Adelaide Plains Water Allocation Plan

2022

Government of South Australia
Department for Environment and Water

GREEN ADELAIDE

LANDSCAPE SOUTH AUSTRALIA HILLS AND FLEURIEU

LANDSCAPE SOUTH AUSTRALIA NORTHERN AND YORKE

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Adelaide Plains
Water Allocation Plan

I, David Speirs MP, Minister for Environment and Water,
hereby appove this Water Allocation Plan pursuant to section 56(2)(a)
of the *Landscape South Australia Act 2019*.

This Water Allocation Plan will become operational
on 1 July 2022.

Minister for Environment and Water

Date: 16/02/2022

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1 Introduction

This document is the Adelaide Plains Water Allocation Plan (this Plan). The purpose of this Plan is to set out the management arrangements for the allocation and use of prescribed groundwater within the Adelaide Plains. It replaces the existing Water Allocation Plan for the Northern Adelaide Plains Prescribed Wells Area (2000), and will be the first water allocation plan for the Dry Creek and Central Adelaide Prescribed Wells Areas.

This Plan has been developed in accordance with:

- Section 52 of the *Landscape South Australia Act 2019* (the Landscape Act) which requires that when water resources are prescribed, a Water Allocation Plan must be developed for the prescribed water resources.
- State commitments under the *Intergovernmental Agreement on a National Water Initiative*, which is a national blueprint for water reform, particularly in relation to Objective 23 (iii and iv):
    - '*Statutory provision for environmental and other public benefit outcomes, and improved environmental management practices;*
    - *Complete the return of all currently over-allocated or overused systems to environmentally-sustainable levels of extraction*.'

1.1 Area and Water Resources Managed by this Plan

The groundwater resources managed by this Plan are located within three Prescribed Wells Areas, which lie within the Green Adelaide, Northern and Yorke, and Hills and Fleurieu Landscape regions, thereby covering the majority of the Adelaide metropolitan area (including the western hills face zone of the Mount Lofty Ranges). The Prescribed Wells Areas are described collectively as the Adelaide Plains and comprise:

- Northern Adelaide Plains Prescribed Wells Area (which includes the Northern Adelaide Plains Proclaimed Region and the Kangaroo Flat Area, delineated on GRO Plan No 429/2003. Gazetted on 22 July 2004, pages 2600-2602).
- Dry Creek Prescribed Wells Area (the area specified in the Gazette on 28 November 1996, page 1747).
- Central Adelaide Prescribed Wells Area (delineated on GRO Plan No 372/2005. Gazetted on 7 June 2007, pages 2573-2574).

This Plan's area stretches from Kangaroo Flat in the north, to the Onkaparinga River in the south, to the coast in the west, and to the top of the 'hills face zone' in the east, covering a total area of approximately 1,455 km^2. The boundaries of the three separate Prescribed Wells Areas covered by this Plan are shown in Figure 1.1.

Within this area, groundwater is contained within the sedimentary aquifers of the plains, and the fractured rock aquifers of the foothills and western slopes of the Mount Lofty Ranges. The types of groundwater resources are described in more detail in section 2.

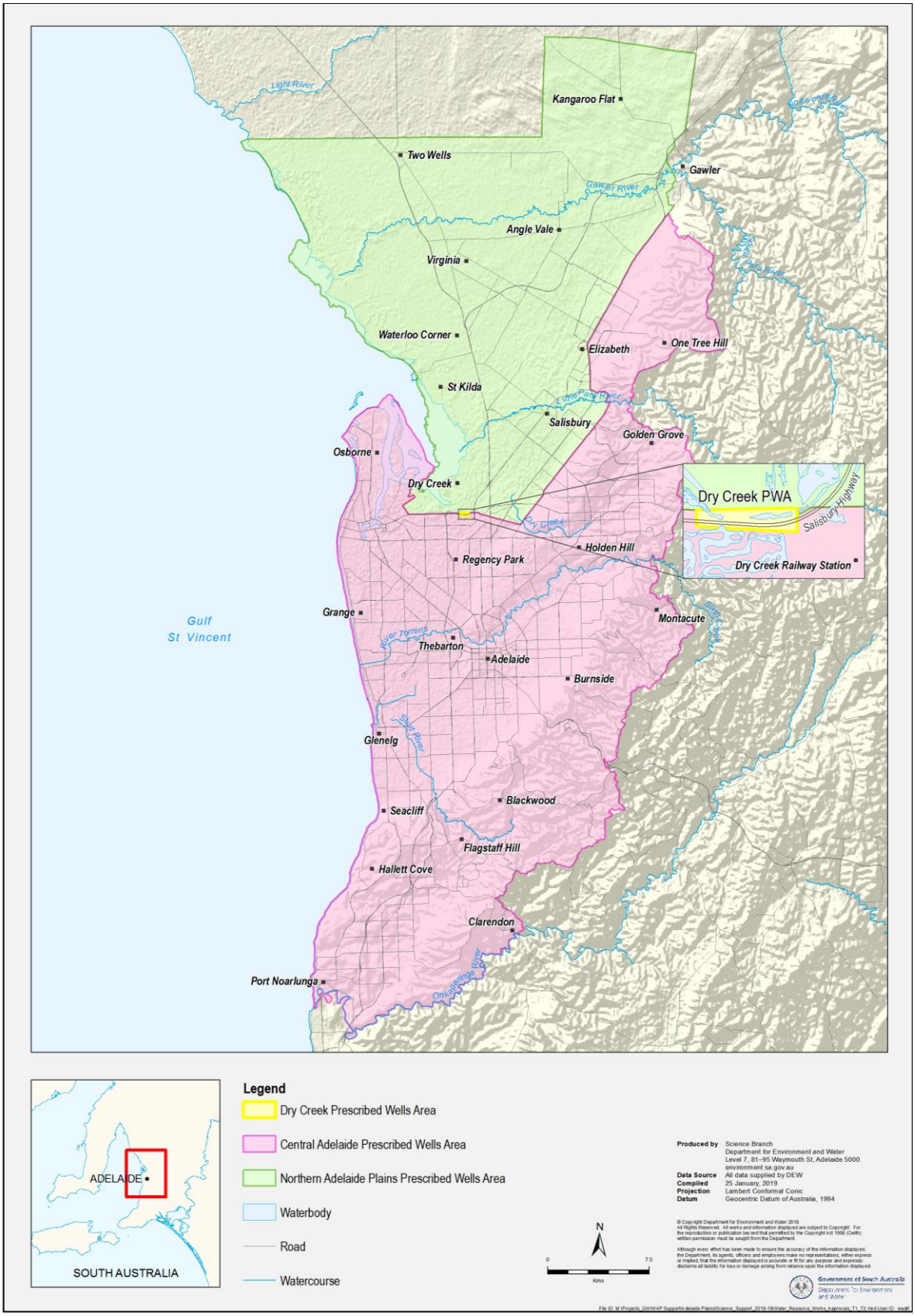

Figure 1.1. Prescribed Wells Areas of the Adelaide Plains

1.2 Objectives

The objectives of this Plan are to license, allocate and manage water in a manner which:

- Ensures that groundwater resources are managed within acceptable resource condition limits.
- Provides for the flexible and variable use of groundwater at times and in areas where needed to maximise economic and social outcomes.
- Maintains groundwater-dependent ecosystems at a low level of risk.
- Provides security of water access entitlements to users of the resource.
- Supports the Managed Aquifer Recharge industry by maximising security and certainty of access to recharged water and establishes a flexible, case-by-case approach to Managed Aquifer Recharge without compromising other water users.
- Ensures the use of effluent or imported water presents only a low level of risk to groundwater-dependent ecosystems or the productive capacity of the land.

1.3 Steps in Developing this Plan

1.3.1 Prescription and issuing of licences

The establishment of a prescribed wells area for the first time initiates a process to issue new water licences to eligible existing groundwater users. Whilst water licences have already been in place for decades in the Northern Adelaide Plains Prescribed Wells Area, and for some time in the Dry Creek Prescribed Wells Area, they are being (or have recently been) issued for the first time to existing users in the Central Adelaide Prescribed Wells Area and the Kangaroo Flat section of the Northern Adelaide Plains Prescribed Wells Area. The licensing process is the responsibility of the Minister for Environment and Water through the Department, and has been conducted as a separate process to the development of this Plan.

1.3.2 Scientific investigations

This Plan draws on the results of multiple scientific investigations, which include the use of a groundwater model developed by the Department and designed to test the possible impact on groundwater levels and salinity from various extraction scenarios. Issues that were investigated include:

- requirements of groundwater-dependent ecosystems[1]
- surface water/groundwater interactions[2]
- impacts of extraction[3,4,5]

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[1] Sinclair Knight Merz (2012). Environmental water provisions for the groundwater-dependent ecosystems of the Adelaide Plains.

[2] Sinclair Knight Merz (2011). Adelaide Plains Groundwater Investigation Projects Part 3: Surface water/groundwater interactions.

[3] Department of Environment, Water and Natural Resources (2017). Estimation of groundwater resource capacity and recommended extraction limits for the Adelaide Plains Water Allocation Plan, DEWNR Technical Report 2017/03, Government of South Australia through Department of Environment, Water and Natural Resources, Adelaide.

[4] Department for Environment and Water (2020). Estimation of groundwater resource capacity and recommended extraction limits for the Adelaide Plains Water Allocation Plan: Addendum 2020, DEW Technical Report 2020/17, Government of South Australia, Adelaide.

[5] Department for Environment and Water (2021). Investigating the use of resource condition trigger levels for groundwater management in the Adelaide Plains Water Allocation Plan, DEW Technical Report 2021/13, Government of South Australia, Department for Environment and Water, Adelaide.

- climate change impacts on groundwater resources[6]
- monitoring requirements.

1.3.3 Investigation of consumptive demand

The current and possible future demand for groundwater for consumptive purposes were considered. The information obtained included:

- volumes allocated for licensed extraction (Northern Adelaide Plains and Dry Creek Prescribed Wells Areas), or allocations to be issued in relation to the existing user water requirements (Central Adelaide Prescribed Wells Area)
- data from metered extraction (Northern Adelaide Plains and Dry Creek Prescribed Wells Areas)
- estimation of non-licensed demand for stock or domestic uses (Central Adelaide Prescribed Wells Area), forestry and other non-licensed uses of groundwater[7]
- consultation with stakeholders about the quality, quantity and reliability of the supply of groundwater required for current enterprises.

1.3.4 Analysis of risk

The development of this Plan included the consideration of risks to the groundwater resources, the environment, community values, and the ability to implement this Plan's principles (Table 1.1). The key risks were analysed and where possible measures were developed to mitigate these risks.

Table 1.1. Risk assessment

Category of risk	Processes to analyse risk	Measures to address risks in the Plan
Risks to the groundwater resources	Risks to aquifers and groundwater resources were identified through a review of scientific literature and modelling of extraction scenarios on the groundwater model 'AP2011'[8].	Sustainable extraction limits and management policies have been set to ensure a low level of risk to groundwater resources over the next 30 years.
Risk to groundwater-dependent ecosystems	A risk analysis was undertaken to identify the values of groundwater-dependent ecosystems, their level of dependence on groundwater, and the threats to those ecosystems.[9]	Management policies have been designed to maintain groundwater-dependent ecosystems at a low level of risk.
Risks to community values	Consultation on the impacts of the proposed management policies was undertaken, particularly focused on the areas of intense water use in the Northern Adelaide Plains.	Management policies have been chosen to minimise social and economic impacts and maximise the ability to adapt to changing seasonal and climate conditions.
Risks to the implementation of this Plan	Consultation with the Department about the ability to administer water licences and permits, undertake compliance actions	Where possible, principles in this Plan were developed in

[6] Harding C, Deane D, Green G, Kretschmer P (2015). Impacts of Climate Change on Water Resources in South Australia Phase 4, Volume 2 DEWNR Technical report 2015/01, Government of South Australia through Department of Environment, Water and Natural Resources, Adelaide.

[7] Australian Groundwater Technologies (2011). Estimating non-licensed groundwater use across the Adelaide Plains Prescribed Wells Area.

[8] RPS Aquaterra (2011). Adelaide Plains groundwater flow and solute transport model.

[9] Sinclair Knight Merz, (2010). Groundwater-dependent environmental assets of the Adelaide Plains and McLaren Vale (Stage 1).

Category of risk	Processes to analyse risk	Measures to address risks in the Plan
	concerning licence and permit conditions, and continue monitoring of groundwater condition.	consideration of feasibility of implementation and enforcement.

1.3.5 Development of principles to achieve the objectives

After the risks were analysed, principles were developed to ensure the objectives are achieved and the identified risks are minimised. These principles are set out in section 7 of this Plan.

The principles are consistent with the Landscape Act's requirements in relation to the format of water licences, water access entitlements, water allocations and other permits and authorisations. The principles will:

- establish, or provide a mechanism for establishing, the volume of water available to be allocated within each consumptive pool within the prescribed areas
- set out the circumstances for issuing and varying water licences, water access entitlements and water allocations, to avoid localised impacts on third parties and maintain an acceptable condition of the resource
- for some areas, set out the resource condition triggers which, if exceeded, will initiate a management response to avoid localised impacts to the aquifer integrity and protect the condition of the resource
- set out the buffer zones needed to protect groundwater-dependent ecosystems and other water users from new or additional water take from the resource
- outline the requirements for issuing authorisations and approvals for the management of relevant water affecting activities and the use of effluent or imported water.

1.4 Reviewing this Plan

This Plan will be reviewed at least once within 10 years of approval. The associated Monitoring, Evaluation, Reporting and Improvement Plan (see section 8) will provide a framework for assessing the success of this Plan in achieving its objectives. This review may, if required, result in an amendment to this Plan.

2 Groundwater Resources and Consumptive Pools

2.1 Background

The importance of water resources to the Kaurna people, their cultural and spiritual connection to the water resources and the associated groundwater-dependent ecosystems, and their knowledge of the Adelaide Plains is recognised and acknowledged. This Plan establishes a Cultural Water Consumptive Pool that acknowledges the inherent right of Aboriginal people to have access to water to continue to practise their culture upon Country.

There is a strong body of scientific knowledge related to the groundwater resources within the Adelaide Plains, which has informed the development of a groundwater numerical model and been used to help develop the management strategies in this Plan. The model is currently the best scientific tool available to understand the likely effects of groundwater extraction from the main productive aquifers of the Adelaide Plains.

2.2 Cultural Water

Kaurna connection to the Adelaide Plains area is expressed through creation stories (cultural and spiritual histories) about the Country. These stories reveal the significance of the relationship between the Country and the people, both practically and spiritually. For Aboriginal Nations, water is life – it provides life to everyone and everything that ever lived and ever will live. In this way, water is the lifeblood of the landscape and is intimately connected to all of the other elements of the landscape, supporting spiritual, cultural, environmental, social and economic life. Water, and all of the connected elements, must be managed to allow it to remain healthy, and continue to function and support people to live as it has for many thousands of generations.

There are several sites which are of cultural significance to the Kaurna people within the Adelaide Plains. Many of these are surface water features which are not prescribed or managed under this Plan such as Karrawirra Parri (Torrens River) meaning "Red Gum Forest River" and Ngangki Parri (Onkaparinga River) meaning "Women River" in Kaurna, in addition to a number of traditional Kaurna groundwater fed springs along the coast near Kingston Park[10].

The Landscape Act requires that a water allocation plan must, when allocating water, "*take into account the present and future needs of the occupiers of land…*"[11] where an occupier includes a person "*who is entitled to use the land as the holder of native title in the land*"[12]. In March 2018, the Kaurna people were recognised as native title holders for lands around Adelaide under the *Native Title Act 1993*. This established native title rights over 17 parcels of land situated from Lower Light to Myponga, five of which are situated within the Adelaide Plains.

[10] SA Water, Kaurna Water Wisdom, 13 November 2020, Video

[11] Section 53(1)(e) of the *Landscape Act*

[12] Section 3 of the *Landscape Act*

Recognising the social, spiritual and customary objectives and values of Aboriginal people in water planning has been limited to date, with the exception of the SA Murray-Darling Basin. There is, however, recognition of the need to work in partnership with Aboriginal Nations to better understand the water landscape and apply the cultural knowledge learnt over thousands of years to the management of water as a resource. This approach takes time. Therefore, this version of the Plan does not identify or quantify current and future water needs for First Nations people. Instead, the development of this Plan has been used to start conversations with Nations to begin to understand cultural objectives for the prescribed water resources.

Pursuant to section 105 of the Landscape Act, a notice of authorisation to take water for native title purposes was published in the South Australian Government Gazette on 13 September 2012, page 4437. This authorisation allows for "*the taking of water from any prescribed watercourse, lake or well, or surface water prescribed area within the State of South Australia by a person who is a native title holder in relation to the land or waters on or in which that watercourse, lake, well, or surface water prescribed area is situated and the taking is for the purpose of satisfying that person's personal, domestic, cultural, spiritual or non-commercial communal needs where they are doing so in the exercise or enjoyment of their native title rights and interests, providing 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 a watercourse.*"

Native title holders therefore have the right to take and use water within a particular area in relation to satisfying their personal, domestic, cultural, spiritual or non-commercial communal water needs. Given the importance of access to water for cultural purposes, including the use of water for this purpose by Aboriginal people who are not native title holders, this Plan authorises the use of groundwater through the creation of a Cultural Water Consumptive Pool. Water from this pool is authorised to be used for the purpose of satisfying an Aboriginal person's personal, domestic, cultural, spiritual or non-commercial communal needs where they are doing so in the exercise or enjoyment of their cultural interests. Water licences are not required to be issued in relation to this consumptive pool, rather the Cultural Water Consumptive Pool acknowledges the inherent right of Aboriginal people to have access to water to continue to practise their culture upon Country.

2.3 Groundwater Resources

The following sections provide a brief overview of the hydrogeology and an assessment of the capacity of the groundwater resources to meet the needs of water users, including the environment. The first section focuses on the aspects of the aquifers that need to be considered when managing the groundwater resources. This includes their type and characteristics, their current condition, and their contribution to the water requirements of ecosystems and human demands for water. The second section outlines the capacity of the groundwater resources and the resource extraction limits for different parts of the aquifers.

The principles presented in section 7 of this Plan are derived from an understanding of these aquifer characteristics and the capacity of the groundwater resources to support extraction.

Unless otherwise referenced, material in this section is drawn primarily from:

- Department of Environment, Water and Natural Resources, 2017, *Estimation of groundwater resource capacity and recommended extraction limits for the Adelaide Plains Water Allocation Plan*, DEWNR Technical report 2017/03, Government of South Australia, through Department of Environment, Water and Natural Resources, Adelaide.

- Department for Environment and Water, 2020, *Estimation of groundwater resource capacity and recommended extraction limits for the Adelaide Plains Water Allocation Plan: Addendum 2020*, DEW Technical report 2020/17, Government of South Australia, Adelaide.
- Department for Environment and Water, 2021, *Investigating the use of resource condition trigger levels for groundwater management in the Adelaide Plains Water Allocation Plan*, DEW Technical report 2021/13, Government of South Australia, Department for Environment and Water, Adelaide.
- Department for Environment and Water, 2017, *Central Adelaide Prescribed Wells Area T1 aquifer 2016 Groundwater level and salinity status report*, Government of South Australia, Department for Environment and Water, Adelaide.
- Department for Environment and Water, 2017, *Kangaroo Flat region of the Northern Adelaide Plains Prescribed Wells Area T2 aquifer 2016 Groundwater level and salinity status report*, Government of South Australia, Department for Environment and Water, Adelaide.
- Department for Environment and Water, 2018, *Northern Adelaide Plains Prescribed Wells Area T1 aquifer 2017 Groundwater level and salinity status report*, Government of South Australia, Department for Environment and Water, Adelaide.
- Department for Environment and Water, 2018, *Northern Adelaide Plains Prescribed Wells Area T2 aquifer 2017 Groundwater level and salinity status report*, Government of South Australia, Department for Environment and Water, Adelaide.

2.4 Consumptive Pools

A water allocation plan must "*determine, or provide a mechanism for determining, from time to time, a consumptive pool, or consumptive pools for the water resource*". A consumptive pool is defined in the Landscape Act as the water "*that will from time to time be taken to constitute the resource within a particular part of a prescribed water resource for the purposes of Part 8…*"[13]. This Plan must therefore determine a consumptive pool or pools, so as to account for all of the groundwater that may be lawfully taken from the Adelaide Plains for consumptive purposes (such as irrigation, stock and domestic, commercial, forestry and any other consumptive use). The Minister must further determine, from time to time, the volume of water that is to be made available for allocation from a consumptive pool[14].

The consumptive pools determined for this Plan for the 'native groundwater' are discussed below and outlined in section 7.1 and are based on aquifer type and spatial location within the prescribed areas, where the spatial location is based on zones of concentrated extraction, or the 'remainder' of the aquifer. Additional consumptive pools have been established for the Managed Aquifer Recharge activities as discussed in section 6.3 and for Aboriginal cultural water as discussed in section 5.8.

2.5 Hydrogeology

2.5.1 Overview

The groundwater resources of the prescribed wells areas of the Adelaide Plains are found in several aquifers. Across the flats of the Adelaide Plains there are two main aquifer systems, the shallow Quaternary aquifers and

[13] Sections 53(1)(c) and 3(1) of the *Landscape Act*

[14] Section 121(4) of the *Landscape Act*

the deeper, confined Tertiary aquifers. The thin Quaternary aquifers are designated Q1 to Q6, in order of increasing depth, and are generally used for stock or domestic purposes. In the metropolitan area, these aquifers are accessed by numerous backyard bores, yielding water of varying quality, and provide water to the groundwater-dependent ecosystems across the plains.

Below the Quaternary aquifers lie a series of Tertiary aquifers comprising sedimentary layers of sand, gravel and limestone. These deep aquifers are the largest and most important groundwater resource in the Adelaide Plains and, as with the Quaternary aquifers, they are numbered with increasing depth below the ground's surface. The T1 and T2 aquifers are used to support irrigated horticulture, industry and the watering of recreational areas. Below these productive upper Tertiary aquifers, the T3 and T4 aquifers contain much more saline water. At the time of writing, there is only one licensed well accessing these deeper T3 and T4 aquifers.

The extent and productivity of these Tertiary aquifers vary according to the geological provinces within which they occur. Figure 2.1 shows the two provinces – the Adelaide Plains Sub-basin (which extends from the western suburbs to the north beneath the Northern Adelaide Plains) and the Golden Grove Embayment (which underlies the eastern suburbs). A cross section of the Adelaide Plains area displays the two provinces and the various aquifers in Figure 2.2.

The Noarlunga Embayment is a separate hydrogeological unit which contains sedimentary Quaternary and Tertiary aquifers (Figure 2.2). There is little extraction of groundwater from this aquifer system.

To the east of the Adelaide Plains, the foothills and hills face zone are underlain by fractured rock aquifers which have highly variable yields. Groundwater is extracted in these areas to support a wide range of relatively small-scale agriculture and horticultural enterprises and is also used for stock and domestic purposes.

The consumptive pools, discussed below and described in section 7.1 of this Plan, are delineated based on these main aquifers and the localised impacts within these aquifers[15,16]. The hydrogeology and management implications for each groundwater resource are described in more detail in the sections that follow.

2.5.2 Quaternary aquifers

Six sedimentary Quaternary aquifers exist across the Adelaide Plains which vary greatly in thickness, lithology and permeability. Quaternary sediments consist mainly of mottled clay and silt with thin interbeds of sand and gravel that form aquifers that may be connected.

The high salinity of the Quaternary aquifers generally limits their value for extraction. However, there are some pockets of low-salinity water that occur where recharge is higher – for example, beneath streams that flow out of the Ranges across the Adelaide Plains.

The shallowest Quaternary aquifer (and therefore the most widely used) is widespread over the Adelaide Plains and is located from the surface to depths of up to 15 metres below ground level, with an average thickness of 2 metres. Average supplies from this aquifer rarely exceed 2 L/s.

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[15] Department of Environment, Water and Natural Resources (2017). Estimation of groundwater resource capacity and recommended extraction limits for the Adelaide Plains Water Allocation Plan, DEWNR Technical Report 2017/03, Government of South Australia through Department of Environment, Water and Natural Resources, Adelaide.

[16] Department for Environment and Water (2020). Estimation of groundwater resource capacity and recommended extraction limits for the Adelaide Plains Water Allocation Plan: Addendum 2020, DEW Technical report 2020/17, Government of South Australia, Adelaide.

The alluvium within the River Torrens valley and high sand dunes along the coast also form aquifers that are accessed for domestic use (mainly garden watering).

Groundwater contamination has been found in the shallow aquifers across the Adelaide Plains, including some parts of the Quaternary aquifers. Where groundwater is affected by contamination and there is a likelihood that it may be used for domestic or irrigation purposes, the Environment Protection Authority has powers to establish a groundwater prohibition area under section 103S of the *Environment Protection Act 1993*. This may prohibit or restrict the taking of groundwater in these areas.

Management implications

The Quaternary aquifers are generally low-yielding, and are mostly used for small-scale domestic use and watering gardens. The limited size of the aquifers means that they are essentially self-regulating in that any overuse will only result in impacts on a small local scale.

The Quaternary aquifers of the Adelaide Plains Sub-basin (excluding the Kangaroo Flat region) and the Golden Grove Embayment will be managed as a single consumptive pool (Figure 2.4). A general extraction limit has been set to allow some further extraction, subject to assessment of localised impacts.

2.5.3 Adelaide Plains Sub-basin

Within this province, the T1 and T2 aquifers are around 100 metres thick each and are the most productive aquifers with yields between 10 and 30 L/s. They extend westwards beneath Gulf St Vincent. Some limited leakage occurs between these aquifers – generally this is downward from the T1 in the northern part of the area, and upward from the T2 to the T1 further south. These productive aquifers are underlain by the less productive T3 and T4 aquifers.

2.5.3.1 T1 aquifer

The T1 aquifer has a maximum thickness of about 120 metres just north of the Para Fault near Adelaide Airport and gradually thins and pinches out around the Gawler River in the north of the Adelaide Plains.

The direction of regional groundwater flow in the T1 is from the Adelaide Hills towards Gulf St Vincent. As this aquifer is confined, it does not receive direct recharge from rainfall. The main source of recharge is thought to be from groundwater from the fractured rock aquifers of the Mount Lofty Ranges flowing across the Eden-Burnside Fault.

From the late 1990's, pumping from the T1 aquifer in the Northern Adelaide Plains Prescribed Wells Area had formed long-standing cones of depression at Waterloo Corner and near the coast around the Dry Creek salt fields. However, as most salt field operations ceased in 2015, groundwater pressure levels have subsequently recovered by 3–10 metres in this area. Similarly, further south, the irrigation of open spaces in the West Lakes–Grange area and industrial extractions in the Thebarton and Regency Park areas had also formed long-standing cones of depression. However the closing of some operations and the introduction of Managed Aquifer Recharge activities have resulted in rising groundwater pressure level trends.

In the Northern Adelaide Plains Prescribed Wells Area, the water within the T1 aquifer is generally of good quality, with salinity of less than 1,500 mg/L. However, salinities of nearly 3,000 mg/L have been measured in some areas. In the Central Adelaide Prescribed Wells Area, the T1 aquifer has recorded salinities of up to 4,200 mg/L, but is typically less than 1,500 mg/L.

Management implications

The T1 aquifer is considered to be robust and can withstand short term increases in extraction. However, sustained over-extraction, particularly in the Northern Adelaide Plains Prescribed Wells Area, will increase the risk of inducing downward leakage of more saline water from the overlying Quaternary aquifers, the lateral encroachment of higher-salinity groundwater from other areas of the aquifer and seawater intrusion along the coast.

The T1 aquifer of the Adelaide Plains Sub-basin has been delineated as two separate consumptive pools to enable location specific management approaches. The aquifer has been separated into the T1 Northern Adelaide Plains and T1 Regional consumptive pools (Figure 2.3) for management purposes, which are further discussed in section 6.4 of this Plan.

2.5.3.2 T2 aquifer

The T2 aquifer extends across all of the Adelaide Plains Sub-basin and is separated from the overlying T1 aquifer by a confining layer of clay. As with the T1 aquifer, the thickness of the T2 aquifer is greatest just north of the Para Fault at about 80 metres and thins in a northerly direction to 20 metres near Gawler. Most extractions from this aquifer occur in the Northern Adelaide Plains Prescribed Wells Area.

High levels of extraction from the T2 aquifer over many decades have created a long-standing cone of depression in groundwater pressure level, centred on Virginia. This situation has been relatively stable over the past 20 years or so and is considered to be within acceptable limits under current levels of average annual extraction.

Salinity levels in the T2 aquifer are characterised by reasonably stable trends over the past 10 years. However, the lateral inflow of more saline groundwater toward the cone of depression could be causing salinity increases in irrigation wells located close to the boundary of low salinity zones, assuming that contamination due to corroded well casing is not occurring. Salinity levels in the T2 aquifer vary considerably, ranging up to 9,000 mg/L. However, about 80 percent of the 499 wells monitored for salinity within the past 5 years show salinities of less than 1,500 mg/L.

Management implications

Overall extraction can vary from year to year depending on rainfall, where drier years generally require more groundwater extraction. It is very important for horticulture irrigators to be able to adapt to seasonal conditions and be able to increase extraction during dry years. If the long-term average extraction remains stable, the condition of the T2 aquifer should remain stable. However, sustained over-extraction, particularly in the Northern Adelaide Plains, will increase the risk of lateral salinity increases thereby reducing the viability of the aquifer to sustain the horticulture industry.

Similarly to the T1 aquifer, the T2 aquifer of the Adelaide Plains Sub-basin has been delineated as two separate consumptive pools to enable location specific management approaches: the T2 Northern Adelaide Plains and T2 Regional Consumptive Pools (Figure 2.3). Additionally the T2 aquifer within the Kangaroo Flat region is managed in a separate consumptive pool as discussed below.

2.5.3.3 Kangaroo Flat

The Kangaroo Flat area has been separated from the remainder of the Adelaide Plains Sub-basin for management purposes as further discussed in section 6.4 of this Plan due to characteristics that distinguish it from the rest of the aquifer. In particular:

- the T1 aquifer and the Munno Para Clay confining layer that normally overlie the T2 aquifer are generally absent; and
- there is strong connectivity with the overlying Quaternary aquifer, which contains saline groundwater.

Increasing extraction leading up to and during the Millennium Drought (2001-2009) resulted in significant salinity increases due to downward leakage from the Quaternary aquifer. An assessment of the resource capacity determined a sustainable limit of 1,500 ML/y[17]. In recent years, extraction has been below the sustainable limit and groundwater salinity has decreased.

Management implications

All aquifers within the Kangaroo Flat region (including the Quaternary, the T1 where present, the T2 and the underlying fractured rock aquifers) will be managed as a single consumptive pool (Figure 2.3). Allocated volumes in this area should not enable extraction to exceed the sustainable limit of 1,500 ML/y in order to prevent a repetition of significant salinity increases.

2.5.3.4 Lower Tertiary (T3 and T4) aquifers

There is very little information available concerning the Tertiary T3 and T4 aquifers which underlie the T1 and T2 aquifers in the Adelaide Plains Sub-basin because of their great depth (300 to 500 metres). These aquifers are also highly saline (up to 80,000 mg/L). Given the thick Blanche Point Marls aquitard, there is no significant hydraulic connection with the overlying T2 aquifer. At the time of development of this Plan, there was only one well with an allocation in this aquifer.

Management implications

The T3 and T4 aquifers can be considered one resource and will be managed as a single consumptive pool (Figure 2.4). Due to the low hydraulic connection between the T3 and T4 aquifers and other productive aquifers, any risks from further development of these aquifers are very low to negligible. However given the lack of information for these aquifers, extraction should initially be limited to the volume currently authorised to be taken. However future development will be permitted where the applicant is able to provide evidence to support that the additional take of water presents only a low level of risk to existing users or to the resource.

[17] Barnett S.R (2013). Capacity of the groundwater resource of the Kangaroo Flat area of the Northern Adelaide Plains Prescribed Wells Area. South Australia. Department of Environment, Water and Natural Resources, DEWNR Technical Note 2013/02.

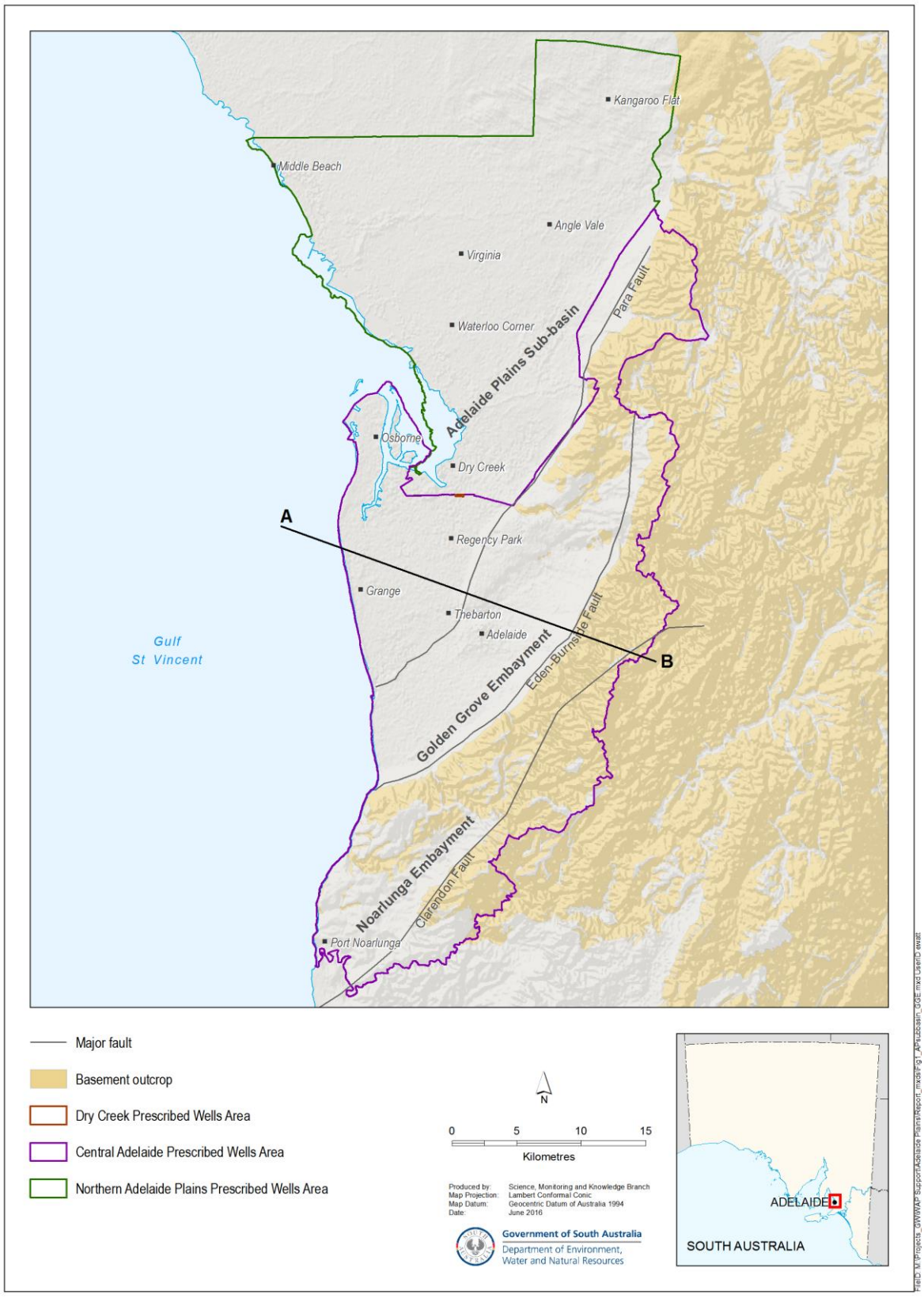

Figure 2.1. Geological provinces of the Adelaide Plains

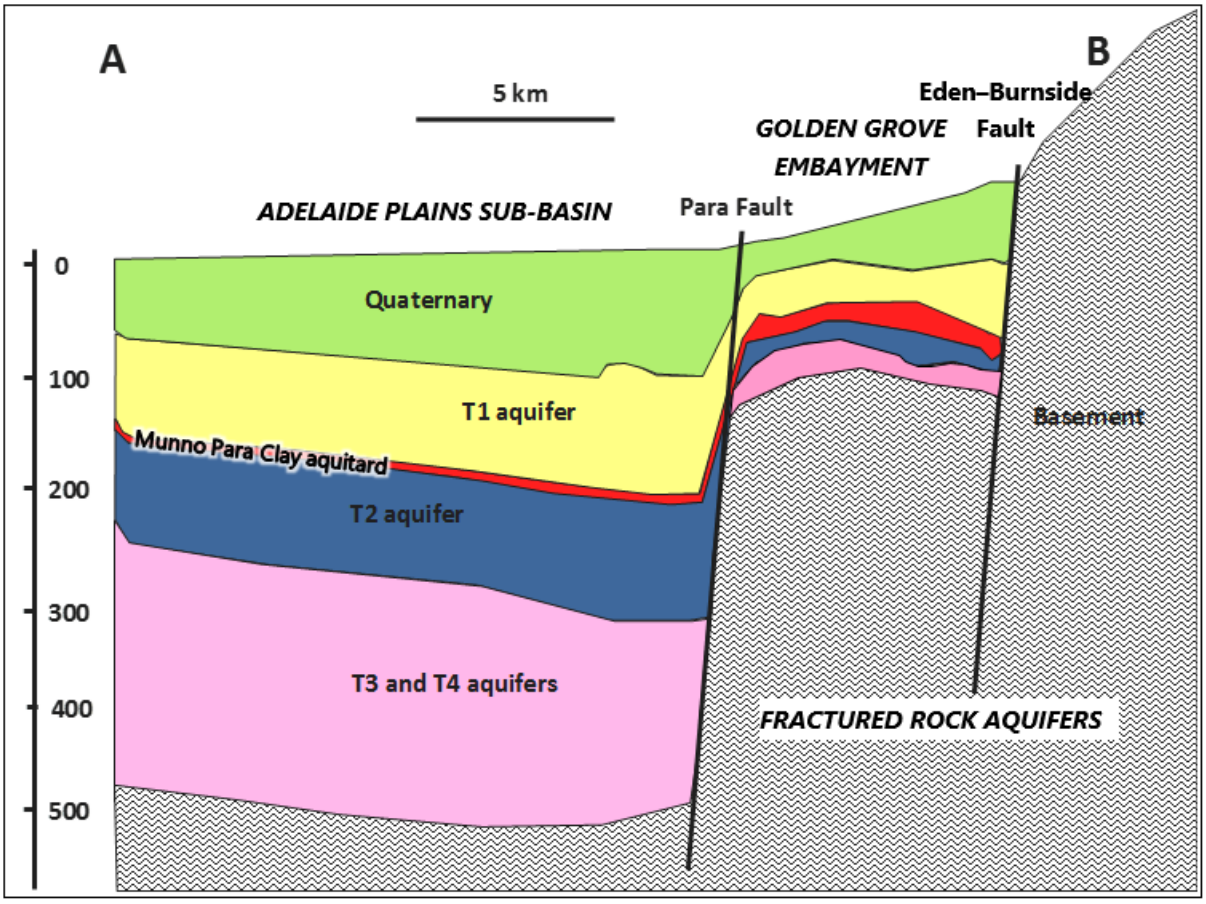

Figure 2.2. Aquifer cross-section of the Adelaide Plains

2.5.4 Golden Grove Embayment

The Golden Grove Embayment, which sits adjacent the Adelaide Plains Sub-basin and is hydrogeologically separated from the Sub-basin by the Para Fault (Figure 2.1), comprises a series of sedimentary aquifers underlain by confined fractured rock aquifers. The Quaternary aquifer present in the Adelaide Plains Sub-basin extends across the Golden Grove Embayment and is not faulted to the extent the deeper Tertiary aquifers are by the Para Fault (Figure 2.2) thereby remaining in connection with the Quaternary aquifer of the plains. The Tertiary sediments form a complex sedimentary sequence that thickens from about 20 metres in the Tea Tree Gully area to over 300 metres near the coast at Brighton. Most extractions occur from the T1 and T2 aquifers, which are found only in the south-western part of the Embayment. Minor extraction occurs from Tertiary sand units which were deposited along the Eden-Burnside Fault and receive lateral recharge from the fractured rock aquifers of the Mount Lofty Ranges.

The level of extraction from the T1 and T2 aquifers within the Golden Grove Embayment is not considered to be causing resource condition problems and modelling suggests that extraction could be increased in this area. In the fractured rock area of the embayment, there is low extraction due to higher salinity levels.

Management implications

Because the T1 and T2 aquifers are thinner and more likely to be interconnected than those in the Adelaide Plains Sub-basin, the T1, T2 and fractured rock aquifers which comprise the Golden Grove Embayment should be considered to be one resource and managed as a single consumptive pool (Figure 2.3). It should be noted that the Tertiary aquifers and the fractured rock aquifers have a different spatial extent within this consumptive

pool as displayed in Figure 2.3, but despite this spatial extent difference they are managed as one consumptive pool. Additional demand is expected to be low because of variable salinity and yields in all aquifers, and the highly urbanised nature of the area.

The Quaternary aquifer in this area, being somewhat connected to the Quaternary aquifer in the Adelaide Plains Sub-basin (Figure 2.2), will be managed separate to the other aquifers in the Golden Grove Embayment and is instead included within the Quaternary Consumptive Pool.

2.5.5 Noarlunga Embayment

The sedimentary aquifers of the Noarlunga Embayment, which sits to the south of the Golden Grove Embayment separated by the Eden-Burnside Fault (Figure 2.1), are little used because they contain brackish, poor quality water and are covered mainly by urban development. This embayment is bound on the southern margin by the Onkaparinga Hills and Clarendon Fault and to the north by basement outcrop south of the Eden-Burnside Fault. Sediments reach a maximum thickness of about 170 metres in the south-west area of the embayment.

There are three main aquifer systems in the Noarlunga Embayment:

- Shallow Quaternary sands and gravels with salinities ranging from 1,000 mg/L to 3,000 mg/L and low well yields (less than 0.5 L/s);
- Tertiary Port Willunga Formation aquifer which occurs only around the Onkaparinga Estuary, with reported salinities ranging between 600 and 2,500 mg/L;
- Tertiary Maslin Sands aquifer, with salinities ranging from 1,000 to 4,000 mg/L with reported well yields generally less than 10 L/s.

While the sedimentary aquifers of the Noarlunga Embayment are underlain by the fractured rock aquifer, connection between the Tertiary aquifer and the underlying fractured rock aquifer is negligible.

Management implications

The Quaternary and Tertiary groundwater resources of the Noarlunga Embayment will be managed as a single consumptive pool (Figure 2.4). There is unlikely to be high future demand from these aquifers due to the high salinity of the groundwater and the urban land use. The recommended acceptable annual extraction limits are based on allowing some further development, if required. The fractured rock aquifers which underlie the sedimentary aquifers of the Noarlunga Embayment are managed through the Southern Fractured Rock Consumptive Pool discussed below.

2.5.6 Fractured rock aquifers

The fractured rock aquifers are primarily found in the Mount Lofty Ranges part of the Adelaide Plains. Unlike the sedimentary aquifers, this type of aquifer yields water through numerous fractures and faults, with the yield of a well depending on the size and number of fractures intersected by the well, and the interconnectivity of the fractures.

The fractured rock aquifers are unconfined and have variable connectivity with the Tertiary aquifers across the Eden-Burnside Fault. A significant amount of recharge to the Tertiary aquifers occurs by this process. Most wells that access the fractured rock aquifer are in the hills face zone.

Typically, reported yields from wells that penetrate the fractured rock aquifers are highly variable, ranging from less than 1 L/s to greater than 20 L/s where large or numerous fractures have been intersected by the well.

Groundwater salinity within these aquifers is also highly variable and is determined by rainfall. Salinity is typically less than 1,000 mg/L in the central area near Mount Lofty where rainfall is highest, but increases to 2,000 mg/L along the northern section of the hills face zone, and increases to over 5,000 mg/L in the southern portion towards the coast.

Management implications

Given the steep terrain, large areas of native vegetation and average well yields of only 5 L/s, it is unlikely that there will be a large increase in water demand in the future. Management will focus on localised impacts of extraction and the fractured rock aquifers of the hill face zone have been separated into two consumptive pools: Northern Fractured Rock and Southern Fractured Rock (Figure 2.4). Buffer zones around wells will be used to limit impacts on other water users or nearby groundwater-dependent ecosystems.

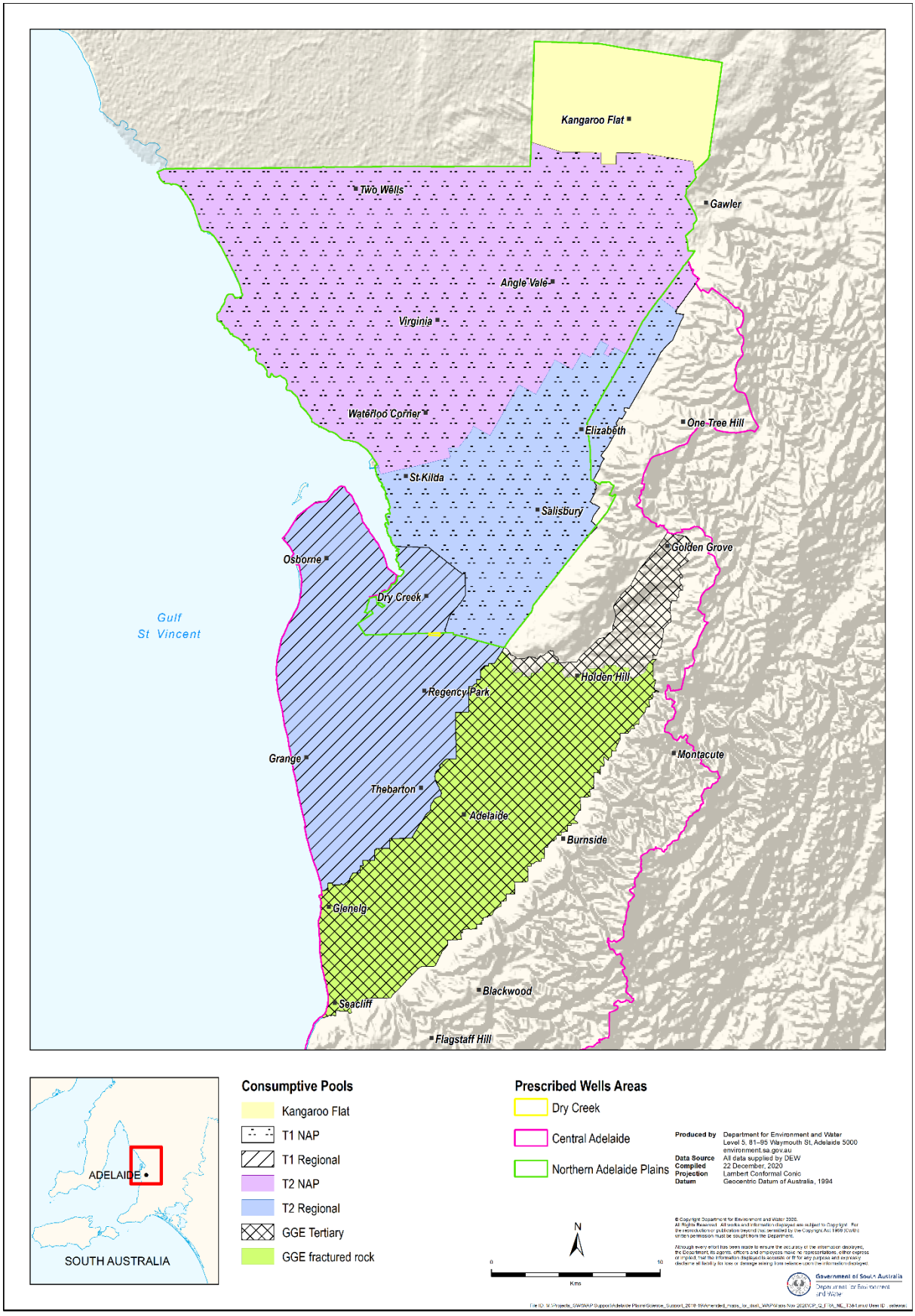

Figure 2.3. Consumptive pools for the T1 and T2 aquifers, Kangaroo Flat and the Golden Grove Embayment of the Adelaide Plains

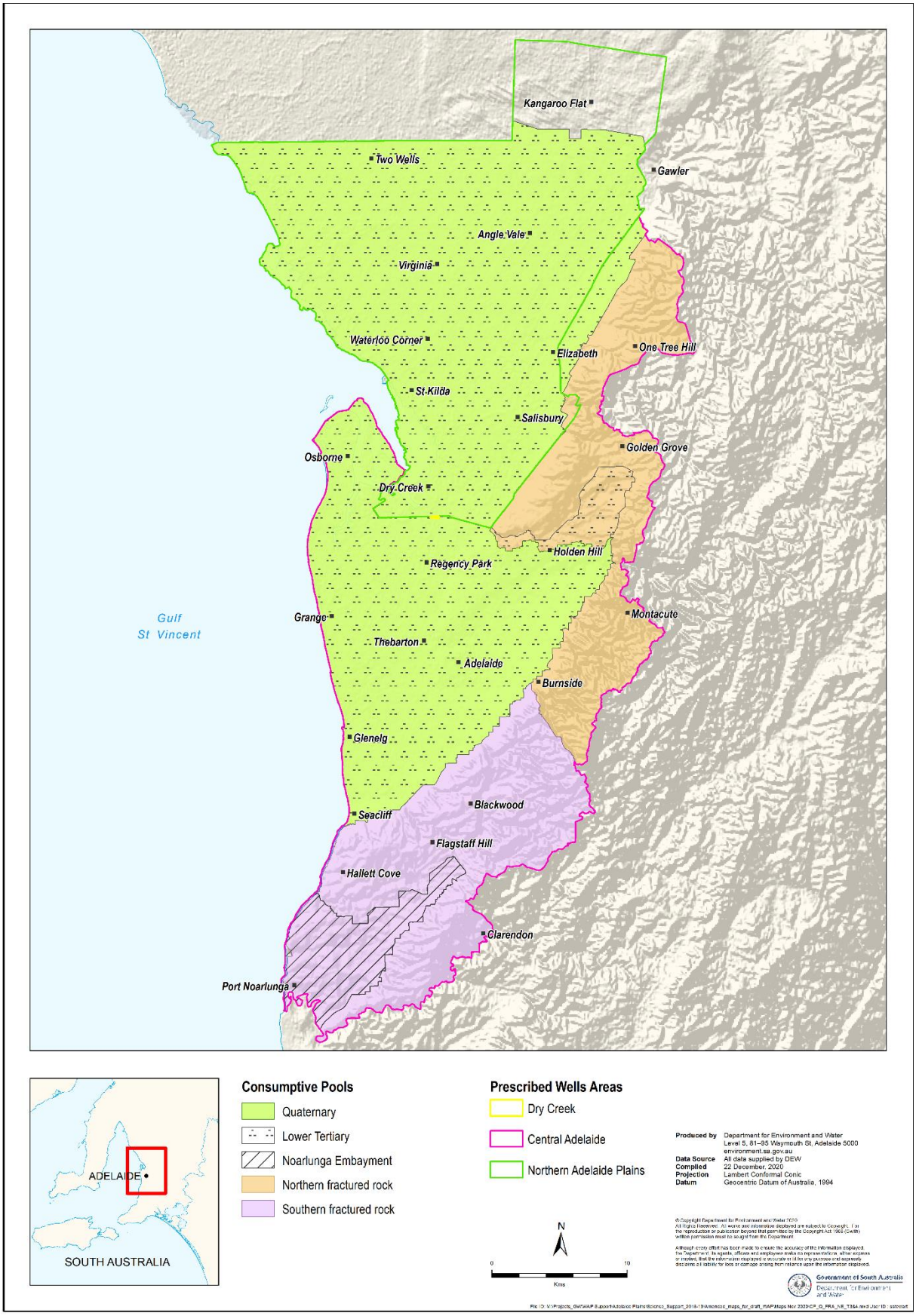

Figure 2.4. Consumptive pools for the Quaternary, Lower Tertiary (T3 and T4 aquifers), the fractured rock aquifers and the Noarlunga Embayment of the Adelaide Plains

2.6 Climate Change Impacts

The confined Tertiary aquifers beneath the Adelaide Plains do not receive recharge from rainfall and are therefore less vulnerable to the impacts of climate change compared to the unconfined aquifers. The unconfined fractured rock aquifers are recharged by incident rainfall and are consequently much more likely to be impacted by climate change in the short term. The fractured rock aquifers are a source of recharge to the confined Tertiary aquifers, provide baseflow for streams and maintain spring flows and groundwater seeps.

Investigations have been undertaken into the potential impacts of climate change on the groundwater resources of the Adelaide Plains. The key findings are[18]:

- projected reductions in rainfall in the Western Mount Lofty Ranges will likely lead to reductions in recharge to the fractured rock aquifers, and a long-term decline in groundwater levels. This will directly affect the parts of the Central Adelaide Prescribed Wells Area that lie within the Mount Lofty Ranges;
- any sustained decline in groundwater levels that occur in the Western Mount Lofty Ranges in the future will result in a reduction in groundwater flow from the Western Mount Lofty Ranges to the sedimentary aquifers that will likely result in a small decline in groundwater pressure levels in the confined Tertiary aquifers. Model results suggest that these small declines will likely take many decades to realise, except close to the boundary between the fractured rock aquifers and the sedimentary aquifers where deeper declines can be expected, albeit gradually over a number of decades. These declines will be in addition to any existing decline that will likely result from increased groundwater extraction due to increasing temperatures; and
- if land use patterns and horticultural practices remain the same, there will almost certainly be an increase in the irrigation water requirements due to projected increases in temperature and evapotranspiration, and hence increases in crop water use for the same area of cropping.

Given the uncertainties in how and when climate will change in the future, an adaptive management approach will allow sufficient flexibility to change management responses as the condition of the resource varies. This can be achieved through the implementation of resource condition limits that can be used to manage extraction should it be deemed necessary. Targeted monitoring of the groundwater resources aimed at evaluating their status and condition is critical to the effectiveness of any adaptive management approach, which will also be supported by regular reviews of the water allocation plan.

2.7 Capacity of the Water Resources

To ensure water using activities can continue sustainably into the future, resource extraction limits (or an assessment of the resource capacity) have been developed for each of the consumptive pools described above and in section 7, with the exception of the Managed Aquifer Recharge Consumptive Pool (further discussed in section 6.3) and the Cultural Water Consumptive Pool (further discussed in section 5.8). The resource extraction limit is the volume of water that can be extracted from the resource over a sustained period while minimising the risk of exceeding the resource condition limits (this limit excludes the water taken for unlicensed purposes or licensed stock and domestic uses, which is accounted for outside of the resource extraction limit).

[18] SA Climate Ready

Resource condition limits are quantifiable limits that represent a state beyond which the impact on the physical condition of the resource becomes unacceptable. The resource condition limits for the aquifers within the Adelaide Plains are:

- Quaternary aquifers: the volume of water extracted annually must not result in unacceptable impacts upon groundwater-dependent ecosystems or existing users.
- T1 aquifer: the winter groundwater pressure level should not drop below –5 metres AHD in the Waterloo Corner area or below –15 metres AHD in the Central Adelaide Prescribed Wells Area by 2040. This is to mitigate the salinity threat from increased downward leakage of saline (or higher salinity) water from the overlying Quaternary aquifer and the encroachment of higher salinity water from surrounding areas.
- T2 aquifer: the winter groundwater pressure level should not drop below the base of the confining layer separating the T1 and T2 aquifers by 2040 to avoid compromising the structural integrity of the confining layer or the T2 aquifer.
- Noarlunga Embayment: the volume of water extracted annually from the Quaternary and Tertiary aquifers must not result in unacceptable impacts to groundwater-dependent ecosystems or existing users.
- Fractured rock aquifers: the annual volume of baseflow should be maintained within the range of historical observations.

Once the resource condition limits were defined, it was possible to determine resource extraction limits, being the volume of extraction that can be sustained over time while minimising the risk of exceeding these resource condition limits (Table 2.1).

For the consumptive pools which relate to the T1 and T2 aquifers in the Northern Adelaide Plains Prescribed Wells Area, the resource extraction limits have been derived from the results of modelling a range of scenarios with differing levels of extraction in relation to the defined resource condition limits, so as to determine the volume of water that can be taken on an ongoing basis without resulting in a breach of the resource condition limits[19].

The Kangaroo Flat Consumptive Pool resource extraction limit was determined through a resource assessment report[20] and was confirmed as an appropriate extraction volume through the groundwater model.

Within the Dry Creek and Central Adelaide Prescribed Wells Areas T1 and T2 aquifer consumptive pools, the resource extraction limit was determined by modelling the existing user requirements[21] and additional volumes (20-30% increase) to ensure that this higher volume of extraction would not exceed the resource condition limits. A water balance approach or a knowledge of the existing use of the resource was utilised for the remaining consumptive pools to determine an appropriate resource extraction limit[15].

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[19] Department of Environment, Water and Natural Resources (2017). Estimation of groundwater resource capacity and recommended extraction limits for the Adelaide Plains Water Allocation Plan, DEWNR Technical Report 2017/03, Government of South Australia, Department of Environment, Water and Natural Resources, Adelaide.

[20] Barnett S.R (2013). Capacity of the groundwater resource of the Kangaroo Flat area of the Northern Adelaide Plains Prescribed Wells Area. South Australia. Department of Environment, Water and Natural Resources, DEWNR Technical Note 2013/02.

[21] As per section 155(2) and 155(10) of the *Landscape Act*, being the volume of water required to meet the future requirements of a person who took water from the resource or legally committed to take water from the resource prior to prescription (during the establishment period).

Table 2.1. Resource Extraction Limits and rationale per consumptive pool

Consumptive Pool	Resource Extraction Limit ML/y	Rationale for Resource Extraction Limit
Quaternary	6,762	This limit covers existing licensed holders and estimated existing user demand, allows some further development of the aquifers, and reserves some water for aquifer maintenance and groundwater-dependent ecosystems. This limit was determined based on a water balance calculation and consideration of the environmental water provisions.
T1 Northern Adelaide Plains	4,159	The limit is based on a 30% increase on current average annual extractions. Modelling suggests this does not result in unacceptable drawdown.
T1 Regional	10,494	The limit is based on a 30% increase on estimated existing user demand. Modelling suggests this does not result in unacceptable drawdown.
T2 Northern Adelaide Plains	15,555	The limit is based on a 20% increase on current average annual extractions within the existing cone of depression, to limit major increases in extraction in this zone, and is equal to the allocation volume in the remainder of the zone under the previous Northern Adelaide Plains Water Allocation Plan. The risk of structural damage to the confining layer above the T2 aquifer under this scenario is low.
T2 Regional	6,023	The limit is based on estimated existing user demand plus 2,000 ML/y. This limit is subject to the proviso that for any application to increase extraction by more than 250 ML/y from a well or group of wells, a hydrogeological investigation should be conducted to determine the impact on the resource and other users.
Kangaroo Flat	1,500	Based on an assessment of the aquifers in the Kangaroo Flat region of the Northern Adelaide Plains Prescribed Wells Area.
Lower Tertiary (T3/T4)	2,385	Based on current volumes allocated in relation to these aquifers. Further development is likely to be limited by the depth of the aquifers and high salinities.
Golden Grove Embayment	4,552	As increased extraction may be sought in this zone, a scenario was modelled by doubling the estimated existing user demand plus 1,000 ML/y. Modelling results suggest the risk of reaching the resource condition limit is low, with drawdown of up to 3 metres compared to the current conditions. This limit is subject to the proviso that for any application to increase extraction by more than 250 ML/y from a well or group of wells, a hydrogeological investigation should be conducted to determine the impact on the resource and other users.
Noarlunga Embayment	1,717	The extraction limit is a based on a conservative estimate of the capacity of this resource based on previous scientific studies.
Northern Fractured Rock	5,116	The volume of groundwater available for licensed extraction from this part of the fractured rock aquifer was derived using a water balance approach, calculated as the recharge minus the sum of baseflow and non-licensed extraction.
Southern Fractured Rock	1,409	Due to the uncertainties in the water balance calculations for this part of the fractured rock aquifers, the recommended extraction limit is based on maintaining the current level of extraction.

Given the approach applied to the Central Adelaide consumptive pools, both sedimentary and fractured rock, it is possible that there may be more water available to be extracted from within these consumptive pools which would not result in the resource condition limits being breached. As such this Plan provides the opportunity for more entitlement shares to be issued in these consumptive pools if new information supports the capacity being increased (Principle 3).

In two consumptive pools (the T1 Northern Adelaide Plains and the T2 Northern Adelaide Plains Consumptive Pools), the total allocations on currently held authorisations exceed the resource extraction limits. An adaptive trigger-level management approach is considered appropriate at this time to manage these consumptive pools. This adaptive approach works by limiting the volume of water that can be extracted (allocation) within a consumptive pool during periods when the resource is at higher risk. In order to do this, resource condition triggers have been developed for these consumptive pools, where a resource condition trigger acts as an early warning system that the resource condition limit is at risk of being breached and initiates a management response that minimises the risk of this occurring[22]. The resource condition triggers and the adaptive management approach for these high risk consumptive pools are described in detail in section 6.4 and 7.5 of this Plan.

[22] Department for Environment and Water (2021). Investigating the use of resource condition trigger levels for groundwater management in the Adelaide Plains Water Allocation Plan, DEW Technical Report 2021/13, Government of South Australia, Department for Environment and Water, Adelaide.

3 Environmental Water Requirements

3.1 Overview

For the purposes of water allocation planning in South Australia, environmental water requirements are defined as the water needed to sustain the ecological values of ecosystems, including their processes and biodiversity, at a low level of risk. For the purposes of this Plan, a low level of risk is defined as 'the water regime required to maintain self-sustaining populations resilient to drought'.

Environmental water provisions are defined by this Plan as those parts of environmental water requirements that this Plan aims to meet at any given time, with consideration of existing users' rights and social and economic impacts. Environmental water provisions do not necessarily aim to return water-dependent ecosystems to a pristine condition, but to keep them at an acceptable level of risk, as determined through the water planning process.

Within the area covered by this Plan, there are a series of ecosystems that depend either entirely or in part on the groundwater resources of the area for their water needs. The highest concentration of these groundwater-dependent ecosystems is located in the Mount Lofty Ranges between Anstey's Hill and Coromandel Valley, with relatively few groundwater-dependent ecosystems occurring across the Adelaide Plains. This is mainly due to urbanisation and the low relief of the plains resulting in few areas where groundwater can discharge, compared to the deeply incised ranges exposing outcropping bedrock.

The development of each of the groundwater-dependent ecosystems has been influenced by the availability of water, and may be impacted by the extraction of groundwater. Therefore, this Plan includes principles designed to manage risks to groundwater-dependent ecosystems from the taking of groundwater.

During the development of this Plan, investigations to determine what types of groundwater-dependent ecosystems are present, and to assess their current value, current status and vulnerability to threats were undertaken[23]. This section summarises the results of these studies, and describes the environmental water requirements of the groundwater-dependent ecosystems which were identified as being at risk from groundwater extraction. It also sets out how this Plan's principles will establish management actions with the objective of making provisions for environmental water which meet the environmental water requirements.

Through consultation with an expert panel comprising external consultants and Departmental ecologists, it was determined that this Plan should seek to ensure that access to groundwater would not be the limiting factor to maintaining the current extent and condition of three groundwater-dependent ecosystem types within the prescribed wells areas. This approach was endorsed by community advisory committees during the preparation of this Plan.

To achieve this objective, this Plan defines the (groundwater) environmental water requirements of these groundwater-dependent ecosystems, and aims to meet them. This will be achieved through the implementation of principles that will maintain groundwater-dependent ecosystems' current access to groundwater, and so allow them to continue in their current state and distribution. The environmental water

[23] Sinclair Knight Merz (2012). Environmental water provisions for the groundwater-dependent ecosystems of the Adelaide Plains.

requirements have taken into consideration the groundwater development across the Adelaide Plains, to assess the risk to ecosystems dependent on the prescribed resource.

The majority of such development occurs from the Tertiary confined aquifers, which have very limited influence on the groundwater-dependent ecosystems in the Prescribed Wells Area. Extraction from the Quaternary and fractured rock aquifers is more likely to have a risk of impacting on these groundwater-dependent ecosystems. The highest level of risk identified is a moderate risk to terrestrial vegetation communities that are potentially dependent on groundwater.

The management actions used in this Plan to achieve this objective of meeting the environmental water requirements are:

- the requirements for allocations to not exceed, or further exceed, resource extraction limits determined for each consumptive pool;
- the use of buffer zones around groundwater-dependent ecosystems, limiting new or increased extraction in proximity to groundwater-dependent ecosystems; and
- the inclusion of monitoring requirements.

3.2 Risk Analysis

Table 3.1 summarises the types of groundwater-dependent ecosystems that were considered to see whether, and where, they occur across the Adelaide Plains. It also explains the reasons why their environmental water requirements have or have not been explicitly addressed by the principles in this Plan.

Table 3.1. Groundwater-dependent ecosystems types, occurrence and risk

Type of groundwater-dependent ecosystems investigated	Occurrence within the Adelaide Plains [24]	Risk from groundwater extraction
Fractured rock springs	Numerous examples found in the Mount Lofty Ranges.	Low risk – this Plan identifies and aims to meet the environmental water requirements, and proposes monitoring of the groundwater conditions which support these groundwater-dependent ecosystems.
Groundwater-dependent streams	Numerous examples found in the Mount Lofty Ranges and across the plains.	Low risk – this Plan identifies and aims to meet the environmental water requirements, and proposes monitoring of the groundwater conditions which support these groundwater-dependent ecosystems.
Coastal wetlands	This type is represented by the Barker Inlet, St Kilda and Port Gawler region.	Low risk – not required to be addressed by this Plan. Aquifer is saline and not subject to use.
Terrestrial vegetation at the base of the hills	Shallow groundwater systems in the Quaternary aquifer west of the Eden-Burnside Fault contribute to the environmental water requirements of River Red Gum at the base of the hills.	Moderate risk – this Plan identifies and aims to meet the environmental water requirements, and proposes investigation and monitoring of the condition of these groundwater-dependent ecosystems and their ability to access shallow groundwater.

[24] Sinclair Knight Merz (2012). Environmental water provisions for the groundwater-dependent ecosystems of the Adelaide Plains.

Type of groundwater-dependent ecosystems investigated	Occurrence within the Adelaide Plains [24]	Risk from groundwater extraction
Coastal perched aquifer	Most sites have been drained. However, Buckland Park is an example of where it is relevant.	Low risk – not required to be addressed by this Plan. Aquifer is poorly defined, localised, ephemeral and not subject to use.
Estuarine groundwater-dependent ecosystems	Examples located at Field River, Christies Creek, Onkaparinga River and Pedler Creek.	Low risk – not required to be addressed by this Plan. Aquifer is poorly defined, localised, ephemeral and not subject to use.
Marine groundwater-dependent ecosystems	It is hypothesised that groundwater discharge off the coast may contribute to ecological water requirements of marine ecosystems.	Insufficient evidence to quantify risk, but accepted as low risk for the timeframe of this Plan. Hydrogeology and ecology is poorly known and environmental water requirements cannot be evaluated using existing information.

Based on this analysis, three types of groundwater-dependent ecosystems are expressly considered by the principles in this Plan, as they were identified as likely to be affected by development of groundwater resources across the Adelaide Plains. These include:

- fractured rock aquifer springs;
- groundwater-dependent streams; and
- terrestrial vegetation potentially dependent on groundwater.

These groundwater-dependent ecosystems are all associated with shallow groundwater or the discharge of groundwater to the surface from aquifers used for extraction. These groundwater-dependent ecosystems have evolved based on the availability of water. Based on the different ecological functional groups present in each groundwater-dependent ecosystems, the environmental water requirements for these three groups are defined in this Plan, based on maintaining these ecosystems at a low level of risk, which has been interpreted as 'the water regime required to maintain self-sustaining populations resilient to drought'.

The other four groundwater-dependent ecosystems types present in the Central Adelaide and Northern Adelaide Plains Prescribed Wells Areas were excluded due to being at low risk of impacts due to groundwater use, or because there is insufficient evidence to define an environmental water requirement. The majority of groundwater use in the area covered by this Plan is from the confined Tertiary aquifers, which have little influence on the groundwater-dependent ecosystems.

Groundwater-dependent ecosystems present along the Gawler, Little Para, Torrens/Karrawirra Parri or Onkaparinga Rivers are likely to have requirements to access both watercourse and groundwater. These watercourses are prescribed as part of the Western Mount Lofty Ranges Prescribed Water Resources Area (PWRA). Their watercourse environmental water provisions have been considered in the Western Mount Lofty Ranges Water Allocation Plan (WMLR WAP). The WMLR WAP has determined extraction limits and threshold flow requirements for these watercourses, which were based on surface water runoff from the surrounding non-prescribed areas and baseflow from surrounding groundwater in Northern Adelaide Plains and Central Adelaide Prescribed Wells Areas. This Plan complements the WMLR WAP by including provisions to protect baseflow through requiring buffers around these groundwater-dependent ecosystems, which limit the construction of new wells, or increases in extraction from existing wells within the buffer.

The three groundwater-dependent ecosystems types considered in the management principles for this Plan are described in further detail below. The highest level of risk identified is a moderate risk to terrestrial vegetation communities that are potentially dependent on groundwater.

3.3 Groundwater-Dependent Ecosystems and their Water Requirements

3.3.1 Fractured rock aquifer springs

Description

Fractured rock aquifer springs occur at sites of localised groundwater discharge. They occur as isolated features where the fractures of the aquifers, topography and features of the surrounding environment promote the discharge of groundwater to the surface. The duration and frequency of saturated soil conditions caused by this discharge influences the plant communities present and their habitat values. Ecological communities supported by fractured rock aquifer springs include a variety of flora and aquatic macroinvertebrates.

The springs are small in extent and tend to provide specialised habitat for species with a very restricted distribution. They generally have a very high conservation value due to the presence of rare and threatened plant species. Within the Adelaide Plains, a number of important springs are associated with the outcropping fractured rock aquifer between Cleland Conservation Park and Eagle Hill Quarry, including Heptinstall's Springs (Figure 3.1), Wilsons Bog, Chinaman's Bog, Harford Spring and Eagle Hill Quarry, each of which support species threatened at a state and national level.

Figure 3.1. Groundwater-dependent vegetation at Heptinstall's Springs

Environmental water requirements

Many of the springs have small surface catchment areas and consequently receive limited input from surface runoff. Therefore they have a high dependence on groundwater. This groundwater supports a variety of flora groups, as well as aquatic macroinvertebrates.

Groundwater supports these ecosystems in several different ways, depending on the site, including through maintenance of inundation and waterlogged conditions and by provision of a shallow watertable.

This Plan defines the environmental water requirements for fractured rock aquifer springs as:

- the adjacent groundwater levels must be above the pool level (where permanent inundation occurs), above the base of the bog (where permanently waterlogged conditions are located), or above the rooting depth of phreatophytic vegetation (where shallow watertables are required) to maintain

permanent inundation where currently permanent, seasonal inundation where currently seasonal or ephemeral where currently ephemeral[25].

Risks from groundwater extraction

The ecology present at fractured rock springs is dependent on the depth of the watertable, which controls the extent and persistence of waterlogging and inundation. The rate at which water is supplied to the site is also important in sustaining evapotranspiration and throughflow.

Therefore the extraction of groundwater in close proximity to these springs presents a risk of affecting spring hydrology. The threat of current levels of groundwater extraction to fractured rock aquifer springs is considered to be low, as there is little development of groundwater resources in the aquifers maintaining these systems. The extraction limits and buffer zone principles in this Plan aim to maintain the status quo.

3.3.2 Groundwater-dependent streams

Description

Groundwater-dependent streams occur in the Mount Lofty Ranges section of the Adelaide Plains, where springs contribute to stream flow or where the stream bed intersects the water table (Figure 3.2). Here, groundwater contributes to the persistence or permanence of pools, flowing reaches and waterlogged channel beds. This is important for maintaining native fish populations within the area. Common galaxias, mountain galaxias, climbing galaxias and other species occur in reaches that are strongly influenced by groundwater and depend on permanent pools and riffles to maintain populations. Perennial pools and flowing reaches also contribute to macroinvertebrate diversity and support specialised native plants. Ecological communities supported by groundwater-dependent streams include flora, aquatic macroinvertebrates and fish.

Environmental water requirements

In order to support their ecological functions, various flora species may require damp to waterlogged stream beds, continuous flooding, or continuous or persistent baseflow. Depending on the site, groundwater can have an effect on groundwater-dependent streams in several different ways, including by maintaining permanent flows and pools and contributing to waterlogged conditions within the riparian zone.

Macroinvertebrates associated with groundwater-dependent streams are supported by groundwater discharge to surface waters, which contributes to the persistence of aquatic habitat and provides the connecting flows that allow fauna to disperse and colonise new areas. The groundwater conditions that contribute to these processes can, in general, be defined by the presence of the watertable at or near the surface or the discharge of groundwater to the surface.

Fish which are associated with groundwater-dependent streams require groundwater discharge to help maintain baseflow, pool depths and wetted channel areas which increase channel response to catchment runoff. This in turn helps to provide riffle and pool habitat to support fish species as well as beneficial water quality.

This Plan defines the environmental water requirements for groundwater-dependent streams for those reaches identified as 'gaining' groundwater, as:

[25] Sinclair Knight Merz (2012). Environmental water provisions for the groundwater-dependent ecosystems of the Adelaide Plains.

- the baseflow component of streamflow must be sufficient to maintain permanent flow (where identified) or a minimum number of no flow days (where flow is seasonal); and
- the adjacent groundwater levels must be above the stream/pool level (where permanent flow/pools are located), above the base of the stream (where permanently waterlogged conditions are located), or within access of the roots of phreatophytic vegetation (where shallow watertables are required)[26].

Risks from groundwater extraction

The threat of current groundwater use to groundwater-dependent streams is likely to be low, as there is little use of groundwater from the fractured rock aquifer in this area. However, there may be localised groundwater use in close proximity to groundwater-dependent streams that has an effect.

The groundwater catchments associated with fractured rock baseflow are significantly larger than for fractured rock spring discharge. Local pumping will have an acute and immediate impact on springs, whereas the impacts to baseflow from pumping will be spread over a greater area. Any pumping within the groundwater catchment will impact baseflow, but the timeframe between pumping and the impact to streamflow will vary with the distance from the stream. As such, total extraction as opposed to the location of extraction is of more significance to fractured rock baseflow[26].

Currently there is little commercial groundwater extraction activity within the fractured rock aquifer, with most extraction confined to stock and domestic use.

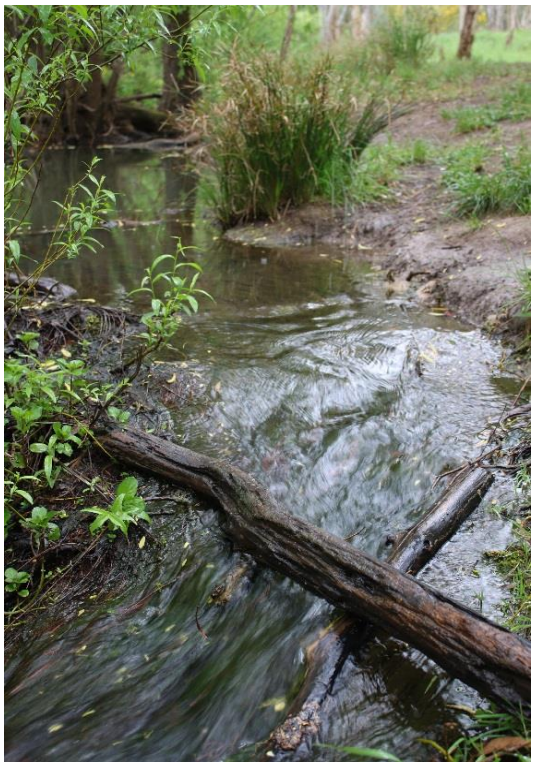

Figure 3.2. Brown Hill Creek – a groundwater-dependent stream

[26] Sinclair Knight Merz (2012). Environmental water provisions for the groundwater-dependent ecosystems of the Adelaide Plains.

3.3.3 Terrestrial vegetation at the base of the hills

Description

Shallow groundwater in the Quaternary aquifer at the base of the hills between Yatala Vale and Springfield helps support a population of large *Eucalyptus camaldulensis* (River Red Gum). This species is known to make use of groundwater when available, and this region represents a groundwater-dependent ecosystem.

Groundwater contributes to the water requirements of these trees by providing elevated soil moisture in the capillary zone above the water table or providing tree roots with water directly from the saturated zone. Trees also access rain infiltration above the water table, but groundwater supplements tree growth, increasing productivity and growth rates, and overall tree habitat value.

Environmental water requirements

Groundwater supports these ecosystems by providing a shallow watertable that roots can access, such that the vegetation is able to maintain photosynthesis in summer when soil moisture stores are depleted. The flora species in this area require high soil moisture in the root zone to support their ecological functions. This means they require access to shallow watertables throughout the year.

This Plan defines the environmental water requirements for terrestrial vegetation at the base of the hills as:

- maintenance of the long-term average recovered (spring) groundwater levels; and
- summer groundwater levels must not decline by more than the rate of change from 2006 to 2010 as measured at a nearby observation bore that was not influenced by groundwater use over this period.

Risks from groundwater extraction

Risks from current groundwater use to terrestrial vegetation at the base of the hills have been identified. There has been increasing use of groundwater from domestic bores on the Adelaide Plains, and groundwater levels have declined. Groundwater monitoring data from the shallow aquifer in this region is very sparse and therefore this threat assessment can currently be made with a low level of confidence only. The buffer zones' distances for new wells or increased extraction from wells have been based on a numerical analysis method which determines the spatial extent of groundwater drawdown resulting from extraction. The distances have been set at a level to ensure minimal decrease in access to groundwater by vegetation.

3.4 Environmental Water Provisions

3.4.1 Management responses for environmental water provisions

Building on the objective to meet the environmental water requirements through environmental water provisions, an investigation to identify appropriate management responses was undertaken. These responses are based on understanding and modelling of how the aquifers respond to extraction, and how they are recharged.

The key management responses are:

- manage overall extraction in relevant consumptive pools;
- provide adequate buffers between groundwater-dependent ecosystems and extraction wells; and
- undertake monitoring of groundwater-dependent ecosystems.

These strategies are explained in further detail below, and reflected in the relevant principles of this Plan.

In relation to the fractured rock aquifers that support groundwater-dependent ecosystems, it is likely that projected reductions in rainfall in the Western Mount Lofty Ranges will lead to moderate reductions in recharge to the unconfined fractured rock aquifers, and a decline in groundwater levels[27]. Groundwater levels will continue to be monitored and the adequacy of the management responses will be reconsidered when this Plan is next reviewed.

3.4.2 Extraction limits

The extraction limits for each consumptive pool in this Plan are based on maintaining at least the current levels of groundwater extraction for human uses (licensed or non-licensed), whilst allowing for use by groundwater-dependent ecosystems.

To determine these limits, the capacity of the groundwater resource in this Plan for the Quaternary and fractured rock aquifers (which primarily support groundwater-dependent ecosystems) was calculated using a water balance method, which considered rates of recharge, consumptive demand, evapotranspiration, and discharge to streams.

Although the volume of groundwater used by groundwater-dependent ecosystems has not been quantified, the extraction limits have taken account of evapotranspiration, which ensures some groundwater is 'reserved' for groundwater-dependent ecosystems. Where insufficient information was available, the extraction limits were set to ensure that not all of the water available within the resource capacity was assigned for consumptive use (licensed or non-licensed).

3.4.3 Buffer zones

Because the Quaternary and fractured rock aquifer consumptive pools cover large geographic areas, overall extraction limits for these zones are a 'blunt' tool for managing potential impacts on groundwater-dependent ecosystems. This management tool is complemented by the requirement to maintain a buffer distance between groundwater-dependent ecosystems and any new or existing well which proposes an increase in extraction.

It should be noted that a well is defined in the Landscape Act as:

- *An opening in the ground excavated for the purpose of obtaining access to groundwater;*
- *An opening in the ground excavated for some other purpose but gives access to groundwater; or*
- *A natural opening in the ground that gives access to groundwater.*

The buffer zones apply equally to wells in the traditional sense and to open excavations in the ground, which provide access to groundwater such as quarries or mine dewatering pits. In this case the entire quarry or pit would need to be outside of the buffer zone assigned to the groundwater-dependent ecosystems being protected.

The buffer zone distances for groundwater-dependent ecosystems used in this Plan are based on modelling and other numerical tools. These were used to test the drawdown of groundwater level associated with extraction from wells, resulting in the recommended buffer distances between pumping and groundwater-dependent ecosystems.

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[27] Pitt T, Osti A, Alcoe D and Green G (2013). Climate change in the Northern Adelaide Plains and implications for horticulture, DEWNR Technical Note 2013/09, Government of South Australia, Department of Environment, Water and Natural Resources, Adelaide.

Consistent with the objective to maintain current levels of access to groundwater by groundwater-dependent ecosystems, the principles state that a well must not be constructed, or a new or increased volume of water must not be authorised to be taken from a well, within the buffer zone of a groundwater-dependent ecosystems, with the buffer zones being specified in Table 3.2.

Table 3.2. Buffer distances for different groundwater-dependent ecosystems and aquifer types

Groundwater-dependent ecosystems Type	Aquifer Type	Buffer Zone (m)
Fractured rock springs and groundwater-dependent streams	Fractured rock aquifer	220
	Unconfined Quaternary aquifer	330
Terrestrial Vegetation	Fractured rock aquifer	250
	Unconfined Quaternary aquifer	250

Figure 3.3, Figure 3.4 and Figure 3.5 show the locations of fractured rock aquifer springs, groundwater-dependent streams and terrestrial vegetation at the base of the hills, and indicate where buffers would apply around these ecosystems.

3.4.4 Monitoring

Section 8 of this Plan outlines the broad objectives and strategies which must be included in a Monitoring, Evaluation, Reporting and Improvement Plan developed for this Plan. This will include a requirement to review the condition of groundwater-dependent ecosystems during the life of this Plan.

Specifically, the Monitoring, Evaluation, Reporting and Improvement Plan developed pursuant to section 8 of this Plan will recommend the monitoring of:

- trends in shallow recovered groundwater levels (measured in spring), and summer groundwater levels in relation to the condition of terrestrial vegetation at the base of the hills;
- monitoring of groundwater conditions at selected sites of gaining reaches of streams; and
- monitoring of groundwater conditions at selected sites of fractured rock springs.

The actions, timeframes and responsibilities to meet these monitoring requirements will be outlined in the Monitoring, Evaluation, Reporting and Improvement Plan. Information gathered through the process will inform the next review of this Plan.

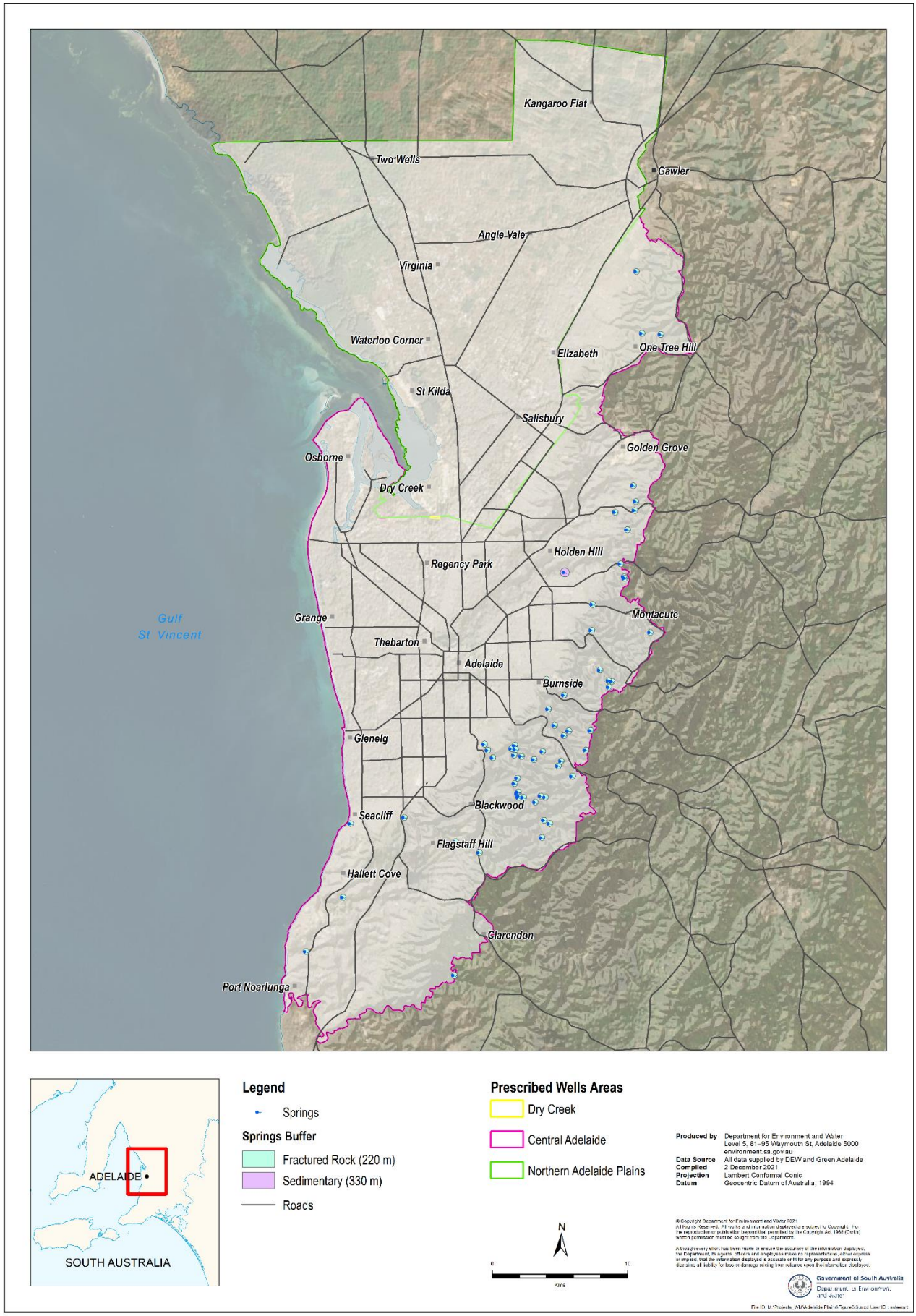

Figure 3.3. Buffers surrounding fractured rock springs

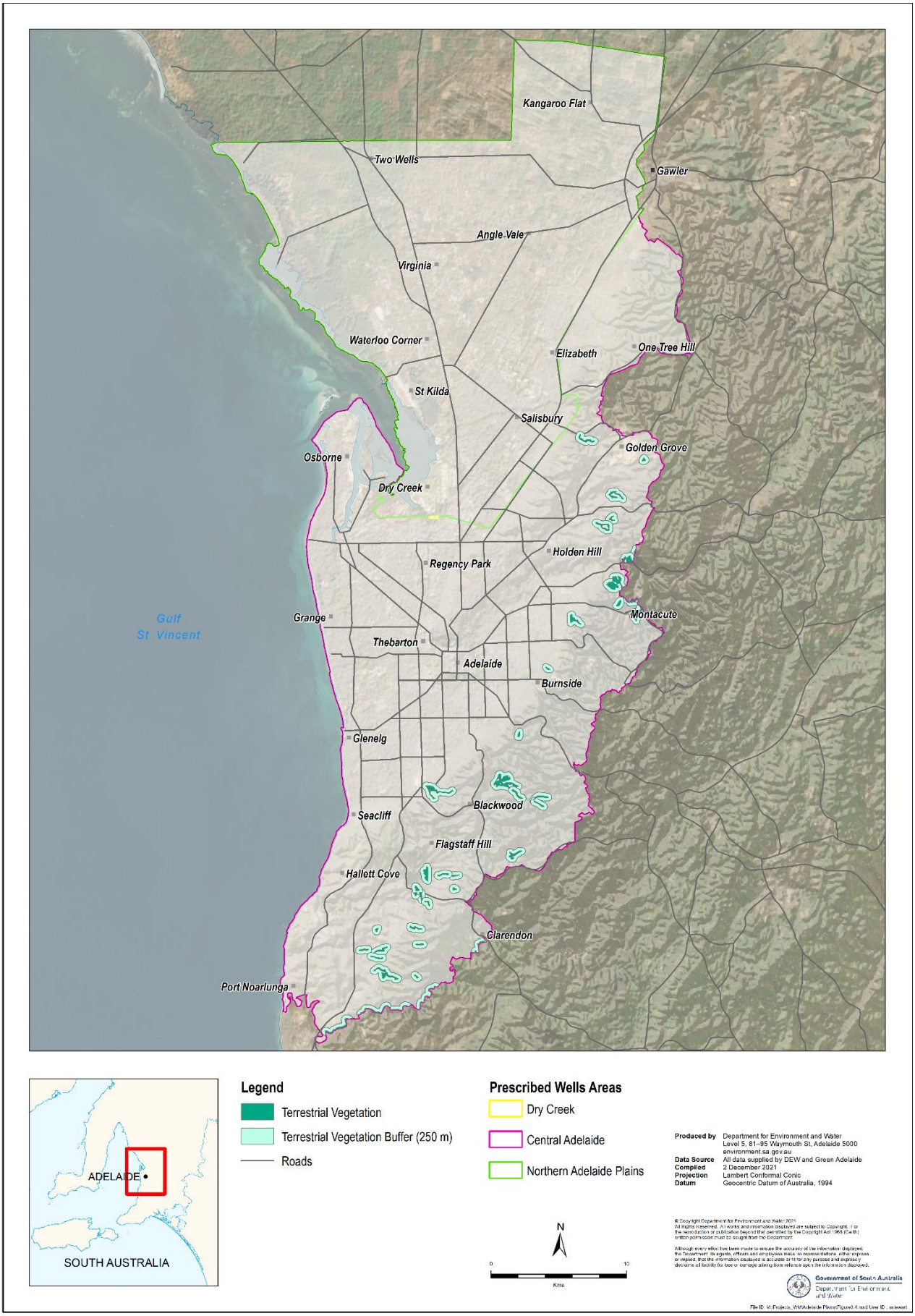

Figure 3.4. Buffers surrounding groundwater-dependent vegetation

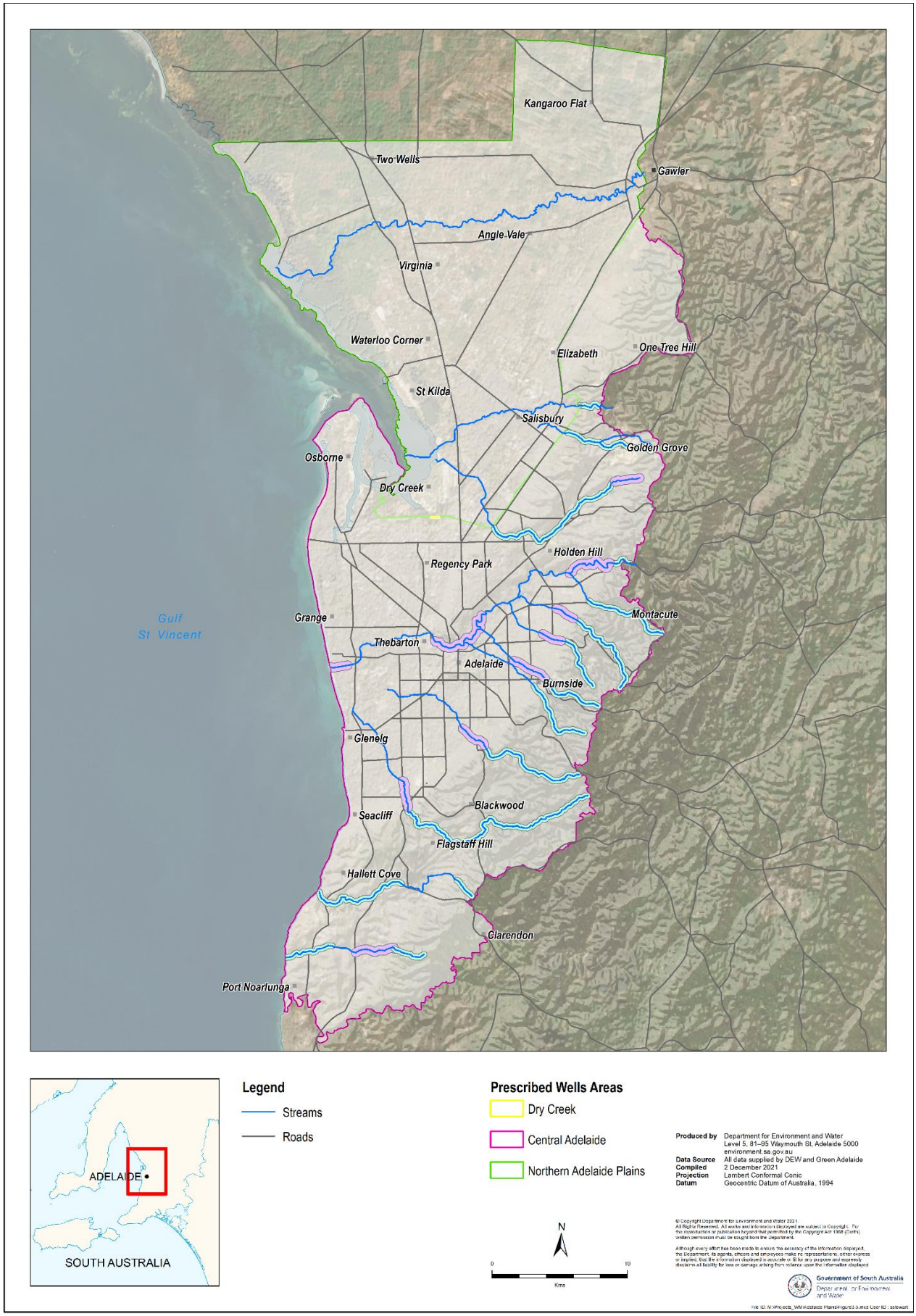

Figure 3.5. Buffers surrounding streams receiving groundwater discharge

4 Effects on Other Water Resources

4.1 Overview

As the extraction of groundwater will have some impact on the groundwater resource, the principles in this Plan ensure that any potential impacts on the groundwater resource itself, users of the resource and ecosystems dependent on the resource are within acceptable limits. Around each point of extraction, there is likely to be a zone of influence where drawdown (or a decline in water level/pressure, often referred to as a 'cone of depression') may be observed. Outside this zone, the impact on water levels/pressures and groundwater flow is likely to be insignificant, not only within the same aquifer from which the extraction is occurring but also in adjacent or overlying/underlying aquifers, particularly where hydraulic connectivity may be limited, though impacts on the regional water budget may also be observed.

The following sections outline likely effects that extraction of the water resources managed by this Plan may have on other water resources or the impacts extraction from other resources may have on the groundwater resources within the Adelaide Plains.

4.2 Impacts on Other Prescribed Areas

The Adelaide Plains borders two other prescribed areas: the Western Mount Lofty Ranges Prescribed Water Resources Area to the east and the McLaren Vale Prescribed Wells Area to the south.

Groundwater in the fractured rock aquifers of the Western Mount Lofty Ranges Prescribed Water Resources Area flows in a westerly direction and continues across a series of faults into the aquifers underlying the Adelaide Plains. The volume of this recharge is difficult to quantify. However, interception of this water in the Western Mount Lofty Ranges Prescribed Water Resources Area may reduce the flow of water to the aquifers of the Adelaide Plains. Continued monitoring of wells within the Adelaide Plains and the Western Mount Lofty Ranges Prescribed Water Resources Area will help to determine whether the taking and use of water in the Western Mount Lofty Ranges Prescribed Water Resources Area is having a detrimental impact upon the resources of the Adelaide Plains.

Within the fractured rock aquifers, the impacts of extraction are not widespread, as water availability depends on local conditions such as the number and size of fractures intercepted by each well. Therefore the taking of water within the fractured rock aquifers of the Adelaide Plains is unlikely to impact upon the availability of groundwater in the fractured rock aquifers of the Western Mount Lofty Ranges Prescribed Water Resources Area and vice versa.

Four large watercourses (the Gawler, Little Para, Torrens/Karrawirra Parri, and Onkaparinga/Ngangki Parri Rivers, referred to in the Water Allocation Plan for the Western Mount Lofty Ranges Prescribed Water Resources Area as 'watercourses across the plains') are prescribed as part of the Western Mount Lofty Ranges Prescribed Water Resources Area. Taking of groundwater, in particular from the shallow Quaternary aquifers of the Adelaide Plains hydraulically connected to these watercourses, may have a detrimental impact on the volume of surface water available for use in addition to impacts to the health and maintenance of any groundwater-dependent ecosystems present. Buffer zones around groundwater-dependent ecosystems, including

groundwater-dependent streams receiving spring flow, have been included in this Plan to limit the impact of taking water from these shallow groundwater resources on the watercourses across the plains.

Taking and use of groundwater in the Adelaide Plains is likely to have little impact on the quality and quantity of groundwater in the McLaren Vale Prescribed Wells Area. This is due to the limited connectivity of the groundwater resources, and the low rates of extraction from the Noarlunga Embayment. Continued monitoring of wells within both the Adelaide Plains and the McLaren Vale Prescribed Wells Area will help to determine whether the taking or use of water within either area is having a detrimental impact on the other resource.

4.3 Impacts on Non-Prescribed Areas

The T2 aquifer extends to the north of the Northern Adelaide Plains Prescribed Wells Area. In this confined sedimentary aquifer, drawdowns due to extraction cause a reduced pressure response which can extend beyond the boundaries of the Northern Adelaide Plains Prescribed Wells Area. The groundwater resources in the adjacent non-prescribed area to the north are generally of poor quality and are low yielding. Therefore the taking and use of water within the Northern Adelaide Plains Prescribed Wells Area is not expected to detrimentally affect these resources. Minor impacts could occur in the area near the Northern Adelaide Plains Prescribed Wells Area boundary if the zone of influence due to extraction extends outside the prescribed wells area.

4.4 Impacts on Surface Water

Groundwater extraction can affect the availability of surface water in two ways. Firstly, where groundwater discharge occurs from unconfined aquifers to gaining streams in the form of baseflow, extractions may reduce the hydraulic gradient toward the stream and hence reduce the volume of baseflow. Secondly, if these extractions occur close to the streams, the hydraulic gradient may be altered sufficiently to induce discharge from the stream to the groundwater. This can occur to both gaining and losing streams.

In the Central Adelaide Prescribed Wells Area, there is widespread connectivity between groundwater and surface water, particularly in the fractured rock aquifers in the Mount Lofty Ranges, where baseflow can be vital in supporting ecosystems. Investigations into the connection of surface water and groundwater in the Adelaide Plains identified that the headwaters of some streams are likely to be affected by current groundwater extractions, including Cobbler Creek, Dry Creek, Fifth Creek, Fourth Creek, First Creek, Sturt River, Field River and Christie Creek.

On the plains, current extractions from unconfined Quaternary aquifers are relatively small and are likely to have only a small potential to affect streamflow in the lower reaches of the Torrens River. Extractions from deeper confined aquifers are unlikely to have direct impacts on streams due to the limited connection.

In order to protect streamflow from the impacts of future licensed extractions, buffer zones around streams in the hills face zone of the Central Adelaide Prescribed Wells Area are required, so that new wells may not be constructed, or extraction increased, in close proximity to these streams. In reality, the terrain within this part of the Mount Lofty Ranges means that it is unlikely there will be a demand for increases in extraction for licensed purposes.

4.5 Seawater Intrusion

Under natural conditions, coastal aquifers with hydraulic connectivity to the sea form an interface between the fresh groundwater and the sea to which it is discharging. The shape and location of this interface is governed by natural processes that include tidal action and climate-driven seasonal or annual changes in aquifer discharge to the sea and may be influenced by high rates of groundwater extraction. The landward migration of the seawater-freshwater interface is known as seawater intrusion, a process that reduces the availability of fresh groundwater. Recent studies suggest that the risk to the fresh groundwater resource within the prescribed areas from seawater intrusion is currently low.

At the coast adjacent the Adelaide Plains, the deeper T1 and T2 aquifers lie beneath 50 metres of Hindmarsh Clay, which thickens to the south to approximately 100 metres thick at the Para Fault near Adelaide Airport. However, the extent and thickness of the Hindmarsh Clay offshore is unknown and hence the degree of connectivity of the deeper Tertiary aquifers with the ocean and the location of the seawater-freshwater interface within these aquifers is also unknown.

Recent work[28] has discovered significant reserves of fresh groundwater in sediments underlying the continental shelf in many parts of the world. About 20,000 years ago, the sea level was 120 metres lower than the current level and this groundwater was most likely recharged when the continental shelf was exposed. This situation may also exist beneath Gulf St Vincent, but has yet to be verified.

[28] Post V, Groen J, Kooi H, Person M, Ge S and Edmunds M (2013). Offshore fresh groundwater reserves as a global phenomenon, NATURE, Volume 504, pages 71-78.

5 Capacity of Water Resources to Meet Demand

Section 2.7 outlined the availability of groundwater for consumptive purposes (excluding the water taken for unlicensed purposes or licensed stock and domestic use), based on scientific investigations. The demand for groundwater for environmental water requirements has been described in section 3. Environmental water provisions are accounted for outside of the consumptive pools delineated in this Plan.

This section assesses whether the groundwater resources have the capacity to meet consumptive demands for groundwater on a continuing basis. In order to do this, it is first necessary to analyse this demand, and therefore the following describes the current demand and assesses projected future demand. 'Demand' includes licensed extraction (including some licensed stock or domestic extraction where prescribed), and other non-licensed uses of groundwater, such as by forestry and for road-making and fire-fighting.

5.1 Current Consumptive Demand

The current major consumptive demands for groundwater in the Adelaide Plains are for:

- agricultural production (primarily horticulture in the Northern Adelaide Plains Prescribed Wells Area and the Mount Lofty Ranges part of the Central Adelaide Prescribed Wells Area);
- commercial and industrial uses (primarily in the Central Adelaide Prescribed Wells Area);
- irrigation of turf and open spaces for recreational, amenity and sporting purposes (primarily in the Central Adelaide Prescribed Wells Area);
- mining activities throughout the Adelaide Plains region;
- stock or domestic use; and
- other non-licensed uses.

For the purposes of developing this Plan, data and information about these demands were obtained from:

- metered extraction data for the Northern Adelaide Plains Prescribed Wells Area where most of the groundwater extraction (both commercial and stock or domestic purposes) is licensed and metered, providing a reliable estimate of current use;
- allocation data for the Northern Adelaide Plains Prescribed Wells Area, which indicates the total volume of water on licence that could be demanded;
- volumes specified in authorisations and prospective water entitlements in the Central Adelaide Prescribed Wells Area, where long-term comprehensive metering data are not yet available;
- volume allocated on licence for the Dry Creek Prescribed Wells Area;
- estimation of non-licensed demand (excluding licensed stock or domestic use in the Northern Adelaide Plains) using a statistical methodology; and
- licensing information about some of the water authorised to be taken by notice issued under section 105 of the Landscape Act, which could either continue as authorisations or be converted to a licence.

Based on this data, at the date of approval of this Plan:

- in the Quaternary, T1 Regional, T2 Regional, Golden Grove Embayment, Noarlunga Embayment and Northern Fractured Rock consumptive pools, new entitlements could be issued to help meet future demand.
- in the Kangaroo Flat, Lower Tertiary and Southern Fractured Rock Consumptive Pools, no new entitlements could be issued to meet future demand as these consumptive pools are already at full capacity – unless, with the exception of Kangaroo Flat, the applicant can demonstrate that the taking of additional water from these consumptive pools is unlikely to impact upon existing users of the resource, ecosystems which depend upon it or the aquifer itself.
- in the T1 Northern Adelaide Plains and the T2 Northern Adelaide Plains Consumptive Pools, no new entitlements could be issued to meet future demand throughout the life of this Plan as the sum of entitlement shares already exceed the capacity of the resource within these consumptive pools.

5.2 Groundwater Demand by Agriculture

5.2.1 Current demand

Across the Adelaide Plains, groundwater is used extensively for a variety of agricultural purposes. In the Northern Adelaide Plains Prescribed Wells Area, approximately 18 GL is extracted in a year of average rainfall, primarily from the T2 aquifer. This total varies according to seasonal conditions. For example, it was around 14 GL in 2005, and 24 GL in 2006 (during the Millennium Drought). The area is an economically important intensive horticultural production zone, supporting the production of a wide variety of crops, including field crops, greenhouse vegetables, almonds and wine grapes.

In parts of this area, groundwater use is supplemented by reclaimed water (treated wastewater) through the Virginia Pipeline Scheme. The extension of the pipeline to Angle Vale in 2009 helped reduce the demand on groundwater. An important use of groundwater is to shandy it with the more saline reclaimed water so that the mix is of adequate quality for horticultural production.

In the Central Adelaide Prescribed Wells Area, approximately 3 - 4 GL of groundwater is used for agricultural purposes annually. The fractured rock aquifer in the Mount Lofty Ranges is accessed for a variety of horticulture, including apples, cherries, stone fruit, berries, cut flowers, grapes, olives, vegetables and nuts. There is also some use of groundwater for irrigation of pasture and lucerne production.

5.2.2 Future demand

Commercial irrigation for horticulture will continue to place the greatest demands on the groundwater resource in the Northern Adelaide Plains Prescribed Wells Area. However the pattern of land use in this area is changing rapidly. Some areas of former agricultural land have been converted to residential housing, such as around Angle Vale. The 30-Year Plan for Greater Adelaide[29], while aiming to avoid the ongoing consumption of highly productive agricultural and horticultural land on the urban fringe, identifies the Northern Adelaide Plains Prescribed Wells Area as an area of likely urban expansion. This may result in less demand for groundwater.

[29] The 30-Year Plan for Greater Adelaide (2017). Department of Planning, Transport and Infrastructure, Government of South Australia, Adelaide.

Other factors which may influence demand are the trend towards increased use of greenhouse horticulture, which is more water-efficient, increasing development of Managed Aquifer Recharge schemes, the availability of recycled water, the availability of new technologies for small scale desalination of groundwater, and the need for increased irrigation due to higher temperatures and evapotranspiration resulting from climate change. Given this range of interconnected factors, it is difficult to predict the future demand for groundwater for agricultural uses. Based on historical records, needs are likely to fluctuate between 13 and 20 GL per year. There will be short-term fluctuations in demand when more or less water is required, largely linked to seasonal variations in climate and rainfall.

5.2.3 Capacity to meet demand

Modelling results have shown that the groundwater of the Adelaide Plains has the capacity to meet the current demand for agriculture over the next decade, at current levels of average annual extraction. This modelling was based on the extraction which occurred in the Northern Adelaide Plains Prescribed Wells Area over an indicative 8-year period, which included several years of drought and some years of average rainfall.

However, as discussed in section 5.2.2, it is uncertain whether demand will increase. Extraction could theoretically increase in the Northern Adelaide Plains Prescribed Wells Area because there is a large volume of currently unused allocations. The management framework set up by this Plan recognises this uncertainty by establishing an adaptive management approach which relies on monitoring of the resource condition against resource condition triggers and taking appropriate action if required.

5.3 Groundwater Demand by Industry

5.3.1 Current demand

In the Central Adelaide Prescribed Wells Area, current industrial and commercial demand for groundwater is in the order of 5 GL per year. This water is used for a wide range of industrial and manufacturing purposes, linen washing, power generation and the production of alcoholic drinks and spring water. Most of the water sourced for these purposes is from the T1 aquifer. Some enterprises requiring a specific quality of water run their own on-site reverse osmosis plants to purify groundwater before use. A large proportion of the total groundwater extraction in this area is undertaken by a small number of enterprises – for example, the 25 highest volume water users account for approximately 75% of the extraction.

In the Dry Creek Prescribed Wells Area, groundwater has been used previously for salt production purposes, however demand for this purpose has reduced over time.

5.3.2 Future demand

Demand for use of groundwater for industrial and commercial purposes is not expected to increase significantly over the life of this Plan. There are increasing opportunities to store and access recycled water, which may decrease reliance on groundwater. Some large industries which were previously using groundwater have ceased operation, and it is not known whether their entitlements will be taken up by other users.

5.3.3 Capacity to meet demand

Most of the industrial and commercial uses of groundwater occur in the Central Adelaide Prescribed Wells Area. The groundwater in this area has the capacity to meet the current demand. As demand is not expected to increase significantly, the groundwater resource should continue to meet demand.

5.4 Groundwater Demand for Irrigation of Turf and Open Space

5.4.1 Current demand

Irrigation of turf for sport and recreation, golf courses and other open spaces currently relies on approximately 10 GL of annual groundwater extraction. This is a very important aspect of groundwater use in the Central Adelaide Prescribed Wells Area, supporting not just economic outcomes, but also a wide range of social and cultural benefits.

5.4.2 Future demand

Future demand for groundwater by this sector is difficult to assess. Within urban areas, there is very limited potential for the expansion of open areas requiring irrigation. However, there is ongoing development of alternative water sources across Adelaide, including stormwater used in Managed Aquifer Recharge schemes, and recycled wastewater. Current groundwater allocations may be insufficient to provide the full water requirements in every year, depending on seasonal conditions. Therefore demand will depend on the pricing and ability to access alternative water supply or to acquire unallocated water.

5.4.3 Capacity to meet demand

The groundwater resource is expected to continue to be able to meet demand for irrigation of turf and open space. This is because most of this activity occurs in the Central Adelaide Prescribed Wells Area, and the volumes of licences issued in this area are less than the assessed capacity of the resource. This means water may be available for allocation if required into the future.

5.5 Groundwater Demand for Mining

5.5.1 Current demand

There are a total of 110 active mining tenements covering approximately 8750 hectares located within the Adelaide Plains region, with 84 of those tenements being identified as a strategic resource area. A strategic resource area is an area within the Greater Adelaide region or near a major regional center that is of key economic value to South Australia due to the quantity or quality of construction materials or mineral resources that are extracted or contained within that area, and are considered as the most strategically important resources contributing to the broader economy and communities.

Quarries are of particular significance throughout the Adelaide Plains. While some are not deep enough to access the groundwater and therefore do not require a water licence, many would be extracting water from the prescribed resources in order to access the underlying mining resource, for use in dust suppression or to meet processing water needs.

As it is not standard industry practice to meter water that has been dewatered from a pit, the quantification of the current demand on the water resource is difficult to predict. It should also be noted that evaporative losses from the pit would also constitute a demand on the resource and this would be harder to estimate than for the pit dewatering. Furthermore, the pits are often a mix of surface water and groundwater and as such accounting for the purposes of surface water versus groundwater for the purposes of licensing is often difficult for industry.

5.5.2 Future demand

The future demand for water from the mining sector will be dependent on the location and quantity of mineral resources within the Adelaide Plains area. In accordance with long-standing state Government policy[30], mining ventures must source their own water supplies within the sustainable framework of landscape planning. Within prescribed areas, mining companies are required to hold a licence and therefore a water access entitlement to take water in the same way as other water users.

5.5.3 Capacity to meet demand

The resource is currently able to meet the demand of the mining sector. However, depending on the location of future expansions in mining, there may not be available water access entitlement shares to meet demand into the future. Mining operations may be able to navigate any limitations on the availability of water access entitlements by effectively working as a Managed Aquifer Recharge scheme, whereby the water they extract from the pit is drained or discharged back into the aquifer at another location.

5.6 Non-Licensed Groundwater Demand and Licensed Stock and Domestic Demand

5.6.1 Current demand

Across the Adelaide Plains, the take of water for non-licensed use and licensed stock or domestic use occurs mostly from the fractured rock and Quaternary aquifers. In the Northern Adelaide Plains Prescribed Wells Area, licensed allocations are issued for stock or domestic extraction, but for the purposes of this Plan this use is accounted for in the same way as non-licensed uses – that is, as additional to the resource extraction limits determined for each of the consumptive pools. Other types of extraction that are classified as 'non-licensed' are:

- commercial forestry groundwater interception;
- use for fire-fighting;
- use for public road making or other infrastructure projects; and
- any other authorisation to take water issued under section 105 of the Landscape Act.

It is necessary to understand the level of demand for non-licensed use and licensed stock or domestic use in order to determine the volume available for other licensed purposes from the consumptive pools.

[30] Department of Water, Land and Biodiversity Conservation (2009). Water for Good: A Plan to Ensure Our Water Future to 2050, Department of Water, Land and Biodiversity Conservation, Government of South Australia, Adelaide.

An investigation found that there are 6049 wells assumed to be active within the Central Adelaide Prescribed Wells Area for non-licensed use. Within the Northern Adelaide Plains Prescribed Wells Area stock and domestic water is licensed and is therefore captured in the allocation data in the State Water Register. As the data is input into the register based on purpose, the volumes of water allocated for stock and domestic purposes were able to be extracted and knowledge of the wells associated with the licence has enabled the water to be apportioned to the relevant consumptive pool.

Additionally, the investigation identified an area of approximately 712 ha commercial forestry (which includes currently planted and areas designated as forestry), the majority of which fall within the hills face zone of the Central Adelaide Prescribed Wells Area. It is estimated that 214 ha of planted hardwood are currently utilising 389 ML/y and 142 ha of softwoods are utilising 236 ML/y with all the use presumed to be taken from the fractured rock aquifer. A further 5 ML/y is presumed to be taken from the fractured rock aquifer for firefighting purposes and 320 ML/y is being taken for road making purposes. In this case it is assumed 80 ML/y is extracted each from the T1 and T2 aquifers, with 160 ML/y taken from the fractured rock aquifer. It is assumed that the volume accounted for annually to support road making would also be suitable to provide any water requirements for railway construction or major infrastructure projects. Table 5.1 shows the estimated non-licensed use and licensed stock or domestic use per aquifer and type of use[31].

Table 5.1. Estimated volumes of non-licensed use and licensed stock or domestic use

Consumptive Pool	**Estimated Non-Licensed Extraction (ML/y)**				
	Stock and Domestic	Forestry	Fire	Roads	Total
Quaternary	1,477				1,477
T1 NAP	57				57
T1 Regional	7			80	87
T2 NAP	54				54
T2 Regional	125			80	205
Kangaroo Flat	6				6
Lower Tertiary	0				0
GGE (T1/T2 and FRA)	63				63
Noarlunga Embayment	5				5
Northern FRA	292	208	5		505
Southern FRA	326	417		160	903
TOTALS	**2,412**	**625**	**5**	**320**	**3,362**

5.6.2 Future demand

The use of water for stock or domestic purposes is expected to remain stable in the Northern Adelaide Plains Prescribed Wells Area, particularly because it is licensed in this area and no new authorisations to take water from the consumptive pools in this area will be issued throughout the life of this Plan.

[31] Australian Groundwater Technologies (2011). Estimating Non-Licensed Groundwater Use Across the Adelaide Plains Prescribed Wells Area, prepared for the Adelaide and Mount Lofty Ranges Natural Resource Management Board, Adelaide.

In the Central Adelaide Prescribed Wells Area, non-licensed use is estimated to increase by approximately 22 ML/y, primarily from the Quaternary aquifers where the groundwater quality is reasonable. This estimate is based on previous rates of drilling of new wells for stock or domestic use at current population levels.

Road construction, forestry and other non-licensed uses are likely to remain at similar levels, assuming no significant or extended periods of drought.

5.6.3 Capacity to meet demand

As demand is not expected to increase significantly, the groundwater resources are expected to continue to meet non-licensed demand.

5.7 Consumptive Demand Summary

Each native groundwater consumptive pool in this Plan is defined volumetrically. The volume of the consumptive pool includes both the volume of water required to meet the non-licensed demands and the licensed stock and domestic demands in addition to the volume of water which is able to be allocated from the consumptive pool for other licensed purposes. Table 5.2 provides a summary of the different components which comprise the consumptive pool at the date of approval of this Plan.

Table 5.2. Consumptive pool volumes

Consumptive Pool	Non-licensed and licensed stock and domestic volume (ML/y)	Maximum volume able to be allocated annually (ML/y)	Total consumptive pool volume (ML/y)
Quaternary	1,477	6,762	8,239
T1 NAP	57	4,601	4,658
T1 Regional	87	10,494	10,581
T2 NAP	54	18,378	18,432
T2 Regional	205	6,023	6,228
Kangaroo Flat	6	1,500	1,506
Lower Tertiary	0	2,385	2,385
GGE (T1/T2 and FRA)	63	4,552	4,615
Noarlunga Embayment	5	1,717	1,722
Northern FRA	505	5,116	5,621
Southern FRA	903	1,409	2,312
TOTALS	**3,362**	**62,937**	**66,299**

5.8 Groundwater for Aboriginal Cultural Purposes

Groundwater may be utilised by Aboriginal people in relation to satisfying their personal, domestic, cultural, spiritual or non-commercial communal water needs from the Cultural Water Consumptive Pool. This water is an inherent right to access water for these purposes and does not require the issuance of a water licence. The volumes of water likely to be used to meet the cultural requirements of Aboriginal people within the Adelaide Plains is difficult to quantify but is not deemed to be substantial.

There is likely to be demand for water from Aboriginal people for economic purposes into the future, although this demand is not quantifiable at the time of writing. Conversations with Aboriginal people will be ongoing to ensure their needs for water are well understood and can be supported where possible.

5.9 Monitoring of Capacity to Meet Demand

The Department monitors the water level and salinity of groundwater resources, the results of which are published in groundwater technical notes and status reports available on WaterConnect. Further monitoring requirements are set out in section 8 of this Plan and will be further defined in the associated Monitoring, Evaluation, Reporting and Improvement Plan.

5.10 Land Values

There is no evidence at present to suggest that the demand for water from the prescribed resources managed by this Plan will increase substantially in the near future.

The 30-Year Plan for Greater Adelaide[32] forecasts further expansion of housing in the Northern Adelaide Plains Prescribed Wells Area thereby limiting the expansion for water use for agriculture in this region. With the exception of industry water demand, there is unlikely to be an increase in demand for water in the Central Adelaide Prescribed Wells Area.

Further, in the Northern Adelaide Plains Prescribed Wells Area there is an active water market which can facilitate the movement of water to areas where required to meet demand in line with the principles in this Plan, and in the Central Adelaide Prescribed Wells Area there is additional water available to meet demand into the future. Additionally, alternative water supply options such as recycled waste water and treated stormwater are becoming more available within the prescribed areas, which may be able to meet future demand for water.

Therefore, given the likely stability in future demand, and the capacity for the existing water resources and alternative water supplies to meet any increase in demand, it is not expected that land values will be influenced by the availability of water during the life of this Plan.

[32] The 30-Year Plan for Greater Adelaide (2017). Department of Planning, Transport and Infrastructure, Government of South Australia, Adelaide.

6 Water Management Strategy

Within the Northern Adelaide Plains, Dry Creek and Central Adelaide Prescribed Wells Areas, a person may only lawfully take water from the prescribed water resources:

a. pursuant to a water allocation that relates to the water resource (which, in the Northern Adelaide Plains Prescribed Wells Area, includes taking water for stock or domestic purposes[33]); or

b. pursuant to an authorisation under section 105 of the Landscape Act[34] which allows for water to be taken for certain purposes (which in the Central Adelaide and Dry Creek Prescribed Wells Areas, allows for the taking of water for stock or domestic purposes); or

c. for the purposes of drinking or cooking if the rate of taking does not exceed the rate prescribed by regulation, namely 100 litres a day[35].

The Landscape Act requires that a water allocation plan be prepared for each prescribed water resource and further specifies that a water allocation plan can relate to more than one water resource. As such the principles in this section relate to the Northern Adelaide Plains Prescribed Wells Area, the Dry Creek Prescribed Wells Area and the Central Adelaide Prescribed Wells Area.

6.1 Water Licensing Regime

A key aspect of a water allocation plan is that it establishes a water licensing regime to regulate the taking of water from the resource. The first step in establishing this licensing regime is determining a consumptive pool or pools.

A water allocation plan must "*determine, or provide a mechanism for determining, from time to time, a consumptive pool, or consumptive pools for the water resource*". A consumptive pool is defined as the water "*that will from time to time be taken to constitute the resource within a particular part of a prescribed water resource for the purposes of Part 8…*"[36]. This Plan must therefore determine a consumptive pool or pools, so as to account for all of the water that may be lawfully taken from the prescribed areas, which excludes water required to maintain cultural and environmental values. The Minister must further determine, from time to time, the volume of water that is to be made available for allocation from a consumptive pool[37]. The consumptive pools determined for this Plan are outlined in section 7.1 and are based on a fixed geographic boundary and aquifer, with the exception of the Managed Aquifer Recharge and Cultural Water Consumptive Pools, which are purpose-based and extend across the entire area managed by this Plan.

A water licence provides a water access entitlement to the holder of the licence to gain access to a share of the water available in the consumptive pool to which the licence relates[38]. A water access entitlement is a specified

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[33] Section 7(5) and (6) of the *Water Resources Act 1997* and regulation 4(2) of the *Water Resources (Northern Adelaide Plains Prescribed Wells Area) Regulations 2004*

[34] Authorisations under Section 105 of the *Landscape Act* for these prescribed areas include the ability to take water for the following purposes without a water licence: firefighting, road making, cultural purposes for native title holders and the application of chemicals to non-irrigated crops and non-irrigated pasture and for the control of pest plants and animals

[35] Section 100(7) of the *Landscape Act* and regulation 17 of the *Landscape South Australia (Water Management) Regulations 2020*

[36] Sections 53(1)(c) and 3(1) of the *Landscape Act*

[37] Section 121(4) of the *Landscape Act*

[38] Section 121(2) of the *Landscape Act*

number of entitlement shares within the consumptive pool, where the volume of water available for allocation from the consumptive pool is determined from time to time by the Minister under section 121(4) of the Landscape Act. A water allocation is issued annually to licensees and this is the volume of water the licensee can take in the particular water-use year.

While a water access entitlement represents the licence holder's right to a share of the resource, a water allocation will relate to a specified period of no more than 12 months[39] and is the volume of water that may be taken during the specified period. The water allocation is determined based on the value of the entitlement share, where in most cases 1 entitlement share will be equivalent to 1 kL of water allocation (e.g. if the licensee's water access entitlement states they hold 100 entitlement shares, the water allocation issued in relation to these shares will be 100 kL) (Figure 6.1).

For the majority of the consumptive pools, the value of the entitlement shares will remain consistent for the life of this Plan (1 share = 1 kL) and the allocation issued each water-use year will be for the same volume. However, in two consumptive pools the value of the entitlement share may vary dependent on the resource condition. This may result in the allocation being issued at a reduced rate for the relevant water-use year. The management response for the relevant consumptive pools is discussed further in section 6.4.

The availability of water from the Managed Aquifer Recharge Consumptive Pool is managed via an alternative mechanism discussed below in section 6.3. Additionally, the Cultural Water Consumptive Pool authorises the take of water for Aboriginal cultural purposes as per section 5.8 of this Plan, but does not require the issue of licences from the consumptive pool to authorise this take.

This Plan facilitates the opportunity to permanently move entitlement shares from consumptive pools where the sum of the entitlement shares exceeds the resource extraction limit, to areas managed by this Plan where water is available to be allocated.

Groundwater may only be taken from within the Adelaide Plains in accordance with a water licence issued under this Plan or through an authorisation issued under the Landscape Act. The water licence will list the wells through which the water allocation may be taken prior to any water being extracted in relation to the licence and therefore a water resource works approval is not required to authorise the taking of water in any circumstances[40].

[39] Section 127(8) of the *Landscape Act*

[40] Section 104(6)(a) of the *Landscape Act* and regulation 19(1) of the *Landscape South Australia (Water Management) Regulations 2020*

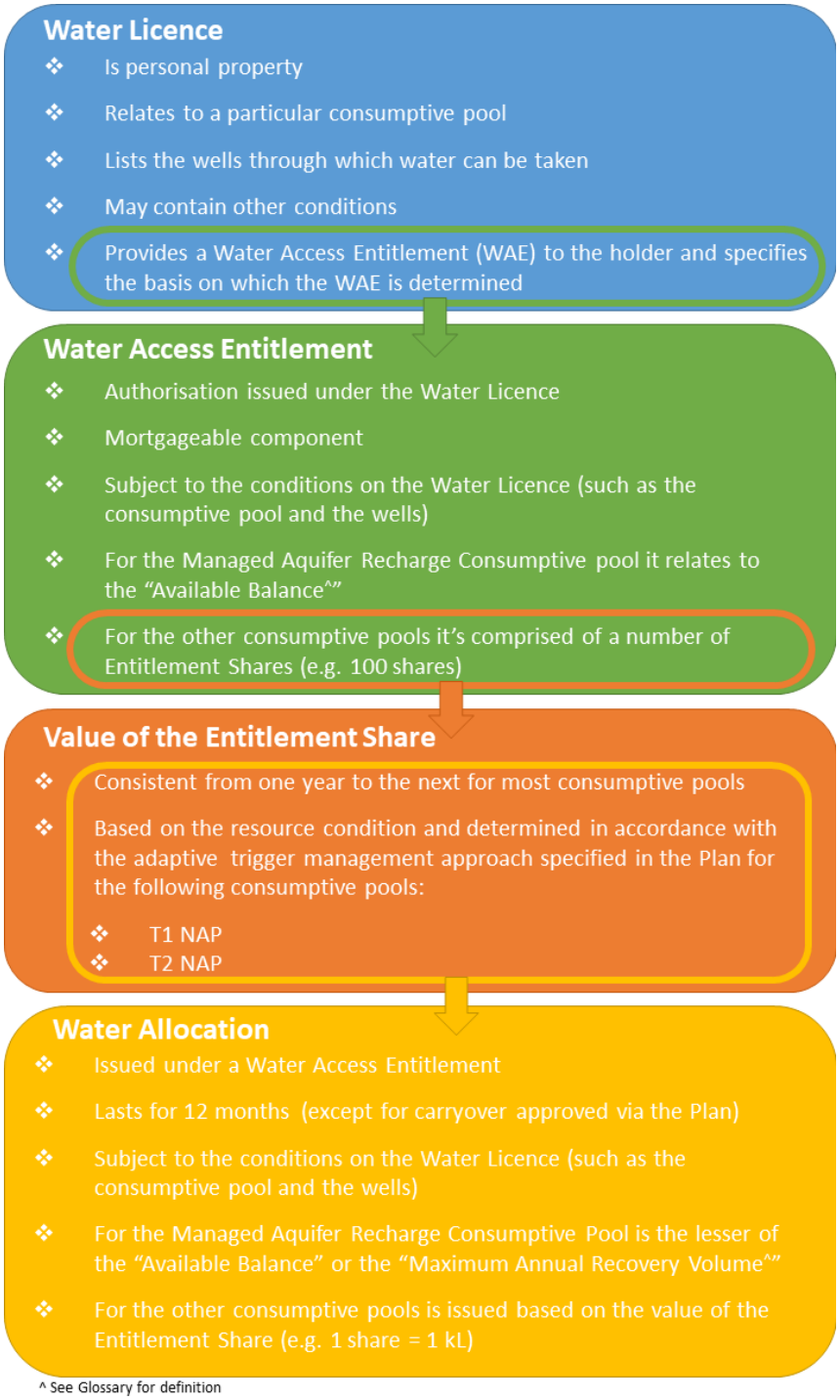

Figure 6.1. Water Licence, Water Access Entitlement, Value of Entitlement Share and Water Allocation

The Minister may grant new water licences with respect to the wells in the prescribed areas in accordance with this Plan and the Landscape Act. The taking and use of such water will be subject to the principles in this Plan to ensure the taking of water will not cause undesired impacts to existing users of the resource, groundwater-dependent ecosystems or the aquifers themselves.

6.2 Water Affecting Activities

Generally, water affecting activities are managed by the objectives and principles set out in the Water Affecting Activities Control Policy formulated by the relevant Landscape Board. The Water Affecting Activities Control Policy policies set out the matters that the relevant authority will take into account when exercising a power to grant or refuse a permit for a water affecting activity[41], such as a permit to erect, construct or place any building or structure in a watercourse or on the floodplain of a watercourse.

However, in particular circumstances, the Minister is the relevant authority for certain water affecting activity permits, such as the granting of permits for the drilling, decommissioning, sealing, repairing, replacing or altering the casing, lining or screen of a well; the draining or discharging of water directly or indirectly into a well; and the use of effluent water and imported water on land.

This Plan sets out the matters that the Minister must take into account when deciding whether to grant or refuse a permit with respect to the aforementioned matters within the Northern Adelaide Plains, Dry Creek and Central Adelaide Prescribed Wells Areas.

The Landscape Act states[42] that a person must not use water taken from a prescribed water resource unless authorised to do so by a site use approval[43]. A site use approval is not required if the water allocation plan for the prescribed resource provides the specified circumstances or situations in which no site use approval is required[44]. As the use of imported and effluent water on land within the prescribed areas is managed through a water affecting activity permit issued in accordance with this Plan, a site use approval is not required under any circumstances.

6.3 Management of Managed Aquifer Recharge Schemes

Managed Aquifer Recharge refers to the intentional draining or discharging of water to aquifers for subsequent use or environmental benefit. Managed Aquifer Recharge offers numerous benefits, including: storage to improve security of water supply; natural water treatment[45]; a low-cost, low-energy water supply option; a freshening of regional aquifer salinity; and replenishing over-exploited aquifers. At the date of approval of this Plan, there are 39 active Managed Aquifer Recharge schemes that drain or discharge water into aquifers for subsequent recovery. This Plan sets out the provisions for the draining or discharging of water into an aquifer, and the recovery of water in relation to the water previously drained or discharged.

Operators of Managed Aquifer Recharge schemes have worked in accordance with their risk management and monitoring plans to protect the resources from any adverse impacts from draining or discharging of water into the resource that may result in artesian conditions. As these risk management and monitoring plans will be the key document to which the Managed Aquifer Recharge operators will align their activities, the water licence

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[41] Section 102(3)(c) of the *Landscape Act*

[42] Section 104(5)(b) of the *Landscape Act*

[43] A site use approval specifies the purposes for which the water is proposed to be used, the place at which the water is proposed to be used and prescribed information about the proposed extent, manner and rate of use of the water as per section 141(1)(a) of the *Landscape Act*.

[44] Section 104(6)(b) of the and *Landscape Act* and regulation 19(2) of the *Landscape South Australia (Water Management) Regulations 2020*

[45] The intentional discharge of surface water, can for example, reduce the localised groundwater salinity or concentration of other minerals, leading to the availability of higher quality water for subsequent extraction.

will be subject to working in accordance with the risk management and monitoring plan and will require updating as the scheme operation changes.

While artesian conditions are generally well managed through the risk management and monitoring plans, areas at risk of artesian conditions in relation to the development of Managed Aquifer Recharge schemes, which coincides with a decline in industry demand for water particularly in relation to the Central Adelaide Prescribed Wells Area, have recently been identified[46].

A permit is required under section 104(3)(c) of the Landscape Act for the draining or discharging of water directly or indirectly into a well. However, if the water to be drained or discharged is sourced from a surface water capture area greater than one hectare within the Adelaide metropolitan area, or the water to be drained or discharged has undergone antibiotic or chemical water treatment with a discharge volume greater than 50 kilolitres per day, the person draining or discharging water into the aquifer is required to hold a licence for an 'activity of environmental significance' under section 36 of the *Environment Protection Act 1993.* The permit is granted by the Environment Protection Authority under section 40(1) of the *Environment Protection Act 1993*.

The water drained or discharged into the aquifer and used in relation to Managed Aquifer Recharge schemes constitutes a single consumptive pool for the purposes of this Plan. This consumptive pool is a separate administrative consumptive pool to the 'native groundwater' consumptive pools and is not volumetrically constrained (i.e. has no maximum capacity).

The volume of water in the Managed Aquifer Recharge Consumptive Pool will change over time in relation to the scheme operator's activities. Individual water access entitlements within this consumptive pool are based on the 'available balance' for the Managed Aquifer Recharge scheme. The 'available balance' takes into account the total volume of water drained or discharged (under a permit issued pursuant to either section 104(3)(c) of the Landscape Act or an environmental authorisation issued under section 40(1) of the *Environment Protection Act 1993*) throughout the life of the scheme's operation, minus any volume that has subsequently been extracted. The total volume that can be recovered in a single water-use year will be limited to a 'maximum annual recovery volume' as identified in the risk management and monitoring plan for the scheme to ensure no adverse impacts are observed at the site of recovery.

Water licences issued pursuant to Managed Aquifer Recharge schemes only authorise the taking of water which has previously been drained or discharged into the aquifer and not subsequently extracted (the 'available balance'). Noting that unless previously authorised by the Minister, the water is to be recovered from well/s located within the same spatial extent as the corresponding 'native groundwater consumptive pool' that aligns with the location and aquifer within which the water was previously drained or discharged. If the scheme operator requires more water than the available balance they must acquire additional access to water. Additional access to water may be acquired by transferring allocation from another scheme operator, subject to meeting the transfer criteria outlined in section 7.9 or by applying for a water licence and allocation in the spatially relevant 'native groundwater' consumptive pool. The water licence for the 'native groundwater' consumptive pool will be separate to the licence in relation to the Managed Aquifer Recharge Consumptive Pool and will be managed separately. If a scheme operator has both a licence in relation to the Managed Aquifer Recharge Consumptive Pool and a licence in relation to a 'native groundwater' consumptive pool and the water is to be taken from the same well/s, the allocation in relation to the 'native groundwater' consumptive

[46] Department for Environment and Water (2021). Aquifer response to managed aquifer recharge in the Adelaide metropolitan area, DEW Technical report 2021/19, Government of South Australia, Department for Environment and Water, Adelaide.

pool will be considered to be extracted first, to enable the 'banking' of the water that was intentionally drained or discharged.

A scheme operator with a licence in the Managed Aquifer Recharge Consumptive Pool is able to transfer the allocation, or part of the allocation, which arises in a particular water-use year to another user of the resource. The transfer of the recharge water allocation is subject to meeting the criteria specified in section 7.9 of this Plan, to protect the resource from any adverse impacts of the transfer, and is assumed to be used in its entirety after being transferred and as such is removed from the scheme operator's available balance.

6.4 Management of High Risk Consumptive Pools

To minimise the risk that the taking of water from a consumptive pool causes the resource condition limit (as discussed in section 2.7) to be breached, a groundwater resource management framework is required. Of the 11 native groundwater consumptive pools, there are two where the sum of entitlement shares (once issued under the transitional provisions of this Plan (section 7.7) at a rate of 1 kL per share) exceeds the resource extraction limit: T1 Northern Adelaide Plains (exceeded by 11%) and T2 Northern Adelaide Plains (by 18%) (Table 6.1). Although the water use in these consumptive pools is currently lower than the total volume of water that is permitted to be taken, these consumptive pools are at the highest risk of exceeding resource condition limits if the average annual water use increases.

Table 6.1. Current entitlement shares and resource extraction limits

Consumptive Pool	Current Entitlement Shares*	Resource Extraction Limit kL
T1 NAP	4,600,631	4,159,000
T2 NAP	18,378,482	15,555,000

*excluding stock and domestic entitlement shares at the date of approval of this Plan

In these consumptive pools, while the sum of the entitlement shares, when valued at 1 kL per share, exceeds the resource extraction limit, water has not historically been taken at a rate that has caused unacceptable impacts to the resource. However, there is a significant risk to the resource should the full authorised volumes be extracted.

An adaptive trigger-level management approach is considered appropriate at this time for these consumptive pools. This adaptive management approach works by limiting the volume of water that can be extracted (allocation) within a consumptive pool during periods when the resource is at higher risk. In order to do this, resource condition triggers have been developed for the T1 Northern Adelaide Plains and T2 Northern Adelaide Plains Consumptive Pools.

The resource condition triggers act as an early warning system that the resource condition limit is at risk of being breached and initiates a management response that minimises the risk of this occurring (Table 6.2).

An adaptive trigger management approach results in flexibility of groundwater use by the licensee, by enabling water extraction to increase beyond the average annual extraction in years when drier conditions are observed. However, it also acknowledges that sustained extraction of the water resource at a rate higher than the average annual extraction is likely to result in adverse impacts to the resource and therefore requires a restriction to the volume of water that can be taken (allocation) when the risk of these impacts occurring is increased. There is evidence suggesting that the resource can sustain short-term increased extraction occasionally – as long as a management approach is in place which restricts extraction to the resource extraction limit, should the increased extraction pose a risk to the resource.

Table 6.2. Resource condition triggers and limits

Consumptive Pool	Resource Condition Trigger	Resource Condition Limit
T1 NAP	1-3 metres below the Millennium Drought low (dependent on monitoring well)	5 metres below sea level
T2 NAP	3-5 metres below the Millennium Drought low (dependent on monitoring well)	Top of the T2 aquifer

The adaptive management approach is dependent on a monitoring regime of specific wells within the consumptive pools. Following winter recovery, if groundwater pressure levels do not rise above the trigger level for the number of wells specified in the 'triggered condition' field (Table 6.3) for the associated monitoring group, then a management response is initiated for the entire consumptive pool associated with that group (i.e. triggering only one group within any consumptive pool will trigger a management response for the entire consumptive pool). For example if the winter groundwater pressure levels do not recover to above -4.3 metres AHD for monitoring well PTA051 and -4.2 metres AHD for monitoring well PTA093, then a management response would be triggered for the T1 Northern Adelaide Plains Consumptive Pool.

The management response is a staged process, with the first step being a notification and the second being variations to the value of the entitlement share (allocation). The trigger management response for the T1 Northern Adelaide Plains and T2 Northern Adelaide Plains Consumptive Pools is provided in section 7.5. The restriction does not apply to any licensed stock and domestic allocations.

Table 6.3. Trigger level monitoring sites and triggered conditions

Consumptive Pool	Monitoring Group	Monitoring Well	Trigger Level (m AHD)	Resource Condition Limit (m AHD)	Triggered Condition
T1 NAP	Group 1	PTA161	-2.5#	-5	2 out of 4
		PTA095	-3.6‡	-5	
		PTA111	-4‡	-5	
		MPA152	-0.62^	-5	
	Group 2	PTA051	-4.3‡	-5	Both
		PTA093	-4.2‡	-5	
T2 NAP	Group 3	MPA144	-33.2*	-46.1	Both
		MPA158	-27.95*	-42.93	
	Group 4	PTA091	-26.72*	-57.5	2 out of 3
		PTA082	-18.4^	-46.3	
		MPA159	-22.09*	-65	

*5 m below the Millennium Drought low
^3 m below the Millennium Drought low
#2.5 m below the Millennium Drought low
‡1 m below the Millennium Drought low

This Plan facilitates opportunities to permanently move entitlement shares in consumptive pools where the sum of entitlement shares when valued at 1 kL per share exceeds the resource extraction limit to areas managed by this Plan where water is available to be allocated, namely the Quaternary, T1 Regional, T2 Regional, Golden Grove Embayment, Noarlunga Embayment and Northern Fractured Rock Consumptive Pools. The permanent movement of entitlement shares will reduce the risk of triggering future management responses.

In order to ensure the number of entitlement shares within the T1 Northern Adelaide Plains and T2 Northern Adelaide Plains Consumptive Pools reduce through the life of this Plan, a new water access entitlement will not be issued in these consumptive pools (except as part of a trade which does not result in an increase in the number of entitlement shares for the consumptive pool) even if any of the entitlement shares have been either surrendered or transferred to become entitlement shares for another consumptive pool.

In addition to the two consumptive pools discussed above, the sum of entitlement shares within the Kangaroo Flat Consumptive Pool also exceeds the resource extraction limit for the pool (137%) and is currently undergoing a reduction scheme, whereby the sum of entitlement shares within the pool will reduce from an equivalent volume totaling 2,058 ML/y to the resource extraction limit of 1,500 ML/y by 2022. This process began in 2017 when existing user licences were issued for the area.

The reduction in entitlement shares for the Kangaroo Flat Consumptive Pool is a different management approach to that undertaken for the other two consumptive pools because the risks to the Kangaroo Flat groundwater were quite different to the risks to the other two consumptive pools. The Kangaroo Flat Consumptive Pool is at significant risk of groundwater salinisation due to the downward movement of saline water from the Quaternary aquifer to the second Tertiary aquifer due to the absence of a sufficient confining layer that separates the two aquifers and the general absence of the first Tertiary aquifer in this area. Unlike the other two consumptive pools, extraction in Kangaroo Flat has also historically exceeded the resource extraction limit. During periods when extraction exceeded this limit, adverse salinity impacts were directly observed. It is therefore important that the volume of water able to be extracted within this consumptive pool is limited to 1,500 ML/y as the resource is unable to withstand volumes of extraction exceeding this level. As of July 2022, when 1,500,000 entitlement shares are issued in the Kangaroo Flat Consumptive Pool with an individual share value of 1 kL, this Plan proposes that the value of the entitlement shares remains consistent for the remaining life of this Plan.

7 Principles

The principles (1 to 65) in sections 7.1 – 7.13 of this Plan apply to all applications for new water management authorisations and to all applications to vary existing water management authorisations (Water Licence, Water Access Entitlement or Water Allocation) made after this Plan becomes operational. The transitional arrangements in section 7.7 of this Plan discuss how holders of existing water licences will be issued water management authorisations under this Plan.

There are principles within this Plan which require the provision of information to support an application for an authorisation in some circumstances. This information allows the Minister to consider the application against the requirements of this Plan and informs any decision to grant or refuse an application. Where an applicant is required to demonstrate a matter to the satisfaction of the Minister, the responsibility for undertaking the relevant hydrogeological or other investigation, and the associated costs, lies with the applicant and not with the Minister or the Government of South Australia. It should be noted that reference to the Minister throughout this Plan refers to the Minister or the Minister's delegate, where a function or power assigned to the Minister under the Landscape Act has been delegated to another body or person[47].

7.1 Consumptive Pools

1. For the purposes of this Plan, there shall be thirteen consumptive pools defined as:

    a. **Quaternary Consumptive Pool**, with a total volume of 8,239 ML/y and a maximum value of all entitlement shares available for allocation within the pool (excluding licensed stock and domestic allocations) being equal to 6,762 ML/y, available to taken from the Quaternary aquifers within the area defined as 'Quaternary' in Figure 2.4;

    b. **T1 Northern Adelaide Plains Consumptive Pool**, with a total volume of 4,658 ML/y and a maximum value of all entitlement shares available for allocation within the pool (excluding licensed stock and domestic allocations) being equal to 4,601 ML/y, available to be taken from the T1 aquifer in the area defined as 'T1 NAP' in Figure 2.3;

    c. **T1 Regional Consumptive Pool**, with a total volume of 10,581 ML/y and a maximum value of all entitlement shares available for allocation within the pool being equal to 10,494 ML/y, available to be taken from the T1 aquifer in the area defined as 'T1 Regional' in Figure 2.3;

    d. **T2 Northern Adelaide Plains Consumptive Pool**, with a total volume of 18,432 ML/y and a maximum value of all entitlement shares available for allocation within the pool (excluding licensed stock and domestic allocations) being equal to 18,378 ML/y, available to be taken from the T2 aquifer in the area defined as 'T2 NAP' in Figure 2.3;

    e. **T2 Regional Consumptive Pool**, with a total volume of 6,228 ML/y and a maximum value of all entitlement shares available for allocation within the pool being equal to 6,023 ML/y, available to be taken from the T2 aquifer in the area defined as 'T2 Regional' in Figure 2.3;

[47] Section 10(1) of the *Landscape Act*

f. **Kangaroo Flat Consumptive Pool**, with a total volume of 1,506 ML/y and a maximum value of all entitlement shares available for allocation within the pool (excluding licensed stock and domestic allocations) being equal to 1,500 ML/y[48], available to be taken from the aquifers in the area defined as 'Kangaroo Flat' in Figure 2.3;

g. **Lower Tertiary Consumptive Pool**, with a total volume of 2,385 ML/y and a maximum value of all entitlement shares available for allocation within the pool being equal to 2,385 ML/y available to be taken from the T3 and T4 tertiary aquifers within the area defined as 'Lower Tertiary' in Figure 2.4;

h. **Golden Grove Embayment Consumptive Pool**, with a total volume of 4,615 ML/y and a maximum value of all entitlement shares available for allocation within the pool being equal to 4,552 ML/y, available to be taken from the T1 and T2 aquifers in the area defined as 'GGE Tertiary' and the fractured rock aquifer in the area defined as 'GGE fractured rock' in Figure 2.3;

i. **Noarlunga Embayment Consumptive Pool**, with a total volume of 1,722 ML/y and a maximum value of all entitlement shares available for allocation within the pool being equal to 1,717 ML/y, available to be taken from the Quaternary and Tertiary aquifers in the area defined as 'Noarlunga Embayment' in Figure 2.4;

j. **Northern Fractured Rock Consumptive Pool**, with a total volume of 5,621 ML/y and a maximum value of all entitlement shares available for allocation within the pool being equal to 5,116 ML/y, available to be taken from the fractured rock aquifers within the area defined as 'Northern fractured rock' in Figure 2.4;

k. **Southern Fractured Rock Consumptive Pool**, with a total volume of 2,312 ML/y and a maximum value of all entitlement shares available for allocation within the pool being equal to 1,409 ML/y, available to be taken from the fractured rock aquifers within the area defined as 'Southern fractured rock' in Figure 2.4;

l. **Managed Aquifer Recharge Consumptive Pool**, being the water available for allocation as a result of metered drain or discharge activities (excluding water discharged for dewatering purposes) undertaken within the prescribed areas managed by this Plan, in accordance with a permit issued pursuant to either section 104(3)(c) of the Landscape Act in accordance with section 7.12 of this Plan, or an environmental authorisation issued under section 40(1) of the *Environment Protection Act 1993*; and

m. **Cultural Water Consumptive Pool**, which is the water that is available to be used by an Aboriginal person for the purposes of satisfying their personal, domestic, cultural, spiritual or non-commercial communal needs where they are doing so in the exercise or enjoyment of their cultural interests, from within the areas defined as 'Northern Adelaide Plains Prescribed Wells Area', 'Dry Creek Prescribed Wells Area' and 'Central Adelaide Plains Prescribed Wells Area' in Figure 1.1.

2. The value of the entitlement shares in the following consumptive pools is subject to variation in accordance with the processes outlined in section 7.5 of this Plan:

[48] This will be reached once the reduction scheme has been completed.

a. T1 Northern Adelaide Plains Consumptive Pool; and

b. T2 Northern Adelaide Plains Consumptive Pool.

3. The Minister may, from time to time, by publishing a notice in *The South Australian Government Gazette*, increase the number of entitlement shares available within a consumptive pool (issued at the same value as the existing entitlement shares within the consumptive pool) if the Minister is satisfied that additional water is available for taking by wells in the relevant consumptive pool, and that the taking of this water:

   a. will present only a low level of risk to the present and future health and maintenance of ecosystems that depend on water from these consumptive pools; and

   b. will not adversely affect the reliability of supply or the quality of water accessed by existing users of water in the consumptive pool or from any other consumptive pool.

4. Principle 3 does not apply to the following consumptive pools:

   a. T1 Northern Adelaide Plains Consumptive Pool;

   b. T2 Northern Adelaide Plains Consumptive Pool; or

   c. Kangaroo Flat Consumptive Pool.

7.2 Water Licences

5. Subject to principle 6, the Minister may grant a water licence in respect of a consumptive pool listed in principle 1. A water licence is not required to authorise the taking of water in relation to the Cultural Water Consumptive Pool. A water licence provides a water access entitlement to the holder of the licence to gain access to a share of the water available in the consumptive pool to which the licence relates.

6. The water licence shall list the wells through which the water is authorised to be taken. The proposed wells for the taking of water are required to meet the criteria for 'Taking Water from a Well' in section 7.11 of this Plan to ensure the taking of water will not cause undesired impacts to groundwater-dependent ecosystems, aquifers or existing users of the resource. The water access entitlement which is provided for under the water licence is subject to the conditions attached to the licence[49].

7. Notwithstanding principle 6, a water licence may be issued without a listing of the wells through which the water is to be taken, but in this case the licence must relate to a specific consumptive pool and any allocation issued in relation to the licence cannot be taken until the licence is varied to include the wells through which the water will be taken. The proposed wells for the taking of water are required to meet the criteria for 'Taking Water from a Well' in section 7.11 of this Plan.

8. The Minister may grant a water licence for the recovery of water previously drained or discharged into a well (recharge water licence) in accordance with a permit issued pursuant to either section 104(3)(c) of the Landscape Act in accordance with section 7.12 of this Plan, or an environmental

[49] Section 121(3)(c) of the *Landscape Act*

authorisation issued under section 40(1) of the *Environment Protection Act 1993*. The licence will relate to the Managed Aquifer Recharge Consumptive Pool.

7.3 Water Access Entitlements

9. Subject to principle 14, the Minister may grant a new, or vary an existing, water access entitlement to provide access to a share of a consumptive pool.

10. A water access entitlement issued on account of a water licence in relation to the consumptive pools listed in principles 1.a - 1.k will be expressed as a number of entitlement shares of a total number of entitlement shares.

11. A water access entitlement issued on account of a recharge water licence in relation to the Managed Aquifer Recharge Consumptive Pool will be calculated as the 'available balance' of the water licence by taking into account the total volume of water drained or discharged to a particular aquifer at a particular location under a permit issued pursuant to either section 104(3)(c) of the Landscape Act or an environmental authorisation under section 40(1) of the *Environment Protection Act 1993* throughout the life of the scheme's operation, minus any volume that has subsequently been extracted (from within the same spatial extent as the corresponding 'native groundwater consumptive pool' that aligns with the location and aquifer within which the drain or discharge activities occurred) and will be known as a recharge water access entitlement.

12. The granting of new entitlement shares shall not cause the total volume of water able to be allocated in relation to the entitlement shares for each consumptive pool to exceed the 'Resource Extraction Limit' specified in Table 7.1. The numbers specified in Table 7.1 are valid at the date of approval of this Plan. Principle 3 may be used in the future to increase the resource extraction limit for specified consumptive pools thereby increasing the ability to issue new entitlement shares.

13. The proposed wells for the taking of water in relation to the entitlement shares are required to meet the criteria for 'Taking Water from a Well' in section 7.11 of this Plan.

14. In the following consumptive pools, the grant or variation of a water access entitlement may only occur where the number of entitlement shares remains consistent with the number of entitlement shares at the time of application:

    a. T1 Northern Adelaide Plains Consumptive Pool; or

    b. T2 Northern Adelaide Plains Consumptive Pool.

    The number of entitlement shares available at the time of application is required to be considered because the number of entitlement shares available within the consumptive pool will reduce over time through the surrender or permanent transfer of entitlement shares to another consumptive pool. The aim is to continue to reduce entitlement shares in the aforementioned consumptive pools throughout the life of this Plan and a new water access entitlement should not be issued unless it is issued in relation to a permanent whole or part of licence transfer.

15. For the purpose of this Plan, any entitlement shares available that have not yet been granted on a water access entitlement will be known as unallocated water.

16. The Minister may issue a new water access entitlement or increase the number of entitlement shares on an existing water access entitlement in relation to unallocated water, on the basis of applications submitted to the Minister under procedures determined by the Minister as being appropriate in the relevant circumstances[50]. A water access entitlement will only be granted or amended if the proposed wells for the taking of water meet the criteria for 'Taking Water from a Well' in section 7.11 of this Plan.

Table 7.1. Entitlement shares and resource extraction limits at the date of approval of this Plan

Consumptive Pool	Current Entitlement Shares*	Unallocated Entitlement Shares#	Resource Extraction Limit kL*
Quaternary	1,976,466	4,785,534	6,762,000
T1 NAP	4,600,631	0	4,159,000
T1 Regional	8,327,222	2,166,778	10,494,000
T2 NAP	18,378,482	0	15,555,000
T2 Regional	3,423,969	2,599,031	6,023,000
Kangaroo Flat	2,057,295	0	1,500,000
Lower Tertiary	2,384,775	0	2,384,775
Golden Grove Embayment	1,516,672	3,035,329	4,552,000
Noarlunga Embayment	3,420	1,713,580	1,717,000
Northern Fractured Rock	2,934,445	2,181,555	5,116,000
Southern Fractured Rock	1,408,898	0	1,408,898

*Excluding licensed stock and domestic entitlement shares in the Northern Adelaide Plains

#The availability of Unallocated Entitlement Shares is subject to the finalisation of the existing user process and may change as a result

7.4 Water Allocation

17. A water allocation may be obtained on account of an entitlement share on a water access entitlement issued under a water licence, on the basis that the water allocation is being granted by the Minister under the terms of the water licence, and will initially relate to a period not exceeding 12 months.

18. Subject to principles 22 and 23 a water allocation obtained on account of an entitlement share will be determined at the rate of 1 share = 1 kilolitre.

19. Principle 18 does not apply to a water allocation in relation to a recharge water access entitlement.

20. A water allocation (recharge water allocation) may be obtained on account of a recharge water access entitlement. The volume of water allocated in any given water-use year shall be the lesser of a) the 'available balance' or b) the 'maximum annual recovery volume' of water authorised to be taken per water-use year as a condition on the water licence, unless the applicant can demonstrate to the satisfaction of the Minister that the taking of up to 100% of the available balance would not contravene the criteria for 'Taking Water from a Well' in section 7.11 of this Plan.

21. With respect to principles 22 and 23, the Minister may, from time to time, by notice in the *South Australian Government Gazette*, determine the volume of water that is to be made available for

[50] Section 122(2) of the *Landscape Act*

allocation from the T1 Northern Adelaide Plains Consumptive Pool and the T2 Northern Adelaide Plains Consumptive Pool.

22. The value of the entitlement shares in the T1 Northern Adelaide Plains Consumptive Pool is subject to variation in relation to the trigger management scheme outlined in section 7.5 of this Plan.

23. The value of the entitlement shares in the T2 Northern Adelaide Plains Consumptive Pool is subject to variation in relation to the trigger management scheme outlined in section 7.5 of this Plan.

7.5 Trigger Management Scheme

24. With respect to principles 22 and 23, the first water–use year that the end of winter groundwater pressure level does not rise above the trigger level for the number of wells specified in the 'triggered condition' field in Table 6.3 for the relevant consumptive pool, the triggered condition is breached and a notice will be issued to all licensees within the consumptive pool advising that future allocations may be reduced, subject to principles 25, 26 and 27.

25. If the end of winter groundwater pressure level recovery in the second water-use year remains below the trigger level, to minimise the risk of breaching the resource condition limit, restrictions to the volume of water which can be extracted will be announced for the relevant consumptive pool commencing 1 July of the next (third) water-use year.

26. If restrictions have been announced pursuant to principle 25, in the third water use-year, the value of the entitlement shares will not be determined at the rate of 1 share = 1 kL and will instead be reduced proportionally to a value that results in the total volume of allocations issued for the consumptive pool not exceeding the resource extraction limit for the consumptive pool as defined in Table 7.1.

27. Whilst the end of winter groundwater pressure level recovery remains below the trigger level, the value of the entitlement share will remain reduced. However, when the end of winter groundwater pressure level recovers to above the trigger level, the value of the entitlement share will revert to 1 share = 1 kL for the following water-use year.

28. With regard to principle 25, the Minister shall announce the restrictions to the volume of water which can be extracted from the relevant consumptive pool by publishing a notice in the *South Australian Government Gazette* determining the value of an individual entitlement share for the relevant consumptive pool.

29. Principles 24 to 28 do not apply to water allocated for stock and domestic purposes and registered in the State Water Register as such.

7.6 Carry-over

30. In relation to the consumptive pools listed in principles 1.a, 1.c, 1.e, and 1.g – 1.k,[51] if a water allocation is not taken during the initial 12 month period, then the unused allocation at 30 June,

[51] i.e. the Quaternary Consumptive Pool, T1 Regional Consumptive Pool, T2 Regional Consumptive Pool, Lower Tertiary Consumptive Pool, Golden Grove Embayment Consumptive Pool, Noarlunga Embayment Consumptive Pool, Northern Fractured Rock Consumptive Pool and Southern Fractured Rock Consumptive Pool.

capped at 10% of the entitlement shares which were on the licence as at 1 July of the water-use year for which the carry-over is being accrued, may be carried over for a period not exceeding 2 years. However, the allocation that may be obtained by a water access entitlement holder from allocations arising in the current water-use year plus any carry-over volume from the previous two water-use years shall not exceed 110% of entitlement shares held by the water access entitlement holder as at 1 July of the current water-use year.

31. When the volume of the sum of entitlement shares in the Kangaroo Flat Consumptive Pool is equal to or less than the resource extraction limit of 1,500 ML/y, an unused allocation, capped at 10% of the entitlement shares which were on the licence as at 1 July of the water-use year for which the carry-over is being accrued, may be carried over for a period not exceeding 2 years. However, the allocation that may be obtained by a water access entitlement holder from allocations arising in the current water-use year plus any carry-over volume from the previous two water-use years shall not exceed 110% of entitlement shares held by the water access entitlement holder as at 1 July of the current water-use year.

32. Carry-over of allocation may only be granted if:

    a. the water has been taken through a water meter for the whole of the water use year for which carry-over is determined, unless the quantity of water taken can be determined on another basis to the satisfaction of the Minister; and

    b. the final water meter reading(s) for the quantity of water taken during the previous water use year have been provided to the Department as per the condition of the licence.

33. Carry-over allocation is deemed to have been used prior to any other allocation on the water account.

34. Carry-over is not permitted in the following consumptive pools:

    a. T1 Northern Adelaide Plains Consumptive Pool;

    b. T2 Northern Adelaide Plains Consumptive Pool; or

    c. Managed Aquifer Recharge Consumptive Pool[52].

7.7 Transitional Arrangements

35. Subject to principle 36, from the designated day, the holder of an existing water licence will be provided with a water licence and therefore a water access entitlement under this Plan. The water licence shall list the wells through which the water is authorised to be taken. The number of entitlement shares issued to the water access entitlement holder shall be determined by converting the volume of water on allocation (excluding carry-over allocation or allocations on account of a temporary transfer) in the previous water-use year to that licensee into entitlement shares, at a rate of one kilolitre per unit share.

36. Separate water licences will be issued in relation to each consumptive pool listed in principle 1 based on the wells listed on the existing licence. Where an existing licence has wells that relate to

[52] Carry-over is not required in the Managed Aquifer Recharge Consumptive Pool as the volume of water available for allocation is not a fixed volume from one year to the next and is instead dependent on the 'available balance'.

multiple consumptive pools, a portion of the entitlement share will be issued to each consumptive pool in consultation with the licensee, but the final determination will be made by the Minister.

37. Further to principles 35 and 36, a water access entitlement in relation to the Kangaroo Flat Consumptive Pool will be issued subject to the existing Ministerial reduction schedule.

38. Principle 35 does not apply to licences issued in relation to the Managed Aquifer Recharge Consumptive Pool. In this case, from the designated day the holder of an existing water licence who drains or discharges water into an aquifer for subsequent recovery of a recharge water allocation will be provided with a water licence and therefore a water access entitlement under this Plan. The licensee will be issued a water access entitlement calculated as the 'available balance' by taking into account the total volume of water drained or discharged under a permit issued pursuant to either section 104(3)(c) of the Landscape Act or an environmental authorisation under section 40(1) of the *Environment Protection Act 1993* throughout the life of the scheme's operation, minus any volume that has subsequently been extracted. The issuance of the water licence will require a review of the existing risk management and monitoring plan to ensure it remains appropriate for the scheme's operation.

39. If the designated day for the unbundling of water licences does not align with the date that this Plan comes into operation, administration of this Plan will, until the designated day, be undertaken with existing licences operating as if they were authorisations issued under this Plan.

40. A water licence provided under the transitional arrangements in principles 35, 37 and 38 may be subject to the conditions outlined in section 7.8 of this Plan.

7.8 Terms and Conditions for Consideration on a Water Licence or Water Allocation

The Landscape Act allows for a water licence or water allocation to be subject to conditions endorsed on the water management authorisation by the Minister[53]. The licence remains in force unless it expires under the terms of the licence[54].

41. When issuing, amending or transferring a water licence or water allocation, the Minister may give consideration to endorsing conditions on the management authorisation to the effect that:

    a. water must only be taken from the wells listed on this authorisation;

    b. water taken from the wells listed on this authorisation must be taken in a manner consistent with the Adelaide Plains Meter Implementation Plan;

    c. the headworks of the wells from which the water is taken pursuant to this authorisation must be maintained and constructed so that the extraction of water from the wells can be accounted for without interference;

    d. the taking of water from the wells listed on this authorisation must not exceed the allocation issued to be taken from the wells; and

[53] Section 123(c)(ii) and section 127(6)(b) of the *Landscape Act*

[54] Section 123(e)(ii) of the *Landscape Act*

e. the approval holder must report the volume of water taken through a water meter during the water use year (i.e. closing readings) to the Department by the specified date.

42. When issuing or amending a water licence or water allocation for the recovery of water previously drained or discharged into a well, the Minister may endorse a condition on the water licence or water allocation to the effect that, unless previously authorised by the Minister:

a. the water taken pursuant to the water allocation must only be taken from the aquifer into which the water was drained or discharged;

b. the water taken pursuant to the water allocation must only be taken from well/s located within the 'same spatial extent as the corresponding native groundwater consumptive pool'[55] that aligns with the location and aquifer within which the drain or discharge activities occurred;

c. if the water is proposed to be recovered from wells located within the spatial extent of the T2 Northern Adelaide Plains Consumptive Pool, the water taken pursuant to the water allocation must not be taken from an area of lower potentiometric surface than where the drain or discharge activities occurred;

d. the volume of water taken in a single water use year must not exceed the 'maximum annual recovery volume' specified;

e. the licensee must operate in accordance with a risk management and monitoring plan approved by the Minister;

f. the risk management and monitoring plan must be updated as the scheme's operations changes, and as requested from time to time by the Minister;

g. the licensee must report the drained or discharged and recovery volumes in a manner approved by the Minister; and

h. the water taken pursuant to the water allocation will be deemed to have been taken after any other allocation authorised for taking from the same well/s.

43. The conditions specified in principles 41 and 42 are additional to, and subject to the conditions endorsed on a water licence issued pursuant to section 7.7 of this Plan and any additional conditions endorsed by the Minister[56].

7.9 Transfers

44. Subject to the succeeding provisions of this section and the Landscape Act[57], the holder of a water licence:

a. may apply to transfer the water licence to another person; or

[55] See Glossary for definition of "*same spatial extent as the corresponding native groundwater consumptive pool*"

[56] Section 135(1)(c)(iii) of the *Landscape Act*

[57] Section 125 of the *Landscape Act*

b. may apply to transfer a water access entitlement, or one or more entitlement shares under the licence, to another person.

The application for the transfer of a water licence, water access entitlement or entitlement shares may be permanent or for a temporary period.

45. Principle 44 does not apply to a water licence or water access entitlement issued pursuant to the Managed Aquifer Recharge Consumptive Pool, unless the transfer is in relation to a change in ownership of the scheme.

46. A water licence, a water access entitlement or an entitlement share may only be transferred temporarily to another person where it remains a water licence, a water access entitlement or an entitlement share for the consumptive pool from which it was initially granted.

47. Subject to the provisions of this section and the Landscape Act[58], the holder of a water allocation may apply to transfer the water allocation, in part or in full, to another person for the period of time for which the allocation is current (up to 12 months).

48. Principle 47 does not apply to a water allocation issued pursuant to the carry-over provisions in section 7.6 of this Plan, unless the transfer is in relation to a change in ownership of the licence with respect to which the water allocation was initially issued.

49. A water allocation may only be transferred to another person where it remains a water allocation for the consumptive pool from which it was initially granted.

50. The following are preconditions to the exercise of the Minister's discretionary power to approve the transfer of a water licence, a water access entitlement, an entitlement share or a water allocation:

a. the permanent transfer of a water licence, a water access entitlement or an entitlement share must not result in the sum of entitlement shares in the receiving consumptive pool exceeding the resource extraction limits in Table 7.1; and

b. the receiving consumptive pool must not be:

i. T1 Northern Adelaide Plains Consumptive Pool; or

ii. T2 Northern Adelaide Plains Consumptive Pool

unless the water licence, water access entitlement, entitlement shares or water allocation originated within the same consumptive pool; and

c. in relation to the T1 Northern Adelaide Plains, the T2 Northern Adelaide Plains Consumptive Pools and the T2 aquifer within the Kangaroo Flat Consumptive Pool, or the Managed Aquifer Recharge Consumptive Pool where it overlaps with the aforementioned consumptive pools:

i. the transfer must be from an area of lower potentiometric surface to an area of the same or higher potentiometric surface; and

[58] Section 132 of the *Landscape Act*

ii. where an applicant has wells located across a range of potentiometric surface values, the maximum volume of water that can be transferred to be taken from the transferee well(s) must not exceed the average metered extraction from the transferor's licensed well(s), located at the same or lower potentiometric surface values in relation to the transferee's well(s), over up to the previous 10 years; and

d. in relation to the Quaternary, T1 Regional, T2 Regional, Lower Tertiary, Golden Grove Embayment, Noarlunga Embayment, Northern Fractured Rock and Southern Fractured Rock Consumptive Pools, or the Managed Aquifer Recharge Consumptive Pool where it overlaps with the aforementioned consumptive pools, the new location of take in relation to the transfer must meet the criteria specified in section 7.11 of this Plan; and

e. the Minister is satisfied that there is unlikely to be adverse impacts on any existing user's ability to continue to access water due to the cumulative impact of other applications for transfers seeking to increase extraction of water from particular well/s; and

f. in relation to the Managed Aquifer Recharge Consumptive Pool, the transfer shall result in the transferred allocation being taken from well/s located within the same spatial extent as the corresponding native groundwater consumptive pool that aligns with the location and aquifer within which the drain or discharge activities occurred; and

g. in relation to the Managed Aquifer Recharge Consumptive Pool, the continued draining or discharging at the site without extraction will only present a low level of risk to:

i. the integrity of the receiving aquifer (e.g. must not cause the overlying confining beds to hydraulically fracture or fail); and

ii. the ability of another water licence holder to access water through an existing operational production well; and

iii. surface and near-surface drainage including, but not limited to, waterlogging of soils, creating perched water tables or excessive increase in the height of water tables, water quality and stream baseflows; and

iv. buildings, roads and infrastructure due to direct or indirect damage.

51. Principle 50.c does not apply if there is existing hydrogeological evidence, or the applicant has undertaken a hydrogeological investigation, that demonstrates to the satisfaction of the Minister that any negative impact on the groundwater resource in relation to the transfer would be negligible.

52. The transfer of a water allocation issued on account of a water access entitlement in relation to the Managed Aquifer Recharge Consumptive Pool will be deemed to have been used in its entirety and will be deducted from the transferor's 'available balance'.

7.10 The Management of Water Wells

A permit is required for the drilling, decommissioning or sealing of a well and the repairing, replacing or altering of the casing, lining or screen of a well[59].

For the purpose of this Plan, 'well' has the same meaning as stated in the Landscape Act and means:

- *An opening in the ground excavated for the purpose of obtaining access to groundwater;*
- *An opening in the ground excavated for some other purpose but gives access to groundwater; or*
- *A natural opening in the ground that gives access to groundwater.*

The occupier of land on which a well is situated is subject to a general obligation to ensure that the well, including the casing, lining, and screen of the well, the headworks of the well and the mechanism (if any) used to cap the well, are properly maintained[60]. If wells are to be located in areas likely to experience artesian conditions, the headworks for the well are required to be fitted in such a way that it can control the flow of water.

In addition to the principles outlined below, please note that consideration may also be given to section 114 of the Landscape Act, which states that without limiting the grounds on which an application to drill a well may be refused, a relevant authority may refuse such a permit if, in the opinion of the authority, the groundwater to which the well would give access is so contaminated that its use would create a risk to the health of people or animals. The Environment Protection Authority has powers to establish a groundwater prohibition area under section 103S of the *Environment Protection Act 1993* to reduce the risk of taking groundwater from the Quaternary aquifers that are affected by contamination. These groundwater prohibition areas will be considered in relation to the drilling of new wells.

53. A permit to drill a well in the prescribed areas may only be granted if the Minister is satisfied that the proposed well will be installed in accordance with the *General Specifications for Well Drilling Operations Affecting Water in South Australia*, and constructed in accordance with the most current edition of the *Minimum Construction Requirements for Water Bores in Australia*.

54. A permit to drill a well in the prescribed areas may only be granted if the Minister is satisfied that the proposed location of the well (coordinates) will meet the criteria set out in section 7.11 of this Plan.

55. Principle 54 does not apply if the well is:

    a. a replacement well that will:

        i. replace an existing production well owned by the existing owner or another party, that is authorised for the purpose of taking a water allocation; and

        ii. be located no farther than 20 metres from the well being replaced; and

        iii. be constructed in the same consumptive pool as the well being replaced; and

        iv. be used for the same purpose as the existing well; and

[59] Section 104(3)(a) and (b) of the *Landscape Act*

[60] Section 119 of the *Landscape Act*

v. if located within an environmental buffer, not be located closer to the environmental asset protected by the buffer; and

the volume proposed to be extracted from the well is equal to or less than that from the existing production well; or

b. for the taking of water authorised under section 105 of the Landscape Act for purposes that do not require a water licence; or

c. to be used for scientific purposes including but not limited to the monitoring of the groundwater resource.

7.11 Taking Water from a Well

56. For the purposes of this section:

a. A well buffer zone is a circular area centred upon the site of a new or existing operational well located within the listed consumptive pool from which new or additional water is proposed to be taken, with a radius in relation to the listed consumptive pool determined in accordance with Table 7.2.

b. An environmental buffer zone is the set-back distance from fractured rock springs, groundwater-dependent streams and terrestrial vegetation located within the listed consumptive pools, as determined in accordance with Table 7.3.

Table 7.2. Well buffer zones

Consumptive Pool[61]	Proposed New or Additional Volume of Extraction (kL)	Radius (m)
T1 Regional T2 Regional Kangaroo Flat Lower Tertiary Golden Grove Embayment Noarlunga Embayment	0 to 10,000	0
	10,001 to 25,000	100
	25,001 to 50,000	150
	>50,000	200
Quaternary Northern Fractured Rock Southern Fractured Rock	Any	50

[61] In relation to the Managed Aquifer Recharge Consumptive Pool, the buffer for the corresponding native groundwater consumptive pool that aligns with the location and aquifer within which the drain or discharge activities occurred shall be utilised.

Table 7.3. Environmental buffer zones

Groundwater-Dependent Ecosystem Type	Aquifer Type	Consumptive Pool[58]	Buffer distance(m)
Fractured rock springs and groundwater-dependent streams	Fractured rock aquifer	Golden Grove Embayment Noarlunga Embayment Northern Fractured Rock Southern Fractured Rock	220
	Unconfined Quaternary aquifer	Quaternary Noarlunga Embayment	330
Terrestrial vegetation	Fractured rock aquifer	Golden Grove Embayment Noarlunga Embayment Northern Fractured Rock Southern Fractured Rock	250
	Unconfined Quaternary aquifer	Quaternary Noarlunga Embayment	250

57. Subject to principle 58 and the transitional provisions in section 7.7 of this Plan, the taking of water from a new well or an increase in water to be taken from an existing operational well will not be granted or varied where:

    a. the well buffer zone for the proposed location of take, determined in accordance with Table 7.2, would overlap with an existing operational well in the same consumptive pool;

    b. the proposed location of take falls within an environmental buffer zone as determined in accordance with Table 7.3;

    c. the proposed location of take is within 300 metres of an existing operational well completed in the same aquifer, where one or both of the wells are used for the purposes of Managed Aquifer Recharge, unless the new location of take is associated with the Managed Aquifer Recharge scheme;

    d. the taking of water is equal to, or greater than a volume of, 250,000 kL in the Lower Tertiary Consumptive Pool, the T1 or T2 aquifers of the Golden Grove Embayment Consumptive Pool, or the T2 Regional Consumptive Pool, unless the applicant has undertaken a hydrogeological investigation to determine that the impact on the resource and existing users would be negligible; or

    e. the taking of water is equal to or greater than a volume of 50,000 kL in the fractured rock aquifer of the Golden Grove Embayment Consumptive Pool, unless the applicant has undertaken a hydrogeological investigation to determine that the impact on the resource and existing users would be negligible.

58. Notwithstanding principle 57, the Minister may grant or vary the volume of water which can be taken from a particular well where the applicant has demonstrated to the satisfaction of the Minister that the granting or varying of the authorisation to take water would not result in any undesirable impacts to the groundwater resource, groundwater-dependent ecosystems, existing users (including any future return of currently transferred entitlement shares), or Managed Aquifer Recharge operators of the resource.

7.12 Draining or Discharging Water into a Well

A permit is required for the draining or discharging of water directly or indirectly into a well[62]. However, if the water to be drained or discharged is sourced from a surface water capture area greater than one hectare within the Adelaide metropolitan area, or the water to be drained or discharged has undergone antibiotic or chemical water treatment with a discharge volume greater than 50 kilolitres per day, an authorisation issued by the Environment Protection Authority under section 40(1) of the *Environment Protection Act 1993* is required instead. In issuing the authorisation, the Environment Protection Authority may take into account the principles listed below.

59. Prior to the granting of a permit to drain or discharge water into a well the following is required to be undertaken by the applicant to the satisfaction of the Minister:

    a. a risk assessment that is consistent with the *National Water Quality Management Strategy – Australian Guidelines for Water Recycling: Managing Health & Environmental Risks, Phase 2- Managed Aquifer Recharge (2009)*, as amended from time to time or any subsequent guidelines current at the time;

    b. a risk management and monitoring plan, based on the findings of the risk assessment, which demonstrates that operational procedures and risk mitigation strategies are in place to avoid any negative consequences identified through the risk assessment; and

    c. any other investigations or documentation required by the Minister.

60. Principle 59 does not apply to water drained or discharged into a well by means of gravity, or roof runoff (surface water), which is proposed to be drained or discharged into a well via a closed system of capture and transport, provided that the system is equipped with a mechanism to divert first flush water and is drained under gravity.

61. A permit may only be granted for the draining or discharging of water to an aquifer where the applicant can demonstrate to the satisfaction of the Minister that such draining or discharging will only present a low level of risk to:

    a. the quality of the water in the receiving aquifer;

    b. the integrity of the receiving aquifer (e.g. must not cause the overlying confining beds to hydraulically fracture or fail);

    c. groundwater-dependent ecosystems or native vegetation;

    d. the ability of another water licence holder to access water through an existing operational production well;

    e. surface and near-surface drainage including, but not limited to, waterlogging of soils, creating perched water tables or excessive increase in the height of water tables; and

    f. buildings, roads and infrastructure due to direct or indirect damage.

[62] Section 104(3)(c) of the *Landscape Act*

62. A permit may only be granted for the draining or discharging of water to an aquifer where:

    a. the water taken pursuant to the recharge water allocation will only be taken from the aquifer into which the water was drained or discharged; and

    b. the water taken pursuant to the recharge water allocation will only be taken from well/s located within the same spatial extent as the corresponding 'native groundwater consumptive pool' that aligns with the location and aquifer within which the drain or discharge activities occurred.

63. When granting a permit to drain or discharge water into a well the Minister may endorse a condition on the permit that requires the permit holder to provide an annual draining or discharge report that includes the following information:

    a. the total amount of water drained or discharged into a well, as measured by each meter, in the water-use year, and at any period as determined by the Minister;

    b. the groundwater level/pressure for the relevant aquifer accessed by the well/s through which water was drained or discharged, as measured by wells specified on the permit, at intervals specified on the permit (where applicable); and

    c. the salinity and other specified chemical components of the water drained or discharged into a well, as well as the receiving native groundwater (as determined on a case by case basis).

    Additional authorisations may be required under the *Environment Protection Act 1993.*

7.13 Water Affecting Activities

The Landscape Act states that a person must not undertake the following activities, amongst other activities, contrary to a water allocation plan or a water affecting activities control policy that applies in relation to the area in which the activity is to be undertaken[63]:

- using water in the course of carrying on a business in a landscape management region at a rate that exceeds the rate prescribed by a water allocation plan or a water affecting activities control policy if the water has been brought into the region by means of a pipe or other channel; or
- using effluent in the course of carrying on a business in a landscape management region at a rate that exceeds a rate prescribed by a water allocation plan or a water affecting activities control policy.

For the purposes of section 104(3)(e) of the Landscape Act, the above mentioned activities are activities for which a permit is required to be issued in accordance with this Plan.

64. For the purposes of this Plan, a water affecting activities imported water or effluent water permit is not required, except where imported or effluent water is applied to land at a rate exceeding 1 ML per hectare per year.

65. Subject to principle 64, a water affecting activity permit to authorise the use of imported or effluent water within the prescribed areas will only be issued if:

[63] Section 104(4)(i) and 104(4)(j) of the *Landscape Act*

a. the salinity of the imported or effluent water applied to land does not exceed the salinity levels of the groundwater in the surface aquifer beneath the site of application;

b. the application of imported or effluent water will not cause a rise in the groundwater level sufficient to detrimentally affect structures or ecosystems;

c. the application of imported or effluent water will not adversely affect the quality of the groundwater resource; and

d. the application of imported or effluent water will not cause unacceptable impacts to the productive capacity of the land, including waterlogging, perched water tables or soil contamination.

8 Monitoring, Evaluation, Reporting and Improvement

Section 53 of the Landscape Act requires a water allocation plan to provide for regular monitoring of the capacity of the resource to meet the demands for water on a continuing basis. Section 54 of the Landscape Act requires that this Plan be reviewed on a comprehensive basis at least once every 10 years. This must include a review of the success of this Plan after considering the outcomes sought to be achieved by this Plan[64]. Additionally, there must be an assessment of whether this Plan remains appropriate or requires amendment[65].

This Plan will be complemented by a Monitoring, Evaluation, Reporting and Improvement Plan, which will develop a comprehensive program aimed at measuring and assessing hydrogeological, ecological and water use parameters, the analysis of which will result in an ability to:

- monitor the capacity of the resource; and
- evaluate the success and appropriateness of this Plan.

The Monitoring, Evaluation, Reporting and Improvement Plan will specify detail regarding the purpose, scope and timing of the monitoring, evaluation and reporting activities relevant for this Plan.

8.1 Monitoring of the Capacity of the Resource

The principles in this Plan are based on maintaining the condition of groundwater resources within their defined resource condition limits, previously described in sections 2.7 and 6.4 of this Plan. Maintaining the groundwater resources within their resource condition limits should result in the ecosystems that depend on the resources being maintained at a low level of risk, whilst also ensuring that existing users are able to continue to access water in the same manner as they have previously and that the cultural value of water is maintained. These resource condition limits represent a state beyond which there is a risk of unacceptably high impacts on the physical condition of groundwater. To ensure the groundwater resources are maintained within these resource condition limits, regular monitoring of the resource is required to enable management responses to be initiated should the groundwater resource decline towards these resource condition limits.

8.1.1 Water level and salinity monitoring

Descriptions of the current monitoring networks at the time of writing this Plan are presented below. It should be noted that the number and location of observation wells in any network may change during the life of this Plan due to a number of factors, including physical access, well construction issues and new groundwater extractions. The monitoring requirements may be reviewed on an as needs basis depending on these factors. Any review of monitoring requirements must aim to maintain monitoring at a spatial and temporal scale sufficient to enable the assessment of the change in water levels and salinities of the groundwater resources within the Adelaide Plains.

[64] Section 54(2)(a)(ii) of the *Landscape Act*
[65] Section 54(2)(b) of the *Landscape Act*

Monitoring of the resource will be tailored through the development of the Monitoring, Evaluation, Reporting and Improvement Plan to ensure that the monitoring undertaken is sufficient to address the key evaluation questions outlined in the Monitoring, Evaluation, Reporting and Improvement Plan.

8.1.1.1 Monitoring of artesian conditions across the Adelaide Plains

The Department, with the cooperation of a number of Managed Aquifer Recharge scheme operators, has installed telemetered data loggers in 26 wells across the Adelaide Plains to determine the spatial extent of artesian conditions during variable recharge years. The installation of telemetered data loggers will determine the best timing for monitoring in non-telemetered wells to capture artesian conditions. It will also allow Managed Aquifer Recharge operators to assess groundwater pressure levels in real time and adapt operations as needed if flowing wells are identified.

8.1.1.2 Northern Adelaide Plains Prescribed Wells Area

As at January 2021, the groundwater observation network for the Northern Adelaide Plains Prescribed Wells Area (including the Kangaroo Flat region) contained 128 observation wells monitored at six monthly intervals for water level, in addition to 18 wells monitored annually for salinity.

While the existing salinity monitoring network is sufficient to oversee changes in regional salinity throughout the Northern Adelaide Plains Prescribed Wells Area, salinity samples may be required to be collected by water users in the Kangaroo Flat region. This is to monitor the heightened risk of salinity increases due to the downward movement of more saline water from the overlying aquifer given the absence of a confining layer.

8.1.1.3 Dry Creek Prescribed Wells Area

Given the small area of the Dry Creek Prescribed Wells Area (0.086 km^2) there is not a specific monitoring network dedicated to monitoring the groundwater level and salinity within this region. Rather it is considered that the trends in groundwater water level and salinity collected from monitoring wells located within the Northern Adelaide Plains Prescribed Wells Area and the Central Adelaide Prescribed Wells Area will provide an overview of the groundwater trends within the Dry Creek Prescribed Wells Area.

8.1.1.4 Central Adelaide Prescribed Wells Area

Groundwater monitoring is mainly concentrated in areas of high groundwater use from the sedimentary aquifers beneath the Metropolitan Area (Adelaide Plains Sub-basin and Golden Grove Embayment) and the fractured rock aquifer in the One Tree Hill area. Very little monitoring has been carried out elsewhere due to the low groundwater demand.

As at January 2021, the groundwater observation network for the Central Adelaide Prescribed Wells Area contained 118 observation wells monitored at six monthly intervals for water level in addition to 36 wells monitored annually for salinity.

8.1.2 Monitoring of water levels in high risk consumptive pools

Continued monitoring of specific wells is required for the T1 Northern Adelaide Plains and T2 Northern Adelaide Plains Consumptive Pools, where the volume of existing allocations at the commencement of this Plan, if fully utilised, presents a risk to the condition of the resource. Monitoring will be continued in these zones to determine when specific management responses are required. Monitoring data will be compared to

the resource condition triggers defined in section 6.4. Groundwater levels will be measured at the end of winter (August – September) to determine the maximum recovery of groundwater levels[66]. The wells to be monitored for this purpose are outlined in Table 8.1.

Table 8.1. Monitoring wells for high-risk consumptive pools

Consumptive Pool	Monitoring Well	Unit Number
T1 NAP	PTA161	6628-18881
	PTA095	6628-19179
	PTA111	6628-20136
	MPA152	6628-20327
	PTA051	6628-19717
	PTA093	6628-18942
T2 NAP	MPA144	6628-18397
	MPA158	6628-20735
	PTA091	6628-16257
	PTA082	6628-13920
	MPA159	6628-20736

If any of these wells become unavailable for monitoring purposes for reasons described earlier, the nearest suitable observation well may be chosen as a replacement.

8.1.3 Monitoring water use from the groundwater resources

The Department will keep a record of the licensed groundwater extractions from the Adelaide Plains in the State Water Register. For the Northern Adelaide Plains Prescribed Wells Area, water use data has been recorded since the 1970's, with water use data recorded since 1999 for the Kangaroo Flat area and since 2013 for the Dry Creek Prescribed Wells Area. Some water use data collection commenced for the Central Adelaide Prescribed Wells Area in the 2019-20 water-use year and once all the water licences are issued to existing users within the Central Adelaide Prescribed Wells Area, all licensed water use will also be recorded in the State Water Register.

Additionally, volumes of the groundwater drained or discharged and extracted from Managed Aquifer Recharge schemes has historically been reported to the Department and this will continue to occur under this Plan.

8.2 Evaluating the Success and Appropriateness of this Plan

This section outlines a Monitoring, Evaluation, Reporting and Improvement framework to inform a comprehensive review of the success and appropriateness of this Plan as required by section 54 of the Landscape Act. This framework is intended to inform the development of a more detailed Monitoring, Evaluation, Reporting and Improvement Plan which will cover:

- a framework to measure and evaluate the success of this Plan at achieving its objectives; and

[66] Department for Environment and Water (2021). Investigating the use of resource condition trigger levels for groundwater management in the Adelaide Plains Water Allocation Plan, DEW Technical Report 2021/13, Government of South Australia, Department for Environment and Water, Adelaide.

- a framework for assessing whether this Plan remains appropriate or requires amendment.

8.2.1 Review of this Plan

A comprehensive review of this Plan must occur at least once in the 10 years following approval. Under normal circumstances it is proposed that the review should occur towards the end of the 10-year period.

A review may be undertaken earlier in response to observed changes in resource condition or changes in legislation or for any other reason. An early review may be targeted to address any specific issues that have been identified.

The review aims to evaluate the effectiveness and appropriateness of this Plan consistent with the requirements of the Landscape Act. The outputs of the review are decisions regarding the need for amendments. The key evaluation questions to be addressed by the review include:

1. To what extent has this Plan been successful in achieving its objectives?
2. To what extent has the implementation of the policies and principles in this Plan been effective in contributing to the objectives?
3. To what extent does this Plan remain appropriate or require amendment?

The evaluation of the appropriateness of this Plan (key evaluation question 3) should be informed by the evaluation of the success and effectiveness of this Plan (key evaluation questions 1 and 2). Therefore, the review is undertaken in two stages, with the first stage focused on effectiveness and success and the second stage addressing the appropriateness of this Plan and the need for amendment. A Monitoring, Evaluation, Reporting and Improvement Plan will be developed to set out how these evaluation questions will be addressed.

8.2.1.1 Stage 1 Evaluation – success and effectiveness of this Plan

A Monitoring, Evaluation, Reporting and Improvement Plan to address the success of this Plan and the effectiveness of its principles should include:

- a program logic showing the rationale for how this Plan is anticipated to succeed in achieving its objectives;
- the assumptions that underpin the achievement of the objectives;
- the suggested lines of evidence, including monitoring; and
- the evaluation method.

Program logic and assumptions inform the scope of the evaluation process and the evidence required.

8.2.1.2 Stage 2 Evaluation – appropriateness and need for amendment

Evaluation to address key evaluation question 3 (appropriateness) will be based on a forward-looking assessment as it must have regard for potential future scenarios regarding use and resource capacity. Therefore, a risk-based approach is appropriate. To implement such an approach, the Monitoring, Evaluation, Reporting and Improvement Plan will cover the following steps consistent with the Department's guidelines for a risk-based review to water allocation plans as follows:

- Establish context
- Risk assessment:
    - Risk identification

    - Risk analysis
    - Risk evaluation
- Risk treatment.

Criteria for the risk assessment will be based on the likelihood and consequences of deviation from the objectives for groundwater resource management. The risk assessment should measure the risks associated with a continuation of the existing, un-amended Plan – i.e. a "business as usual" scenario. In this way, it provides an argument for amendments based on the level of risk identified at the time.

The risk treatment step considers the question of whether amendments are needed to ensure that risks to groundwater resources and community and environmental values are managed at an acceptable or tolerable level.

The Monitoring, Evaluation, Reporting and Improvement Plan will establish a framework for determining the need to amend this Plan based on the level of risk. The framework is likely to specify that high risks must be treated, while the decision to treat other risks (medium and low) should have regard for the benefits relative to the costs of treatment. Benefits of treatment can be ascertained by assessment of residual risk, which considers the anticipated effectiveness of the proposed Plan amendment for treating risk.

The review of this Plan (Stage 1 and 2 evaluations) should be documented in a public report and, if deemed necessary, this Plan will be amended following the risk assessment.

9 Consistency with other Plans and Legislation

This Plan was developed under the *Landscape South Australia Act 2019* and with regard to the following Acts and Agreements:

- *Environment Protection Act 1993* and related policies
- *Mining Act 1971*
- *Native Vegetation Act 1991*
- *Planning, Development and Infrastructure Act 2016* and related development plans
- *Intergovernmental Agreement on a National Water Initiative*, Council of Australian Governments 2004
- *Native Title (South Australia) Act 1994*
- *Aboriginal Heritage Act 1988*
- Relevant plans of management under the *National Parks and Wildlife Act 1972*

Units of Measurement

km^2 = Square kilometres

kL = Kilolitre (1000 litres)

L/s = Litres per second

m = Metre

mg/L = Milligrams per litre

ML = Megalitre (1,000,000 litres)

ML/y = Megalitres per year

GL = Gigalitre (1,000 megalitres)

Shortened Forms

DEW – Department for Environment and Water

The Plan – Adelaide Plains Water Allocation Plan

Glossary

Aboriginal people: Descendants of the original inhabitants existing in a land from the earliest times or from before the arrival of colonists. The term 'Aboriginal' is applied throughout this Plan instead of "Indigenous" as endorsed by the former SA Aboriginal State-wide Advisory Committee.

Allocation: See Water Allocation.

Aquifer: An underground layer of rock or sediment that holds water and allows water to percolate through.

Aquitard: A layer in the geological profile that separates two aquifers and restricts the flow between them.

Available balance: The total volume of water drained or discharged under a permit issued pursuant to either section 104(3)(c) of the Landscape Act or an environmental authorisation issued under section 40(1) of the *Environment Protection Act 1993* throughout the life of the scheme's operation, minus any volume that has subsequently been extracted. Also known as a recharge water access entitlement.

Buffer zone: An area within which certain management objectives exist in order to protect a specific water resource or groundwater-dependent ecosystem, as outlined in Table 7.2 and Table 7.3.

Consumptive pool: The water that will from time to time be taken to constitute the resource within a particular part of a prescribed water resource for the purposes of Part 8 of the Landscape Act, as determined by this Plan.

Consumptive use: Licensed and non-licensed water use for the purposes of Part 8 of the Landscape Act.

Date of approval: The date that the Minister approves this Plan (which may be different to the date that the Plan becomes operational).

Decommissioning: The permanent closure of a well no longer in use.

Department: The administrative unit designated from time to time, by the Minister, by notice in the South Australian Government Gazette as being the Department primarily responsible for assisting the Minister in the administration of the Landscape Act (at the date of approval of this Plan it is the Department for Environment and Water).

Designated day: The day upon which licences are unbundled in relation to sections 88 and 102(1) of Schedule 5 of the Landscape Act.

Domestic purpose: As per the Landscape Act being "*In relation to the taking of water, domestic purpose 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 (b) without limiting paragraph (a) – taking water for the purpose of watering or irrigating more than 0.4 of a hectare of land; or (c) taking water to be used in carrying on a business (except for the personal use of persons employed in the business.*"

Effluent: Domestic or industrial wastewater.

Entitlement shares: The individual shares which comprise a water access entitlement within a particular consumptive pool. The entitlement shares are valued at 1 kilolitre per share except where entitlement shares issued in relation to the T1 Northern Adelaide Plains Consumptive Pool or the T2 Northern Adelaide Plains Consumptive Pool have been varied in accordance with principles 21 to 29 of this Plan.

Existing user: A person who held a water licence under the previous Northern Adelaide Plains Prescribed Wells Area Water Allocation Plan, or was considered an existing user of the resource under section 155 of the Landscape Act or holds a water licence in relation to the Dry Creek or Central Adelaide Prescribed Wells Areas.

First flush water: The initial surface runoff from a rain event. During this phase, water pollution is typically more concentrated when compared to the remainder of the rain event.

Groundwater: Water occurring naturally below ground level or water pumped, diverted and released into a well for storage underground.

Groundwater-Dependent Ecosystem: An ecosystem that requires access to groundwater, on a permanent or intermittent basis, to meet all or some of its water requirements to maintain the community of plants and animals, and the ecological processes and ecosystem services they provide.

Groundwater extraction: The process of taking water from an underground source, either temporarily or permanently.

Groundwater Prohibition Area: A Groundwater Prohibition Area declared by the Environment Protection Authority, or an area declared as an Assessment Area by the Environment Protection Authority for investigation of identified groundwater contamination.

Hydraulic gradient: In unconfined groundwater, the mean watertable gradient in the direction of groundwater flow. In confined aquifers, the pressure gradient in the direction of flow.

Hydrogeology: The study of groundwater, which includes its occurrence, recharge and discharge processes and the properties of aquifers.

Imported water: Water which has been brought into the prescribed area by means of a pipe or other channel, and the water (including surface water) has been extracted and piped, or directed into a channel, under licence or permit under the Landscape Act. Imported water excludes water that would have, prior to diversion, formed part of the water balance of the prescribed groundwater resource.

Landscape Act (the): The *Landscape South Australia Act 2019*.

Licence: see 'water licence'.

Licensed purposes: The purposes for taking water, for which a water allocation is required to take water under the Landscape Act, including the taking of water for stock and/or domestic purposes in the Northern Adelaide Plains Prescribed Wells Area.

Licensee: A person or entity who holds a water licence pursuant to section 121 of the Landscape Act.

Low level of risk: The combination of the likelihood and consequences of an event such that the probability of not meeting the environmental objectives are deemed acceptably low, according to a set risk criteria

m AHD: Defines elevation in metres (m) according to the Australian Height Datum (AHD); 0 m AHD is approximately mean sea level.

Managed Aquifer Recharge (or draining or discharging): The intentional draining or discharging of water to aquifers for subsequent recovery and use or for environmental benefit.

Managed Aquifer Recharge scheme: An enterprise operated by a legal entity which is licensed or authorised under either the Landscape Act, or the *Environment Protection Act 1993*, to undertake the intentional draining or discharging of water into aquifers for the purposes of either subsequent recovery, disposal of water or environmental benefit.

Managed Aquifer Recharge well: An operational well into which a person is authorised to drain or discharge water as part of a Managed Aquifer Recharge scheme.

Maximum annual recovery volume: A volumetric limit stipulated as a condition on a recharge water licence which limits the volume of water which may be taken in a single water use year.

Megalitre (ML): one million litres.

Minister: The Minister responsible for the administration of the Landscape Act.

Monitoring: The systematic measurement of variables and processes over time to address a clearly defined set of objectives.

Monitoring purposes: For the purposes of monitoring the groundwater resource, including water level/pressure or salinity. Excludes any purpose which requires the taking of water, such as aquifer pump tests.

Native groundwater: Water occurring naturally below ground level that exists in the relevant aquifer (i.e. absent of any water drained or discharged into that aquifer by artificial means).

New well: Either a newly drilled or existing well which has not previously been authorised for the taking of water on a licence this Plan

Non-consumptive use: Water for maintaining natural processes, including but not limited to aquifer throughflow and discharge, and water for groundwater-dependent ecosystems.

Non-licensed purposes: The taking of groundwater for a purpose for which a water allocation is not required under the Landscape Act.

Operational well: A well that is used, or is able to be used, to supply water for consumptive use; is known to the Department; and is owned by the existing owner or another party.

Person: As per the *Acts Interpretation Act* 1901 being *"expressions used to denote persons generally (such as "person", "party", "someone", "anyone", "no-one", "one", "another" and "whoever"), include a body politic or corporate as well as an individual*".

Potentiometric surface: The level to which water rises in a well due to the water pressure in the aquifer, measured in metres above sea level.

Prescribed well: A well declared to be a prescribed well under section 101 of the Landscape Act.

Prescribed Wells Area: An area of land within which wells are prescribed.

Recharge water: Water that has been intentionally drained or discharged into an aquifer.

Recharge water access entitlement: A water access entitlement issued in relation to the Managed Aquifer Recharge Consumptive Pool based on the 'available balance', where the 'available balance' takes into account the total volume of water drained or discharged under a permit issued pursuant to either section 104(3)(c) of the Landscape Act or an environmental authorisation issued under section 40(1) of the *Environment Protection Act 1993* throughout the life of the schemes operation, minus any volume that has subsequently been extracted. Also known as the available balance.

Recharge water allocation: A water allocation obtained on account of a recharge water access entitlement. The volume of water allocated in any given water use year shall be the lesser of a) the 'available balance' or b) the 'maximum annual recovery volume' of water authorised to be taken per water use year as a condition on the water licence.

Recharge water licence: A water licence issued for the recovery of water previously drained or discharged into a well in accordance with a permit under either section 104(3)(c) of the Landscape Act in accordance section 7.12 of this Plan or an environmental authorisation issued under section 40(1) of the *Environment Protection Act 1993*. The licence will relate to the Managed Aquifer Recharge Consumptive Pool.

Same spatial extent as the corresponding native groundwater consumptive pool: Within the consumptive pool boundaries for the corresponding non-managed aquifer recharge consumptive pool of the same aquifer and location, in relation to the site of draining or discharging.

Stock water use: The taking of water to provide drinking water for stock other than stock subject to intensive farming.

Throughflow: Shallow groundwater flow through a soil sub-parallel to a hillside. If the underlying rock is reasonably permeable, then the infiltrated water percolates vertically, and there is no throughflow.

Unacceptable impact: An impact, or likely impact, upon the groundwater resource due to the taking of water, which exceeds the thresholds specified in the principles within this Plan or which is likely to negatively impact upon groundwater-dependent ecosystems or existing users of the resource.

Undesired impact: An impact due to the taking of water which would present a moderate, high or extreme level of risk to the present and future health and maintenance of ecosystems that depend on water from the consumptive pool; or would adversely affect the reliability of supply or the quality of water accessed by existing users of water in the consumptive pool or from any other consumptive pool.

Unallocated water: any entitlement shares available within a consumptive pool that have not yet been granted on a water access entitlement.

Unconfined aquifer: An aquifer in which the upper surface has free connection to the ground's surface and the water surface is at atmospheric pressure.

Water access entitlement: An entitlement to the holder of a water licence to gain access to a share of water available in the consumptive pool or pools to which the licence relates as per section 121(2) of the Landscape Act, as specified by the licence and after taking into account any factors specified by the relevant water allocation plan or prescribed by the regulations.

Water allocation: The water obtained on account of a water access entitlement under a water licence as per section 127(1)(a) of the Landscape Act. A water allocation may also be obtained by a person, whether or not the person is a holder of a water licence, on the basis of a transfer of a water allocation that has been provided by the Minister under the terms of a water licence as per section 127(2)(b) of the Landscape Act. A water allocation will relate to a specified period of no more than 12 months as per section 127(8) of the Landscape Act.

Water allocation plan: A plan prepared under Part 4 Division 2 of the Landscape Act.

Water licence: A licence granted by the Minister under section 121 of the Landscape Act that provides the holder with a water access entitlement, which entitles the holder to gain access to a share of the water available for allocation in the consumptive pool as per section 121(2) of the Landscape Act.

Water management authorisation: a water licence; or a water access entitlement; or a water allocation; or a water resource works approval; or a site use approval.

Water-use year: A water use year runs from 1 July to 30 June in the following calendar year.

Well: As defined by the Landscape Act, 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; and/or (c) a natural opening in the ground that gives access to underground water*.

Winter groundwater pressure level: The pressure level to which the groundwater in a confined aquifer will rise post the winter recovery period but prior to the commencement of the irrigation season. Usually measured in early spring (September – October).

Zone of influence: The area around a pumped well in which there is detectable drawdown due to the taking of water.