.37	6.15	0.00	0.60	5.71	1.26
MOORAK	5.68	1.74	0.43	0.54	2.65	1.91
MOUNT BENSON	7.13	6.89	0.00	0.68	8.92	3.08
MOUNT MUIRHEAD	5.89	5.71	0.00	0.56	7.37	2.54
MOYHALL	7.13	6.89	0.00	0.68	6.40	1.41
MURRABINNA	7.13	6.89	0.00	0.68	8.92	1.35
MYORA	5.68	1.73	0.00	N/A	N/A	N/A
ORMEROD	7.13	10.94	0.00	0.68	7.01	1.17
PEACOCK	7.77	7.50	0.00	0.74	9.72	1.47

TABLE 6. VOLUMETRIC CONVERSION

A	B	C	D	E	F	G
VOLUMETRIC CONVERSION ZONE	**Tradeable component drip/spray/flood (ML/halE)****	**Delivery supplement (flood) (ML/halE)*****	**Delivery supplement (spray) (ML/halE)*****	**Drip Bridging Volume (ML/halE)**	**Flood Bridging Volume (ML/halE)**	**Spray Bridging Volume (ML/halE)**
RIDDOCH	5.89	5.71	0.00	0.56	5.28	1.17
RIVOLI BAY	5.89	5.71	0.00	0.56	7.37	2.54
ROSS	6.77	6.55	0.00	0.64	8.47	1.28
SHORT	6.37	6.15	0.00	N/A	N/A	N/A
SMITH	6.37	6.15	0.00	0.60	7.96	1.21
SPENCE	7.13	6.89	0.00	0.68	6.40	1.41
STEWARTS	7.13	10.94	0.00	0.68	7.01	1.17
STRUAN	6.77	2.07	0.00	0.64	9.11	1.58
SYMON	5.89	5.71	0.00	0.56	7.37	2.54
TOWNSEND	7.13	6.89	0.00	0.68	8.92	1.35
WATERHOUSE	6.77	6.55	0.00	0.64	8.47	2.92
WESTERN FLAT	8.42	2.57	0.00	0.80	9.87	2.25
WOOLUMBOOL	7.42	7.18	0.00	0.70	9.28	1.41
YOUNG	5.68	1.74	0.00	0.54	2.65	2.16
ZONE 2A	5.89	1.80	0.00	N/A	N/A	N/A
ZONE 3A	6.37	1.94	0.00	N/A	N/A	N/A
ZONE 5A	7.13	2.18	0.00	N/A	N/A	N/A

Notes:

** Tradeable component calculated as (hectare irrigation equivalents x net irrigation requirement) + 16% for drip, spray and flood irrigation.

***Delivery supplement calculated as [(hectare irrigation equivalents x net irrigation requirement)] + volume required to deliver the net irrigation requirement] – tradeable component

TABLE 7: SPECIALISED PRODUCTION REQUIREMENTS (ML PER HECTARE OF CROP/INFRASTRUCTURE)

VOLUMETRIC CONVERSION ZONE	Grapevines - frost control	Fruit trees	Potatoes	Olives	Onions	Sub clover seed	Maximum Production Pasture		
							spray	flood	drip
BANGHAM	4.65	0.38	1.70	0.28	1.47	0.38	1.01	1.74	0.95
BEEAMMA	4.65	0.38	1.70	0.28	1.47	0.38	1.01	1.74	0.95
BENARA	4.65	0.38	1.35	0.28	1.10	0.31	1.44	1.74	1.25
BLANCHE CENTRAL	4.65	0.38	1.35	0.28	1.10	0.31	1.33	1.74	1.25
BOOL	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.14	1.07
BOWAKA	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
BRAY	4.65	0.38	1.35	0.28	1.10	0.31	1.27	2.51	1.20
COLES	4.65	0.38	1.70	0.28	1.47	0.38	1.20	2.37	1.13
COMAUM	4.65	0.38	1.70	0.28	1.47	0.38	1.20	2.27	1.13
COMPTON	4.65	0.38	1.35	0.28	1.10	0.31	1.44	1.74	1.25
CONMURRA	4.65	0.38	1.70	0.28	1.47	0.38	1.20	2.37	1.13
DONOVANS	4.65	0.38	1.35	0.28	1.10	0.31	1.44	1.74	1.25
DUFFIELD	4.65	0.38	1.70	0.28	1.47	0.38	1.01	2.00	0.95
FOX	4.65	0.38	1.70	0.28	1.47	0.38	1.20	2.37	1.13
FRANCES	4.65	0.38	1.70	0.28	1.47	0.38	1.07	1.40	1.01
GLENBURNIE	4.65	0.38	1.35	0.28	1.10	0.31	1.33	1.74	1.25
GLENROY	4.65	0.38	1.70	0.28	1.47	0.38	1.20	2.27	1.13
GREY	4.65	0.38	1.35	0.28	1.10	0.31	1.31	2.58	1.23
HACKS	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.14	1.07
HINDMARSH	4.65	0.38	1.35	0.28	1.10	0.31	1.33	1.74	1.25
HYNAM EAST	4.65	0.38	1.70	0.28	1.47	0.38	1.07	2.72	1.01
HYNAM WEST	4.65	0.38	1.70	0.28	1.47	0.38	1.07	2.72	1.01
JOANNA	4.65	0.38	1.70	0.28	1.47	0.38	1.20	1.57	1.13
JOYCE	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
KENNION	4.65	0.38	1.35	0.28	1.10	0.31	1.27	2.51	1.20
KILLANOOLA	4.65	0.38	1.70	0.28	1.47	0.38	1.20	2.37	1.13
KONGORONG	4.65	0.38	1.35	0.28	1.10	0.31	1.44	1.74	1.25
LACEPEDE	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
LAKE GEORGE	4.65	0.38	1.35	0.28	1.10	0.31	1.27	2.51	1.20
LANDSEER	4.65	0.38	1.70	0.28	1.47	0.38	1.01	2.00	0.95
LOCHABER	4.65	0.38	1.70	0.28	1.47	0.38	1.07	2.72	1.01
MACDONNELL	4.65	0.38	1.35	0.28	1.10	0.31	1.44	1.74	1.25
MARCOLLAT	4.65	0.38	1.70	0.28	1.47	0.38	1.01	2.57	0.95
MAYURRA	4.65	0.38	1.35	0.28	1.10	0.31	1.31	2.58	1.23
MINECROW	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07

TABLE 7: SPECIALISED PRODUCTION REQUIREMENTS (ML PER HECTARE OF CROP/INFRASTRUCTURE)

VOLUMETRIC CONVERSION ZONE	Grapevines - frost control	Fruit trees	Potatoes	Olives	Onions	Sub clover seed	Maximum Production Pasture		
							spray	flood	drip
MONBULLA	1.55	0.38	1.35	0.28	1.10	0.31	1.27	2.51	1.20
MOORAK	4.65	0.38	1.35	0.28	1.10	0.31	1.44	1.74	1.25
MOUNT BENSON	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
MOUNT MUIRHEAD	4.65	0.38	1.35	0.28	1.10	0.31	1.31	2.58	1.23
MOYHALL	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
MURRABINNA	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
MYORA	4.65	0.38	1.35	0.28	1.10	0.31	1.33	1.74	1.25
ORMEROD	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.87	1.07
PEACOCK	4.65	0.38	1.70	0.28	1.47	0.38	1.01	2.00	0.95
RIDDOCH	4.65	0.38	1.35	0.28	1.10	0.31	1.31	2.58	1.23
RIVOLI BAY	4.65	0.38	1.35	0.28	1.10	0.31	1.31	2.58	1.23
ROSS	4.65	0.38	1.70	0.28	1.47	0.38	1.20	2.37	1.13
SHORT	4.65	0.38	1.35	0.28	1.10	0.31	1.27	2.51	1.20
SMITH	4.65	0.38	1.35	0.28	1.10	0.31	1.27	2.51	1.20
SPENCE	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
STEWARTS	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.87	1.07
STRUAN	4.65	0.38	1.70	0.28	1.47	0.38	1.20	2.27	1.13
SYMON	4.65	0.38	1.35	0.28	1.10	0.31	1.31	2.58	1.23
TOWNSEND	4.65	0.38	1.70	0.28	1.47	0.38	1.13	2.23	1.07
WATERHOUSE	4.65	0.38	1.70	0.28	1.47	0.38	1.20	2.37	1.13
WESTERN FLAT	4.65	0.38	1.70	0.28	1.47	0.38	0.87	1.49	0.82
WOOLUMBOOL	4.65	0.38	1.70	0.28	1.47	0.38	1.07	2.11	1.01
YOUNG	4.65	0.38	1.35	0.28	1.10	0.31	1.33	1.74	1.25
ZONE 2A	4.65	0.38	1.35	0.28	1.10	0.31	1.31	1.71	1.23
ZONE 3A	4.65	0.38	1.35	0.28	1.10	0.31	1.27	2.41	1.20
ZONE 5A	4.65	0.38	1.70	0.28	1.47	0.38	1.13	1.48	1.07

TABLE 8: CROP ADJUSTMENT FACTOR (ML PER HECTARE OF CROP)

VOLUMETRIC CONVERSION ZONE	CORIANDER	FRUIT TREES	GRASS SEED	MAIZE	MUSTARD	NATIVE FLOWERS	NATIVE FOLIAGE	ONION
BANGHAM	1.03	1.94	0.00	2.15	0.00	2.33	0.76	0.99
BEEAMMA	1.03	1.94	0.00	2.15	0.00	2.33	0.76	0.99
BENARA	1.04	0.65	0.25	2.77	0.38	1.40	0.00	0.87
BLANCHE CENTRAL	1.04	0.65	0.25	2.77	0.38	1.40	0.00	0.87
BOOL	0.95	1.82	0.00	2.15	0.00	2.15	0.61	1.07
BOWAKA	1.19	0.52	0.00	2.60	0.31	1.90	0.36	0.61
BRAY	1.09	0.83	0.00	2.68	0.35	1.68	0.18	0.78
COLES	1.10	0.54	0.00	2.66	0.27	1.81	0.28	0.71
COMAUM	1.16	0.85	0.00	2.66	0.34	1.81	0.28	1.15
COMPTON	1.04	0.65	0.25	2.77	0.38	1.40	0.00	0.87
CONMURRA	1.10	0.54	0.00	2.66	0.27	1.81	0.28	0.71
DONOVANS	0.99	0.68	0.25	2.62	0.32	1.40	0.00	1.24
DUFFIELD	1.10	1.94	0.00	2.15	0.10	2.06	0.49	0.48
FOX	1.10	0.54	0.00	2.66	0.27	1.81	0.28	0.71
FRANCES	0.93	1.87	0.00	2.18	0.00	2.22	0.69	1.06
GLENBURNIE	0.99	0.68	0.25	2.62	0.32	1.40	0.00	1.24
GLENROY	1.16	0.85	0.00	2.66	0.34	1.81	0.28	1.15
GREY	1.04	0.73	0.20	2.59	0.35	1.46	0.00	0.81
HACKS	0.95	1.82	0.00	2.15	0.00	2.15	0.61	1.07
HINDMARSH	1.04	0.65	0.25	2.77	0.38	1.40	0.00	0.87
HYNAM EAST	0.93	1.87	0.00	2.18	0.00	2.22	0.69	1.06
HYNAM WEST	0.93	1.87	0.00	2.18	0.00	2.22	0.69	1.06
JOANNA	0.86	1.79	0.00	2.24	0.00	2.04	0.52	1.15
JOYCE	1.11	1.82	0.00	2.15	0.22	1.90	0.36	1.07
KENNION	1.09	0.83	0.00	2.68	0.35	1.68	0.18	0.78
KILLANOOLA	1.10	0.54	0.00	2.66	0.27	1.81	0.28	0.71
KONGORONG	1.04	0.65	0.25	2.77	0.38	1.40	0.00	0.87
LACEPEDE	1.11	1.82	0.00	2.15	0.22	1.90	0.36	1.07
LAKE GEORGE	1.13	0.78	0.00	2.85	0.39	1.68	0.18	0.78
LANDSEER	1.10	1.94	0.00	2.15	0.10	2.06	0.49	0.48
LOCHABER	1.00	1.87	0.00	2.18	0.00	1.97	0.43	0.57
MACDONNELL	1.04	0.65	0.25	2.77	0.38	1.40	0.00	0.87
MARCOLLAT	1.10	1.94	0.00	2.15	0.10	2.06	0.49	0.48
MAYURRA	1.07	0.69	0.20	2.75	0.39	1.46	0.00	0.81
MINECROW	1.11	1.82	0.00	2.15	0.22	1.90	0.36	1.07
MONBULLA	1.09	0.83	0.00	2.68	0.35	1.68	0.18	0.78
MOORAK	1.04	0.65	0.25	2.77	0.38	1.40	0.00	0.87
MOUNT BENSON	1.19	0.52	0.00	2.60	0.31	1.90	0.36	0.61
MOUNT MUIRHEAD	1.07	0.69	0.20	2.75	0.39	1.46	0.00	0.81
MOYHALL	0.95	1.82	0.00	2.15	0.00	2.15	0.61	1.07
MURRABINNA	1.11	1.82	0.00	2.15	0.22	1.90	0.36	1.07

TABLE 8: CROP ADJUSTMENT FACTOR (ML PER HECTARE OF CROP)

VOLUMETRIC CONVERSION ZONE	CORIANDER	FRUIT TREES	GRASS SEED	MAIZE	MUSTARD	NATIVE FLOWERS	NATIVE FOLIAGE	ONION
MYORA	0.99	0.68	0.25	2.62	0.32	1.40	0.00	1.24
ORMEROD	0.95	1.82	0.00	2.15	0.00	2.15	0.61	1.07
PEACOCK	1.05	1.96	0.00	2.28	0.00	2.06	0.45	0.60
RIDDOCH	1.07	0.69	0.20	2.75	0.39	1.46	0.00	0.81
RIVOLI BAY	1.07	0.69	0.20	2.75	0.39	1.46	0.00	0.81
ROSS	1.19	0.85	0.00	2.66	0.36	1.81	0.28	0.71
SHORT	1.09	0.83	0.00	2.68	0.35	1.68	0.18	0.78
SMITH	1.09	0.83	0.00	2.68	0.35	1.68	0.18	0.78
SPENCE	1.02	1.82	0.00	2.15	0.13	1.90	0.36	0.61
STEWARTS	0.95	1.82	0.00	2.15	0.00	2.15	0.61	1.07
STRUAN	0.86	1.79	0.00	2.24	0.00	2.04	0.52	1.15
SYMON	1.07	0.69	0.20	2.75	0.39	1.46	0.00	0.81
TOWNSEND	1.19	0.52	0.00	2.60	0.31	1.90	0.36	0.61
WATERHOUSE	1.19	0.85	0.00	2.66	0.36	1.81	0.28	0.71
WESTERN FLAT	1.12	2.00	0.00	2.09	0.00	2.45	0.87	0.84
WOOLUMBOOL	1.10	1.87	0.00	2.18	0.15	1.97	0.43	1.06
YOUNG	1.04	0.65	0.25	2.77	0.38	1.40	0.00	0.87
ZONE 2A	1.02	0.73	0.20	2.59	0.33	1.46	0.00	1.19
ZONE 3A	1.07	0.83	0.00	2.68	0.33	1.68	0.18	1.20
ZONE 5A	0.95	1.82	0.00	2.15	0.00	2.15	0.61	1.07

TABLE 9: UNDERGROUND WATER DEPENDENT WETLANDS OF HIGH OR VERY HIGH CONSERVATION VALUE IN THE LOWER LIMESTONE COAST PRESCRIBED WELLS AREA (AT NOVEMBER 2012)#

UNDERGROUND WATER DEPENDENT ECOSYSTEM	WETLAND COUNT*
Hog Lake and Butchers Gap Complex	12
Hacket Hill Complex	26
Green Swamp Complex	1
Kalandra Swamp Complex	6
Hanson Scrub	1
Grants Swamp	2
Fairview Wetland Complex	4
Dirty Joes	1
Deep Swamp Complex	13
Deadmans Swamp Complex	1
Cockatoo Lake & Clay Lake	13
Broadlands	1
Borderlands	1
Bool Lagoon Wetland Complex	8
Blackfellows Cave Wetland	2
Big Heath Complex	21
Del Fabbros Swamp Complex	3
West Avenue Complex	34
Toops Gap	1
Telford Scrub	3
Sheepwash Swamp	1
Robe to Beachport Coastal Lakes Complex	22
Reedy Creek	1
Naracoorte Range Wetland	1
Mosquito and Yelloch Creeks	2
Nangwarry & Horshoe Paddock	3
Moyhall Swamp	1
Mount Scott	2
Lake Frome & Mullins Swamp Complex	10
Marcollat Watercourse	15
Kangaroo Flat Complex	1
LSE Rising Springs Central Complex	3
LSE Rising Spring West Complex	3
Lower Coorong Lakes	3
Lochaber Swamp	1
Lake Ormerod	1
Yeulba Swamp Complex	2
Lake Hawdon Complex	14
Barnett Road & Rushy Swamp Complex	12
Lake Bonney & Bucks Lake Complex	12
Keilira Swamp	2
McInnes Wetland	1
Total	**267**

#: sourced from South Australian Wetland Inventory Database for the South East

* : Wetland count indicates the number of separate wetlands located within the complex as mapped in Figure 14 (*Appendix of Figures and Tables*). Some wetlands in this table form part of the same complex as the 13 priority wetlands.

TABLE 10: SETBACK DISTANCES FOR FIRST ROTATION COMMERCIAL FORESTS FROM THE 13 PRIORITY KEY WETLAND COMPLEXES

	Priority Wetland Complex	Management Area	Setback distance for newly established areas of commercial forests (metres)
1	Hog Lake Complex	Mount Benson	1,751
2	Robe to Beachport Coastal Lakes Complex	Waterhouse and Lake George	1,410
3	Lake Hawdon Complex	Bray, Waterhouse, Ross	1,410
4a	Mary Seymour Complex	Moyhall	2,330
4b	Bool Lagoon Wetland Complex	Bool	1,977
5	Deadmans Swamp Complex	Joanna	1,961
6	Green Swamp Complex	Monbulla	1,853
7	Topperwein and Trail Waterhole Complex	Zone 2A	1,640
8	Whennan Complex	Riddoch	1,098
9a	Overland Track Complex	Riddoch	1,098
9b	The Marshes Complex	Hindmarsh	1,684
10	Honan and Kangaroo Flat Complex	Young	1,439
11	Lower SE Rising Springs West Complex (Winterfield Creek, Middle Point Swamp)	MacDonnell, Kongorong	1,211
12	Lower SE Rising Springs Central Complex (Cress Creek Spring, Jerusalem Creek Spring, The Woolwash, Ewens Ponds Complex, Stratman Pond)	Donovans	1,169
13	Lower SE Rising Springs East Complex (Piccaninnie Ponds, Green Point, Pic Swamp)	Donovans	1,169

Figure 1. Prescribed Wells Areas – South East Natural Resources Management Region

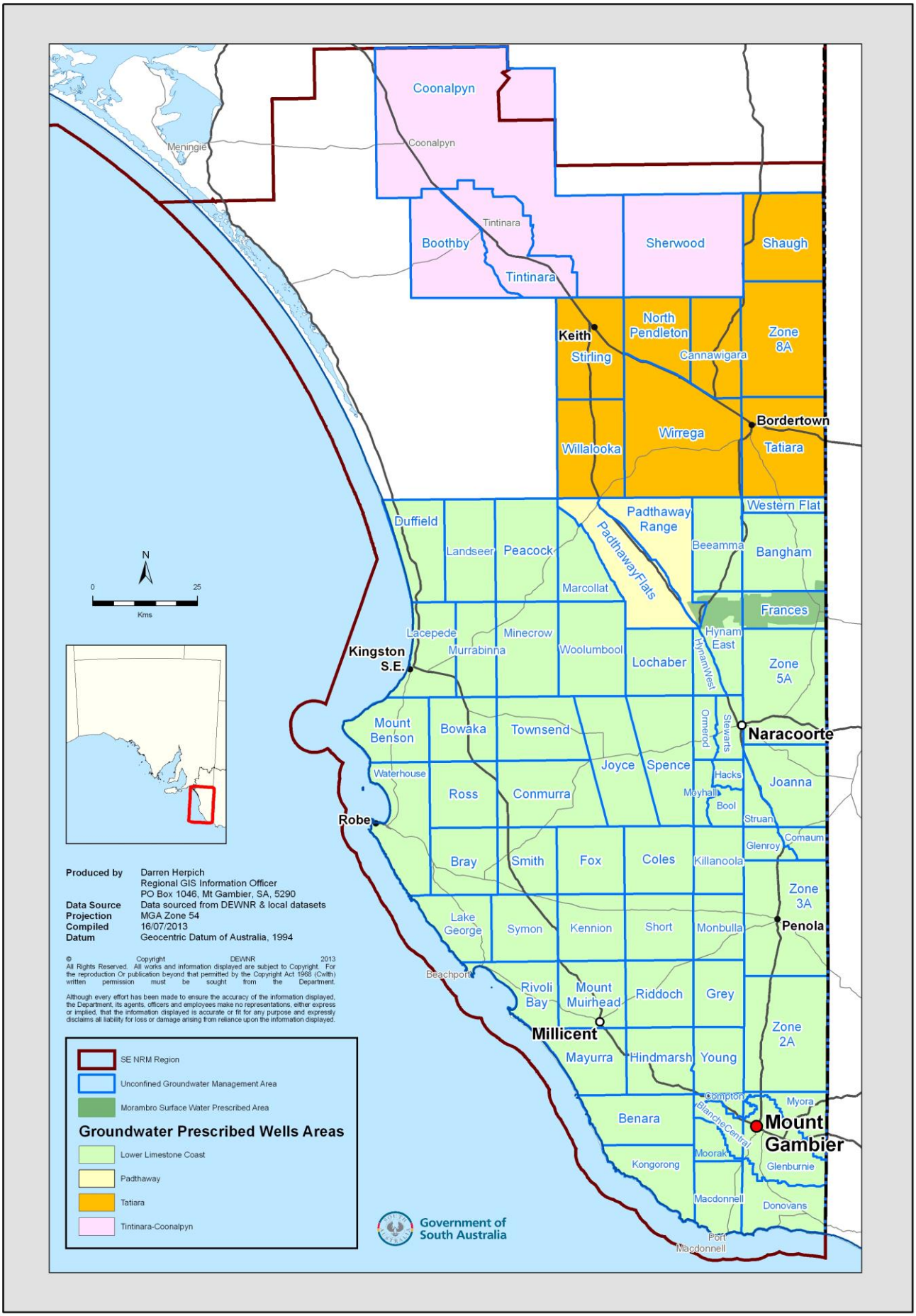


Figure 2. Unconfined aquifer management areas and Designated Area

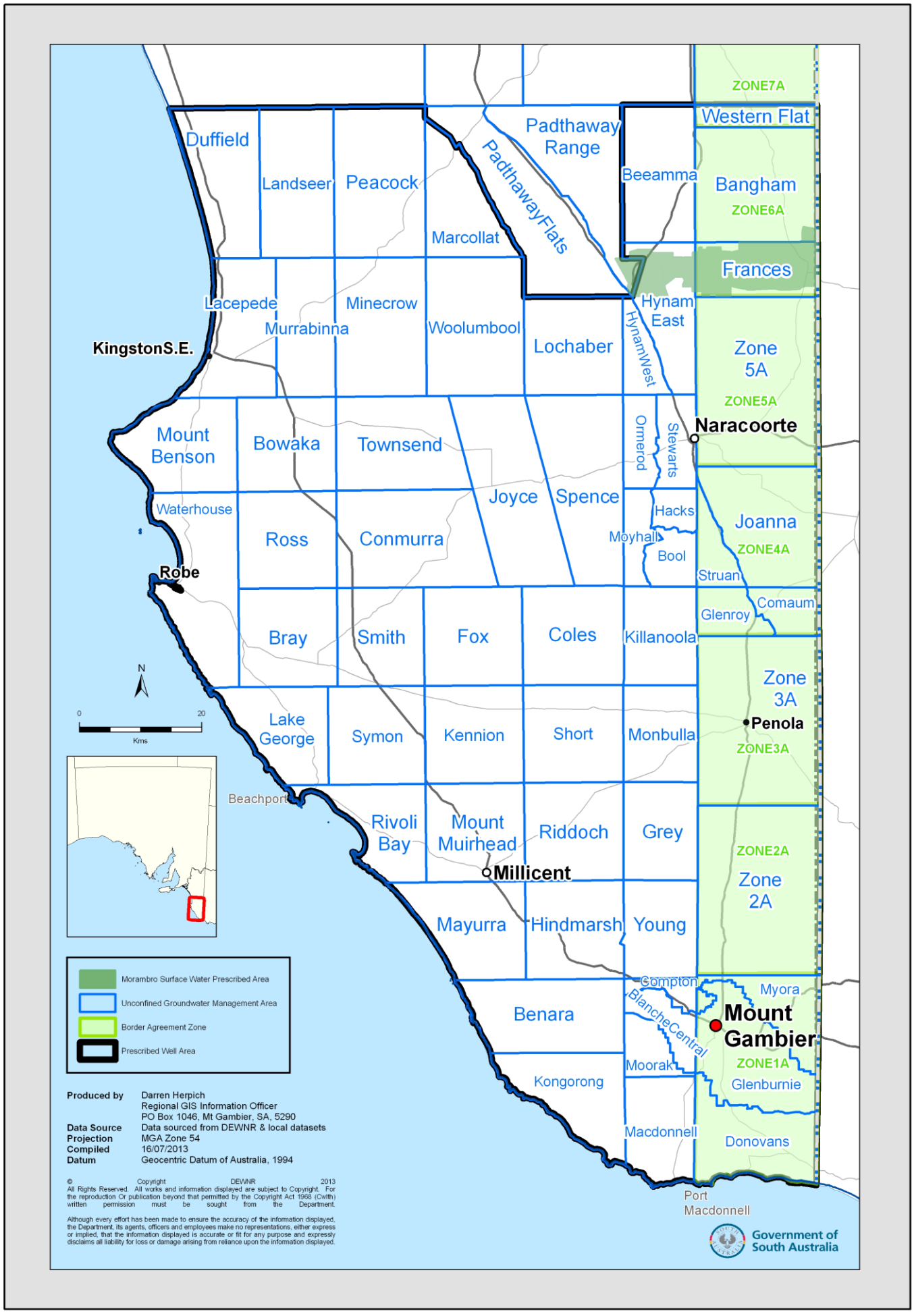


Figure 3. Confined aquifer management areas and Designated Area

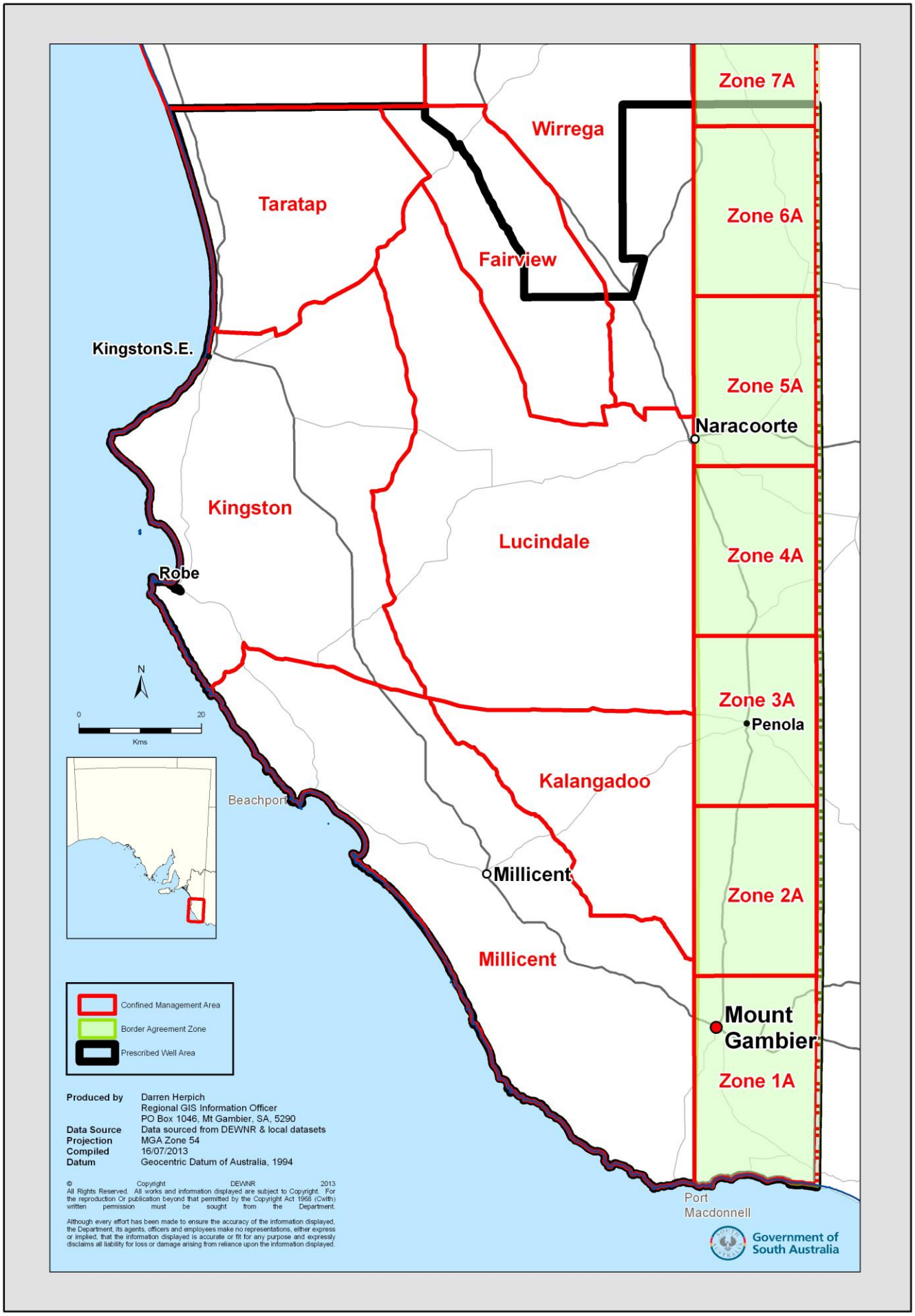


Figure 4. Types and categories of underground water dependent ecosystems (URS 2000)

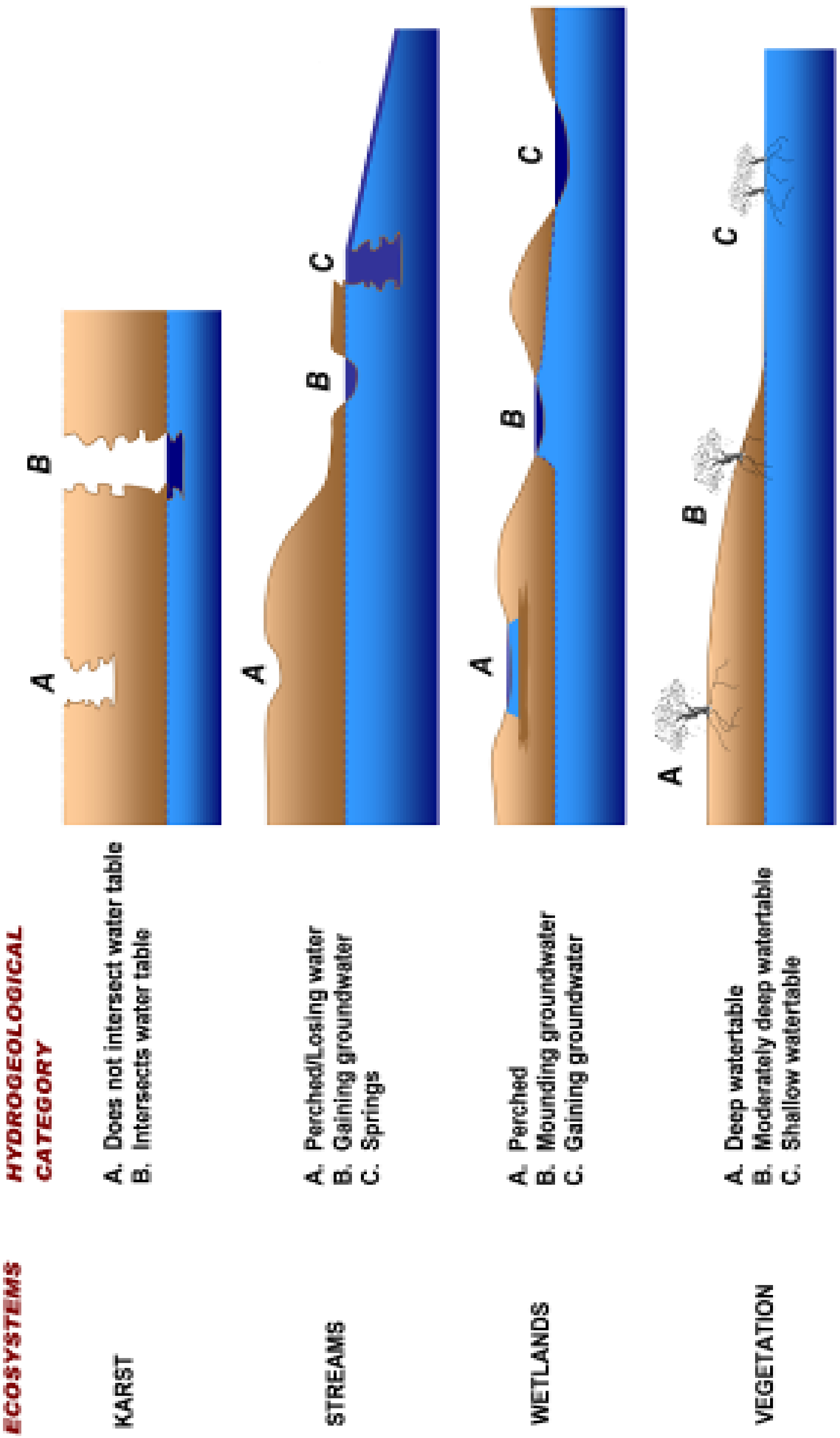


Figure 5. Groundwater level change and trend in the South East Tertiary Limestone Aquifer

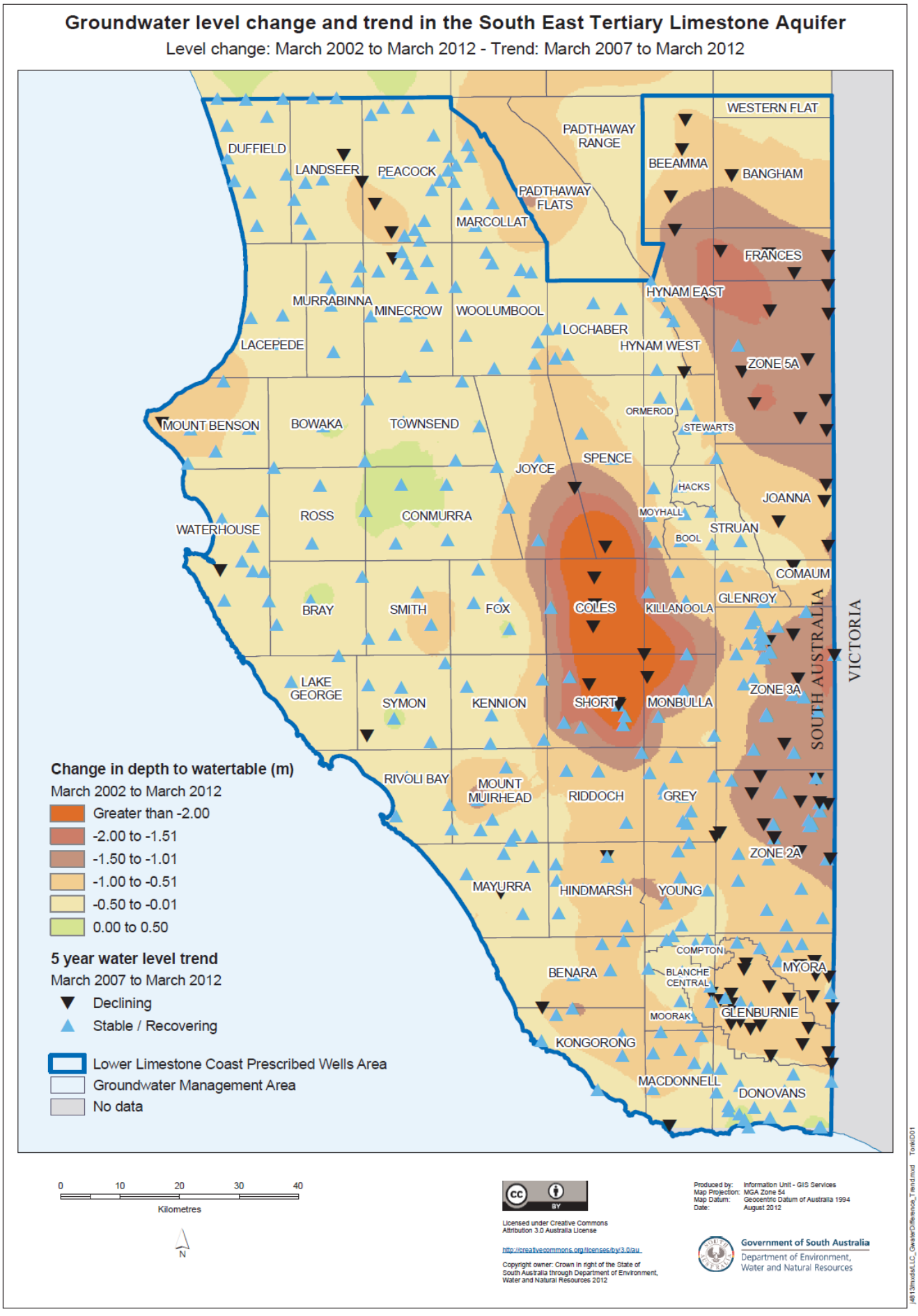


Figure 6. Five year groundwater level change in the South East Tertiary Confined Sand Aquifer

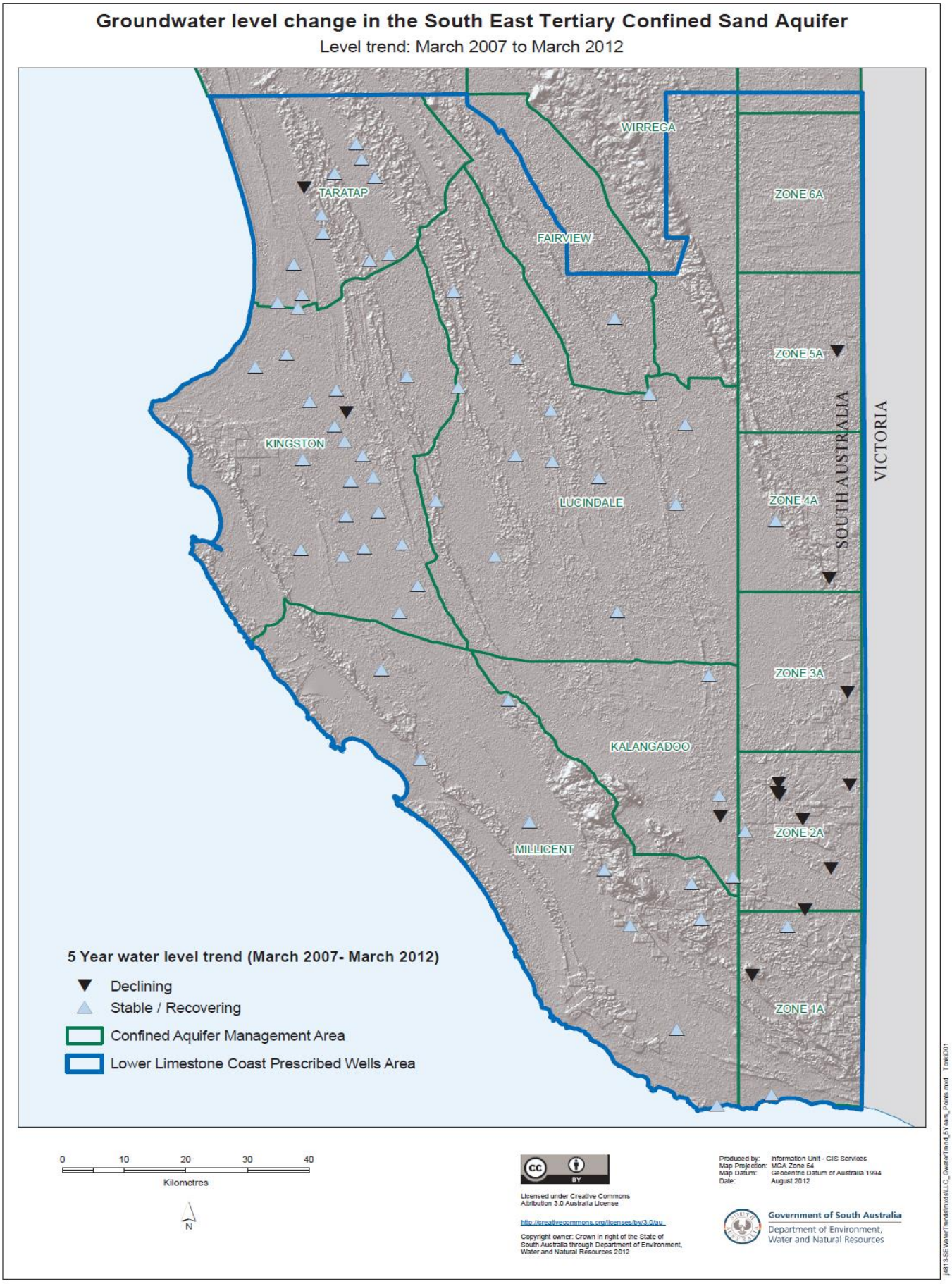


Figure 7. Ten year groundwater level change in the South East Tertiary Confined Sand Aquifer

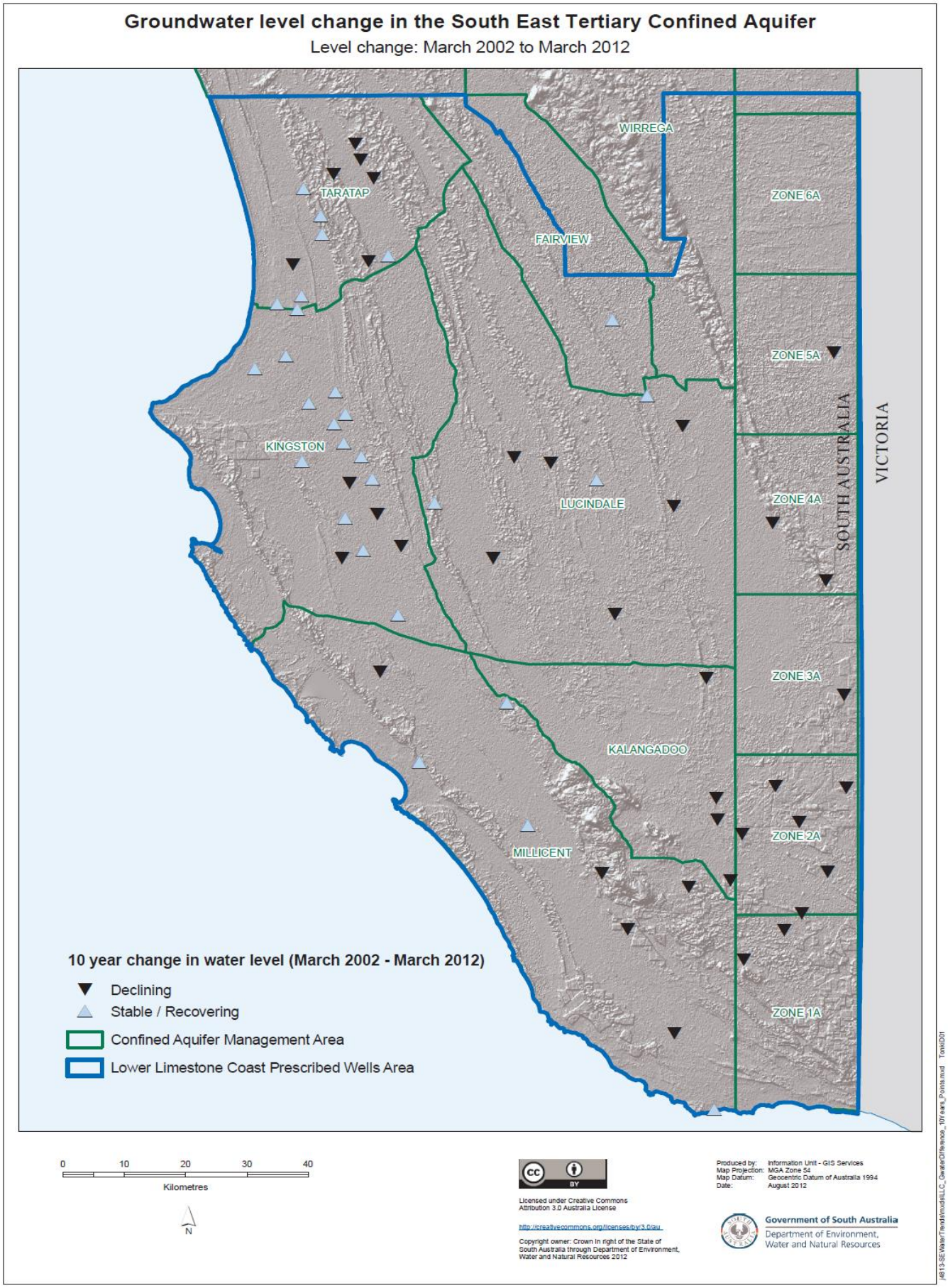
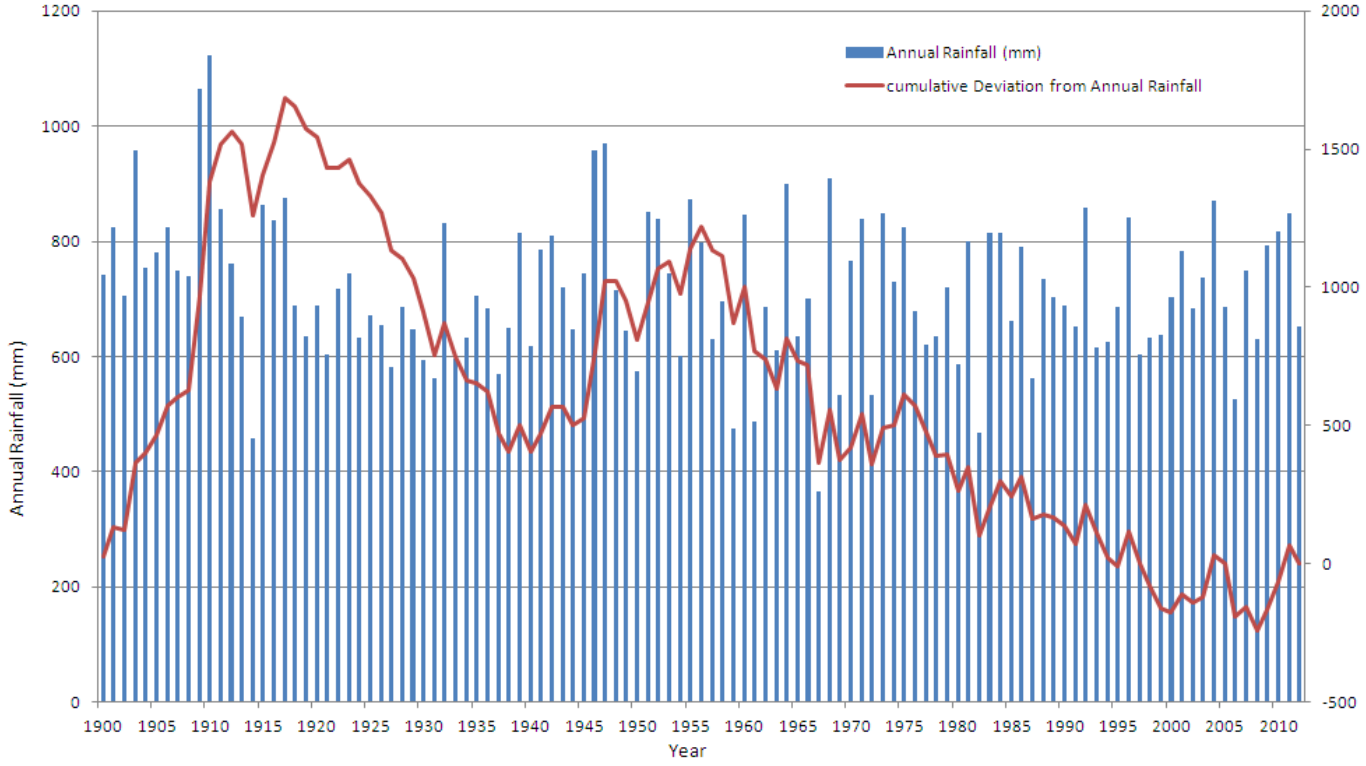


Figure 8. Monthly rainfall and cumulative deviation from mean annual rainfall



Note to Figure 8: 1900 to 1942 records from Station 026020 (Mt Gambier Post Office) and 1942 to 2012 records from station 026021 (Mt Gambier Airport).

Figure 9. Trends in unconfined aquifer underground water salinity

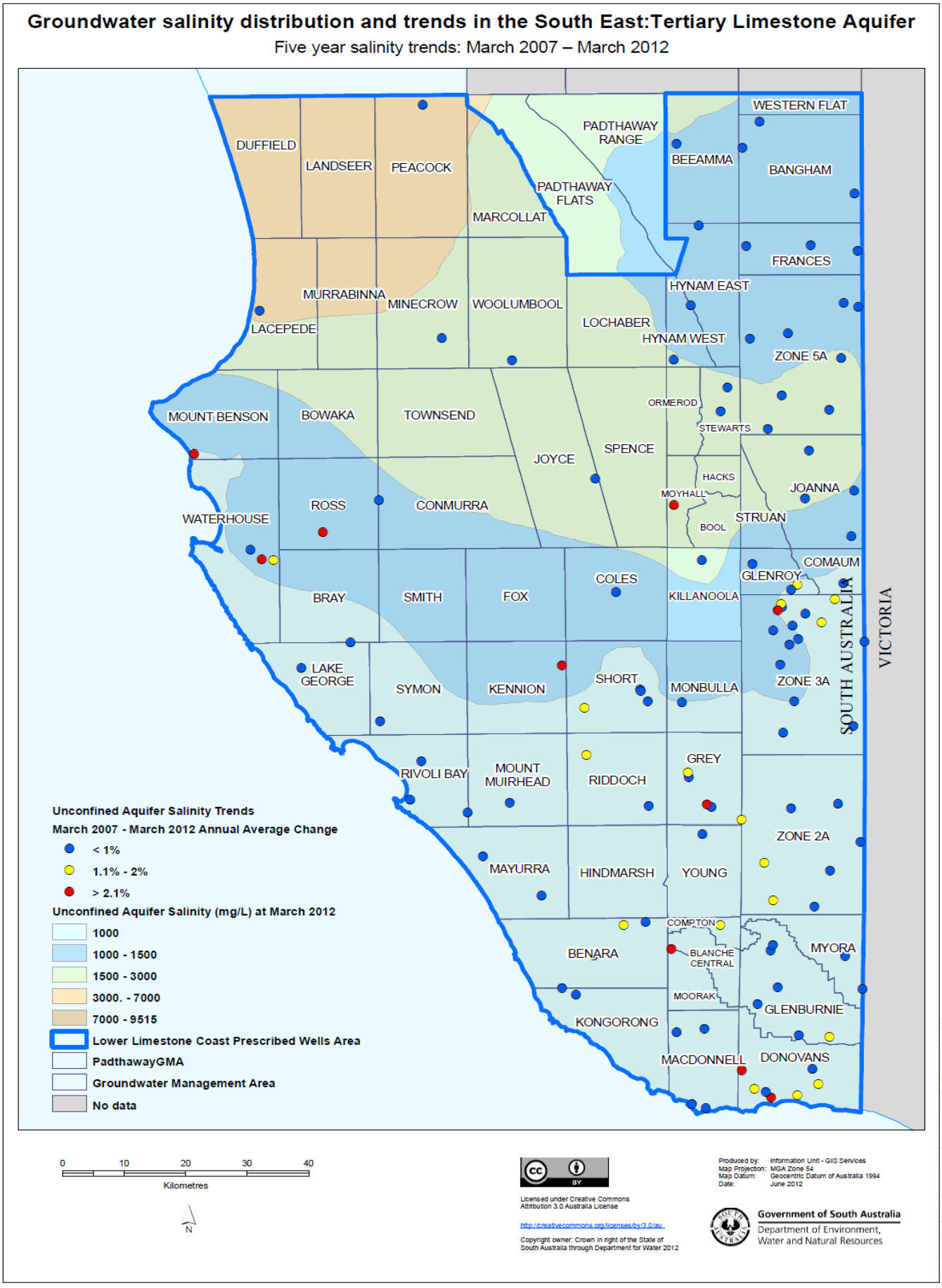


Figure 10. Trends in confined aquifer underground water salinity

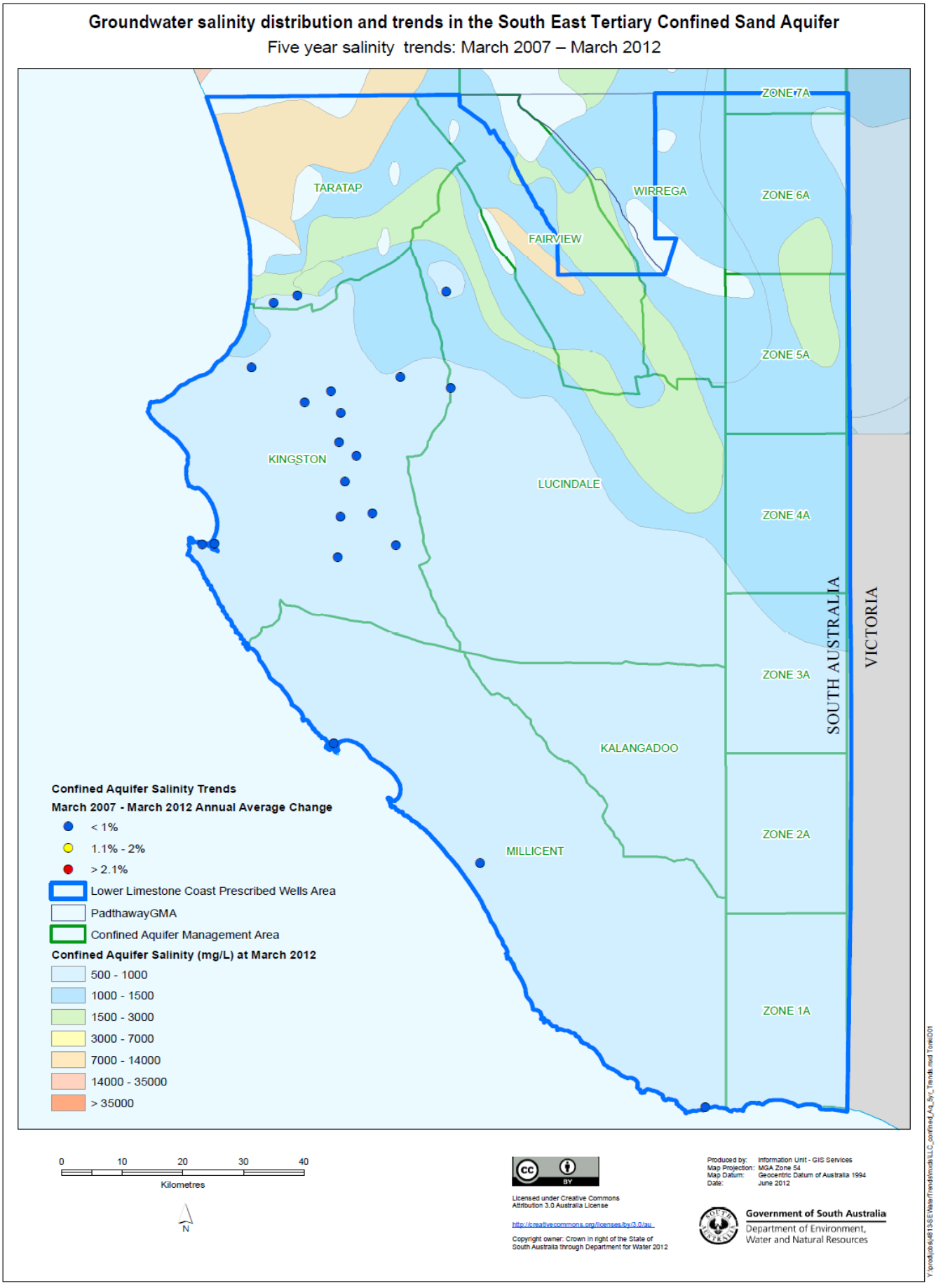


Figure 11. Volumetric conversion zones

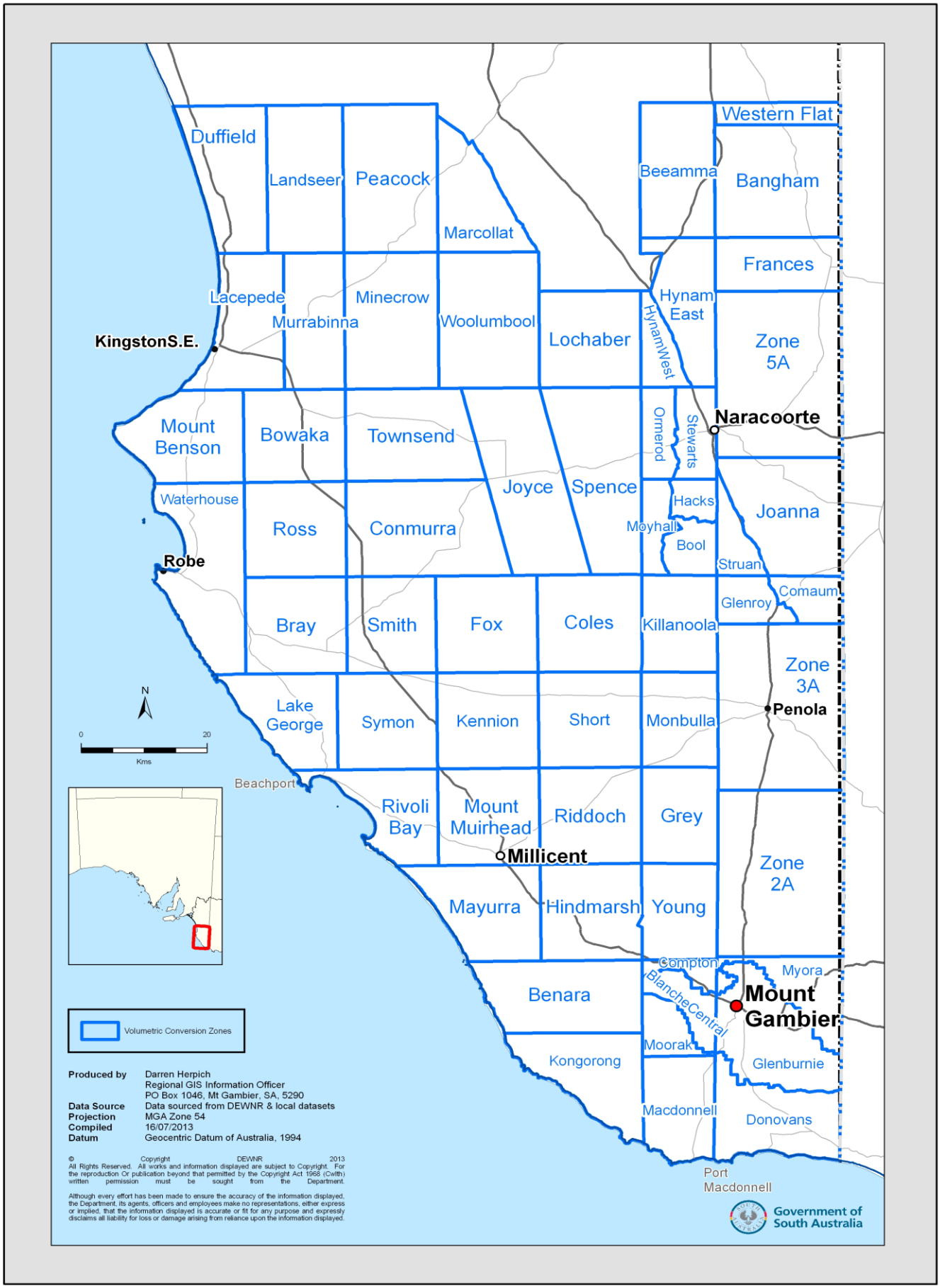


Figure 12. Depth to unconfined aquifer water table

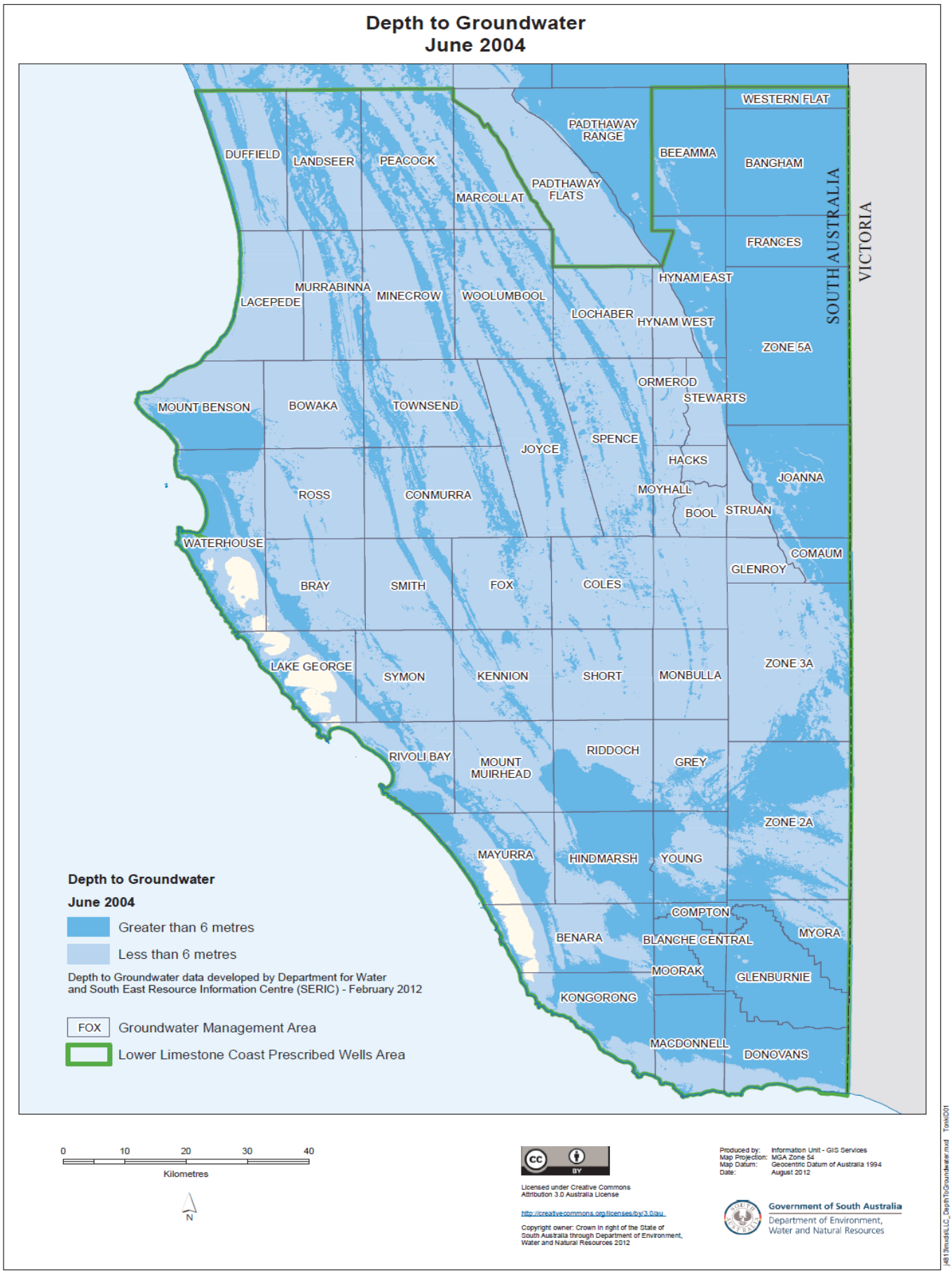


Figure 13. Blue Lake Capture and Buffer Zone

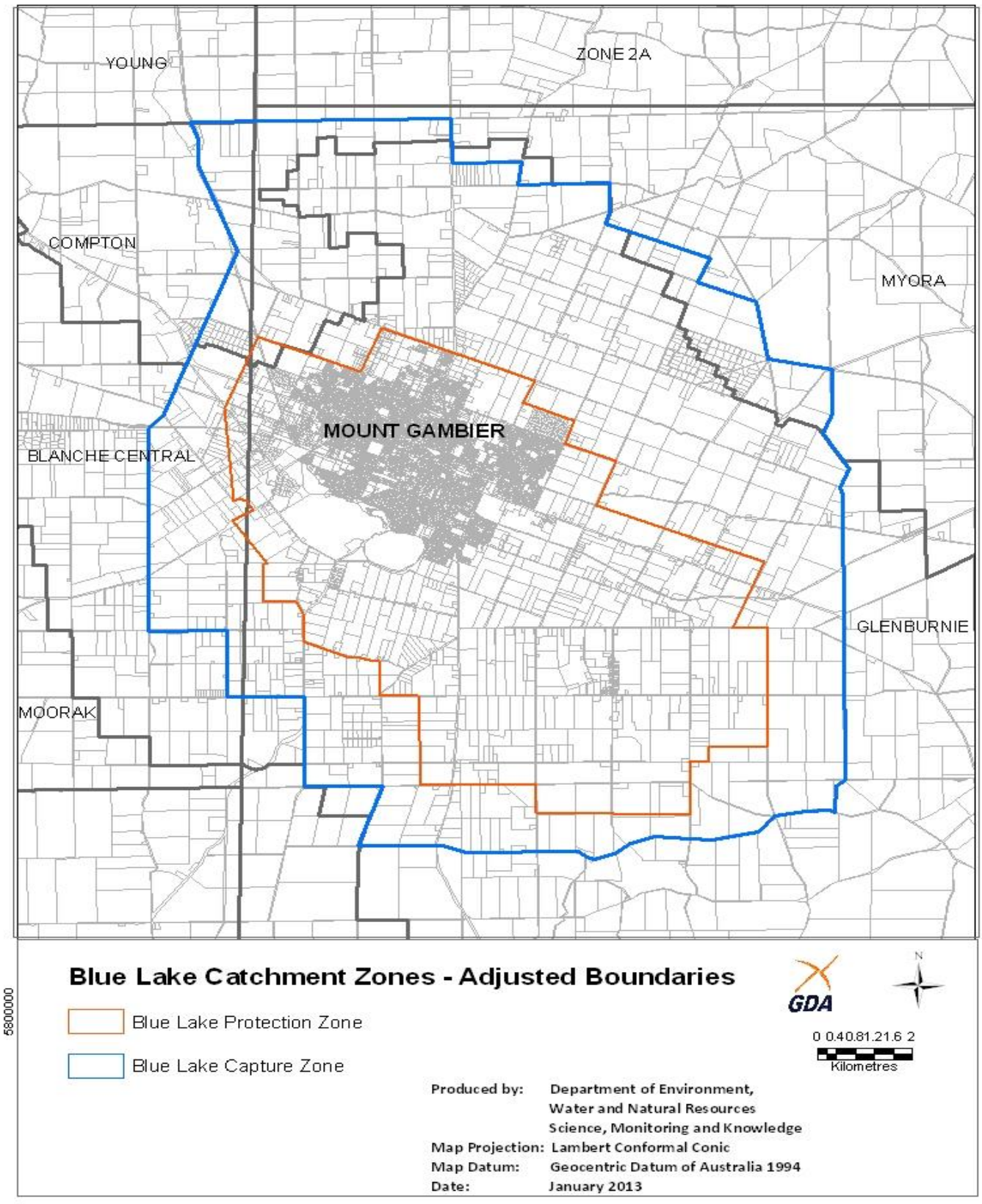


Figure 14. Underground water-dependent ecosystems of high ecological importance (including the 13 priority key wetland complexes)

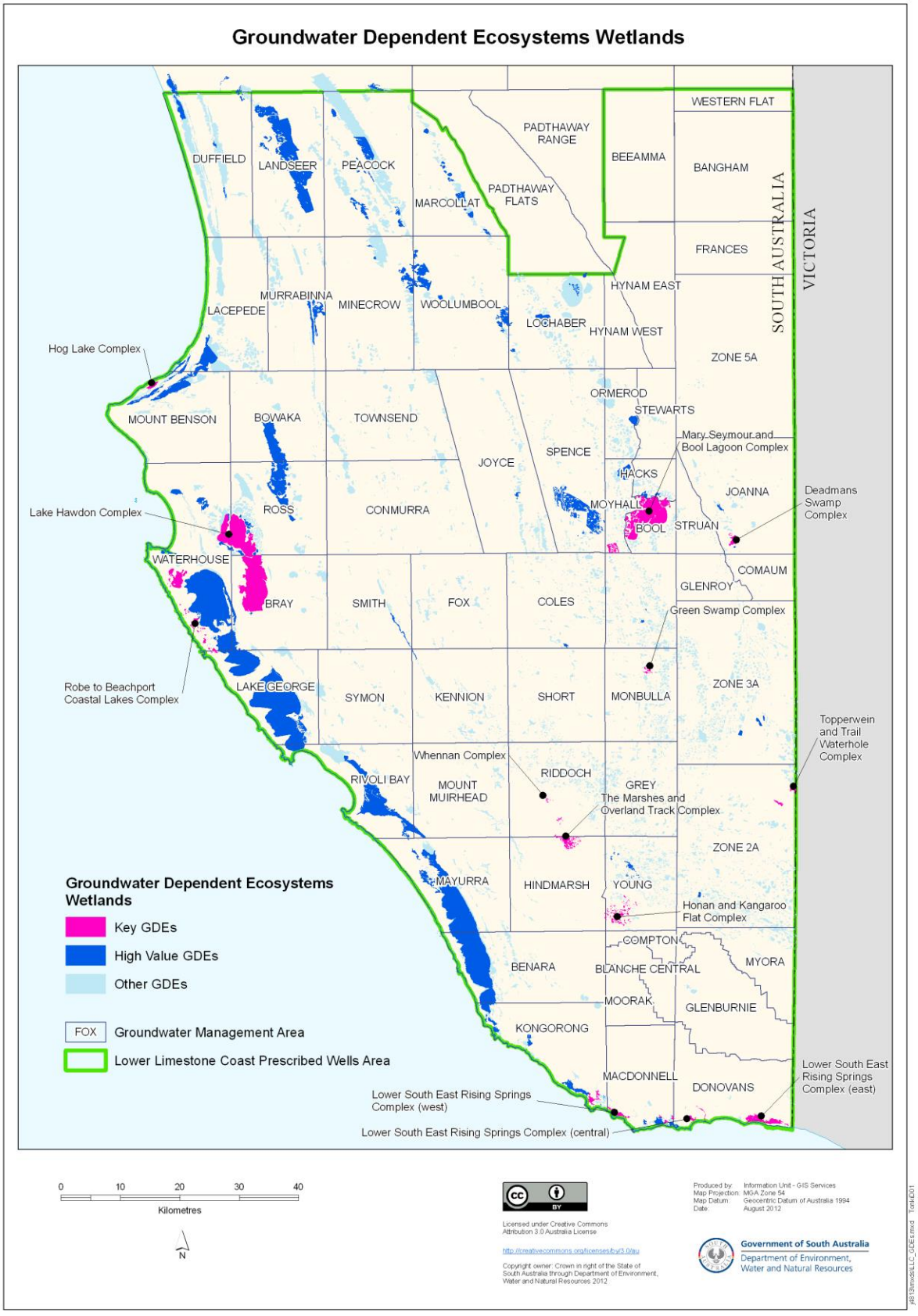


Figure 15. Unconfined aquifer saturated thickness